Meta Imaging Series® Software
MetaMorph® Software
Visual Basic Reference Guide

Version 7.6.5 for
Microsoft Windows XP
and Microsoft Windows Vista

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Chapter 1 – Introduction

1.1 Overview

Introduction

Welcome to the Visual Basic Reference Guide for the MetaMorph® software for image processing and analysis, and the Meta Imaging Series® software system. This manual has been designed to serve as a working reference for the use of the extended set of Visual Basic programming functions by the Run User Program drop-in command in the MetaMorph® software. The Run User Program command, located in the File menu, provides you with the ability to run your own Visual Basic programs from within the MetaMorph program. This will allow you to process and analyze images with greater flexibility.

The full power of Microsoft Visual Basic is available to you, with the ability to run conditional "If…Then…Else" routines, to create nested subroutines and loops, and to pass and return values with the imaging system. It is assumed that you already have a working knowledge of Visual Basic and its application. This manual describes the extended set of programming functions that MetaMorph provides, and is intended to serve as a supplement to any Visual Basic references that you may already have.

Note: The following versions of Microsoft Visual Basic can be used to create programs to run in version 7.0 of the MetaMorph software:

- Microsoft Visual Basic .NET 2008 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2005 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2003 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2002 Professional or Enterprise editions
- Microsoft Visual Basic 6.0 Professional or Enterprise editions
- Microsoft Visual Basic 5.0 Professional or Enterprise editions

Note that the Standard and Express editions of the above versions are NOT supported.

Structure of this manual

This *Reference Guide* starts with some fundamental concepts about Visual Basic user programs and the Run User Program command. The rest of this manual is devoted to a description of the extended set of functions available for use in MetaMorph. Each entry starts with a short description of what the function does. The full syntax of the expression is given, and the involved parameters and returns are explained. For many entries, a “See Also” list of related or otherwise relevant functions is provided. For the most part, these functions will be in the same section of the manual as the function being described. For those located elsewhere in the manual, the pertinent section will be given in parentheses.

The chapters in this guide are roughly arranged in the order that you might expect to use them through the course of an experiment and thereafter:

- Chapter 1 describes how to install the RUNUSER drop-in and create your own user programs with Microsoft Visual Basic.
- Chapter 2 describes functions that are used to communicate with serial or digital devices.
- Chapter 3 covers execution of commands and journals.
- Chapters 4 and 5 deal with the use of image windows and adjusting their display.
- Chapter 6 concerns thresholding and performing basic densitometric procedures.
- Chapter 7 describes how to work with regions of interest.
- And finally, Chapter 8 ends the manual with a description of the morphometric functions that are available.

Continued on next page

1.1 Overview, continued

In this chapter

This chapter contains the following topics:

Topic	See Page
Conventions Used in This Manual	4
The Run User Program Command	6
Visual Basic and User Programs	8
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Data Types and Arrays	18

1.2 Conventions Used in This Manual

Introduction

Before we proceed, it may be useful first to define some of the terms used in this manual and to review some of the typographical conventions that are used.

Some definitions

Array A multidimensional (usually one- or two-dimensional) "table" that stores values. For example, you can define an array and read into it the X and Y coordinates of an object's outline by using the **MorphGetVertexList** function. In Visual Basic, you can declare arrays of up to 60 dimensions. (See Section 1.6, *Data Types and Arrays*.)

Boolean In its widest sense, this is a logical operand such as AND, OR, or NOT. When used to describe a variable, a Boolean indicates a logical state, such as TRUE or FALSE. As integers, FALSE is represented by 0 and TRUE is represented by -1 or some other nonzero value.

Double A double-precision (64-bit) floating-point number that encodes the value of a variable. Numbers can range from approximately -1.8×10^{308} through -4.9×10^{-324} for negative values and 4.9×10^{-324} through 1.8×10^{308} for positive values.

Function A programming "command" that carries out some procedure. For example, the **PrintMsg** function prompts MetaMorph to display a message box that you have previously configured.

Handle An index number used by the program to deal with and keep track of images, image windows, functions, regions of interest, and MetaDevices.

Integer In Visual Basic, a 16-bit binary signed (negative or positive) whole number that encodes the value of a variable. Integers can range from -32,767 through 32,767.

Long A 32-bit signed whole number that encodes the value of a variable. Numbers can range from -2,147,483,647 through 2,147,483,647.

Parameter A value or an identifying element that is passed by the user to the program, such as the handle of an image you want to measure, or a set of coordinates that you want to use to position an image window.

Return value A value or state returned by the program in response to a query. For example, the upper and lower limits of a threshold range, expressed as integers, are the return values for the **GetThresholdRange** function.

Single A single-precision (32-bit) floating point number that encodes the value of a variable. Numbers can range from approximately -3.4×10^{38} through -1.4×10^{-45} for negative values and 1.4×10^{-45} through 3.4×10^{38} for positive values.

String A segment of alphanumeric text.

Variable A placeholder that represents something that is acted upon by a function. For example, the variable *nObjectID* is used to represent the object in an image that is to be deleted by the **MorphDeleteObject** function.

Variant A variable that is not explicitly assigned to a particular data type. Variants can store different types of data—integers, floating point numbers, or character strings—depending on the need at the time.

Continued on next page

Typographical conventions

The following table lists the typographical conventions used in the *Visual Basic Reference Guide*.

This:	Represents…
Italics	Variables Examples: *hImage*, *nXPos*
Bold	Functions Examples: **LoadImage**, **SetRegionSize**
ALL CAPITALS	Returned or passed states or Booleans Examples: EXCLUSIVE, TRUE

1.3 The Run User Program Command

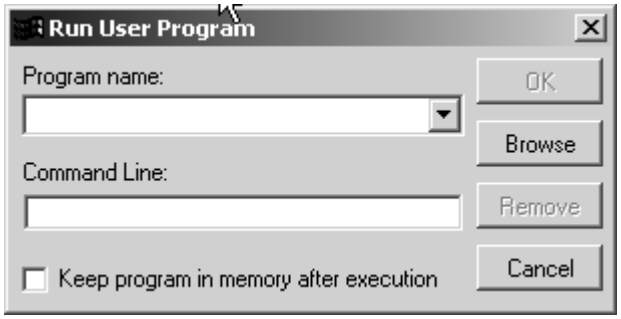
Installing the RUNUSER drop-in

MetaMorph allows you to run Visual Basic functions by using the Run User Program drop-in command. As with all other drop-ins, you will need to use the Configure Drop-ins command in the Meta Imaging Series Administrator to load the RUNUSER drop-in prior to starting MetaMorph. This will place the Run User Program command in your File menu, below the Run Program command (don't confuse the two!).

The Run User Program dialog box

When you choose Run User Program from the File menu, a dialog box will appear which contains a drop-down list box, a text box, a check box, and four command buttons (see Fig. 1.1). This dialog box provides an interface from within MetaMorph for you to pass parameters to the user program which you will have written in Visual Basic.

Figure 1.1 The Run User Program Dialog Box



Run User Program dialog box options

Program Name

Contains a list of all of your user programs that are currently registered with the system. The entries in the list will be descriptions that were entered in Visual Basic when you created your program. If there is no description, the project name entered in Visual Basic will appear instead.

Command Line

This is a text field which will be passed to your user program as the parameter for the **Startup** and **DoCommand** functions (see Section 1.4). You might use this field, for example, to specify the name of an image that your program will then load, convolve with an image filter, threshold, measure, log measurement data from, and close.

Continued on next page

Run User Program dialog box options
(continued)

Keep Program in Memory After Execution
This check box determines whether your user program will stay in memory after running, or if it will be unloaded when the routine is completed. If you select the check box, the program will stay in memory, and will therefore run more quickly on subsequent runs. If you clear this check box, the program will be unloaded after running. This may be useful when you are debugging your program, as you can leave both MetaMorph and Visual Basic running at the same time, alternating between running your program and editing it. Visual Basic would not be able to recompile your program if the check box were still selected.

When the *Keep Program in Memory* check box is selected, the **Startup** function will be called the first time your program is run after being loaded. Subsequent runs will call the **DoCommand** function. When this check box is cleared, the **Shutdown** function will be called after the program finishes. If this check box is cleared before you run the program for the first time, the **Startup** and **Shutdown** functions will be called each time you run the program (see Section 1.4 for more about these three functions).

Browse
If the program you want to run does not appear in the *Program Name* list, this command button will allow you to search your system for it. This button opens the Select Start File dialog box, which is a standard file-selection dialog box that has a *Look In* drop-down list, Up One Level icon button, *File Name* text box, and a table that displays the files in the current folder.

When you create a user program, Visual Basic registers it with the system when it is compiled, and it should then be available in the *Program Name* list. However, if you obtain a program that was compiled elsewhere, it will not have been registered on your system. The *Browse* command button will register the program and insert it in the *Program Name* list.

NOTE- this only works for user programs created with Visual Basic 6 and earlier.

Remove
Choosing this button will remove the currently highlighted user program from the *Program Name* list and unregisters it with the system.

NOTE- this only works for user programs created with Visual Basic 6 and earlier.

OK
Loads the program selected in the *Program Name* list, passes the parameter you specify in the *Command Line* text box, runs the user program, and closes the Run User Program dialog box.

Cancel
Cancels any changes made in the Run User Program dialog box and closes it.

1.4 Visual Basic and User Programs

About user programs

A user program is essentially an ActiveX object that communicates with the MetaMorph application using Microsoft's object linking and embedding (OLE) interface. However, it is not necessary to be familiar with the details of this communication when using Microsoft Visual Basic, the language supported by the MetaMorph software to write user programs.

Note: The following versions of Microsoft Visual Basic can be used to create programs to run in version 7.0 of the MetaMorph software:

- Microsoft Visual Basic .NET 2008 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2005 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2003 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2002 Professional or Enterprise editions
- Microsoft Visual Basic 6.0 Professional or Enterprise editions
- Microsoft Visual Basic 5.0 Professional or Enterprise editions

Note that the Standard and Express editions of the above versions are NOT supported.

Variables and functions required by the MetaMorph software

To be recognized by the MetaMorph software, a Visual Basic user program must contain three variables, *MM*, *gParentWnd* and *gUserID*, and three functions, **Startup**, **DoCommand**, and **Shutdown**. There are several other more technical requirements, but these will be covered in the discussion of the use of specific versions of Visual Basic (Section 1.5).

The two variables, *gParentWnd* and *gUserID*, are of type Long, and *MM* is a variant:

MM

MM is a variant that is used for all of your communication with the MetaMorph software. For example, to put the handle of the current image in the MetaMorph software into the variable *sourceImage*, you would use the following:

```
Public     sourceImage As Long
      MM.GetCurrentImage sourceImage
```

gParentWnd

This will have the handle of the MetaMorph program's main window placed in it. It is primarily useful for languages other than Visual Basic which are not yet supported.

gUserID

This variable is for future expansion, so you won't be using it immediately, but it must be present nonetheless.

Continued on next page

Variables and functions required by the MetaMorph software software
(continued)

The three functions are **Startup**, **DoCommand**, and **Shutdown**.

Startup(*cmdLine* As String) As Long (or Integer)

This function is called when the program needs to be loaded into memory to run. *cmdLine* will contain the text entered in the *Command Line* text box of the Run User Program dialog box. **Startup** should return a value of 0 on success and a nonzero value on failure. The return value is currently ignored in MetaMorph, but in the future it may be used.

DoCommand(*cmdLine* As String) As Long (or Integer)

This function is called when the program is run after it has already been loaded into memory. *cmdLine* will contain the text entered in the *Command Line* text box of the Run User Program dialog box. **DoCommand** should return a value of 0 on success and a nonzero value on failure. As with the **Startup** function return, this return value is currently ignored in MetaMorph, but in the future it may be used. If your program behaves the same way whether it is already loaded or not, you may want to have **Startup** simply call **DoCommand**, and put the code that does the work in **DoCommand**.

Shutdown() As Long (or Integer)

This function is called when the user program is unloaded from memory. **Shutdown** should return a value of 0 on success and a nonzero value on failure. The return value is currently ignored in MetaMorph but in the future it may be used.

Continued on next page

Class modules

Note: the Class modules section below applies only to Visual Basic versions 5 and 6. It does NOT apply either version of Visual Studio .NET.

All of the above functions and variables must be in a Class Module named UserMethods.

To access the *MM* variable from other modules, you must declare a Public Variant in one of the other modules, and then in **Startup** and **DoCommand**, use **Set** to assign *MM* to that variable. For example, suppose your program consists of the Class Module UserMethods, and two regular Modules, Mod1 and Mod2:

```
Mod1:
      Public     pubMM As Variant

UserMethods:
      Public     MM as MMAppLib.UserCall

      Function   Startup(cmdLine As String) As Long
            DoCommand cmdLine
      End Function

      Function   DoCommand(cmdLine As String) As Long
            Set pubMM = MM

            Doit
      End Function

Mod2:
      Function   Doit
            Dim i As Long

            pubMM.GetCurrentImage i
      End Function
```

You see that *pubMM* is visible to the whole program. **Set** must be used for the assignment, since *MM* is a variant. If **Set** is not used, problems will occur.

1.5 Creating a User Program

Introduction

Note: The following versions of Microsoft Visual Basic can be used to create programs to run in MetaMorph 7.0:

- Microsoft Visual Basic .NET 2008 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2005 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2003 Professional or Enterprise editions
- Microsoft Visual Basic .NET 2002 Professional or Enterprise editions
- Microsoft Visual Basic 6.0 Professional or Enterprise editions
- Microsoft Visual Basic 5.0 Professional or Enterprise editions

Note that the Standard and Express editions of the above versions are NOT supported.

Note

One limitation of user programs written in Visual Basic versions 5 and 6 must be noted: because of the manner in which the programs run, the user will not be able to use non-modal dialog boxes. That is, you will be able to work in only one command dialog box at a time. Any attempt to run a program with non-modal dialog boxes will return an error message from the Visual Basic runtime controller.

Visual Studio .NET enables the use of non-modal dialog boxes; however, their use has not been tested with the MetaMorph software and they are not supported by Molecular Devices. Use at your own risk.

Creating a user program with Visual Basic .NET

To create the framework for a user program using Microsoft Visual Basic .NET, use one of the procedures presented in the following tables.

Table 1.1 Creating a User Program with Visual Basic .NET 2005 or 2008

Step	Action
1	Open Visual Studio and create a new project of type Visual Basic: Class Library.
2	Select My Project in the Solution Explorer Select the App Tab and Press “Assembly Info” button Check off “MakeAssemblyCom – visible Press OK
3	Select the References Tab and click “Add” button Select COM Tab. Find the MetaMorph Type Library and select it. Press OK - Adds MetaMorph to the Reference List
4	In the Solution Explorer, choose the project and right click on it Choose Add > New Item Choose “module” and click Add
5	Add the code in Figure 1.2 (below) to Module1.vb.
6	Add any code for your VB application.

7	If deploying this user program to multiple computers with MetaMorph, you must perform the following: 1. In Solution Explorer, highlight the solution, right click on it and choose Add > New Project 2. Find and choose “set up project” and press OK 3. Right click on the set up project and choose Add > Project Output 4. Choose the name of your project from the drop down menu 5. Select Primary Out from the list in the window 6. Choose Configure > Release 7. Press OK
8	From the list of Detected Dependencies, choose “mmapp.exe” and right click on it. Select “Exclude”
9	Under the Build menu, select Build Solution. Once the program has been compiled without any errors, it is ready to be run from the MetaMorph application

Note

The default condition for .NET 2005/2008 for Assembly Name and Root Namespace MUST be the same as the project name. DO NOT CHANGE these names or this will not work with the MetaMorph application.

Table 1.2 Creating a User Program with Visual Basic .NET 2002 or 2003

Step	Action
1	Open Visual Studio and create a new project of type Visual Basic: Windows Application.

2	Add the following lines to the AssemblyInfo.vb file:
	`<Assembly: ComVisible(True)>`
	`<Assembly: ClassInterface(ClassInterfaceType.AutoDual)>`

3	From the Project menu, choose Properties, and go to the General pane in the window that appears (it should start with the General pane automatically).

4	Bring up the properties for the project, select *Common Properties, General*. Under Output Type, select *Class Library*. Under Root Namespace, type in the name you want to appear in MetaMorph in the Run User Program dialog for your project.
	
	Note that if you are running Visual Basic.NET Standard Edition, you will not have a Class Library option. In this case, close Visual Studio, and open the folder that contains your project. Find the file with the .vbproj extension and edit it using Notepad. Change the line that says
	
	`OutputType = “WinEXE”` to `OutputType = “Library”`
	
	Change the line that says
	
	`StartupObject = “YourApplicationName.YourFormName”` to `StartupObject = “”`
	
	Save the changes and close the file. Now start up Visual Studio again and continue with these steps.

5	Bring up the properties for the project, select Configuration Properties, then Build. Check the *Register for COM Interop* checkbox.

6	On the Project menu, select Add Reference, select the COM pane, click the Browse button, and find your MMApp.exe file and select it. Then click *OK* to close the Add Reference window.
7	Add the code in Figure 1.2 (below) to Module1.vb.
8	Add any code for your VB application.
9	Under the Build menu, select Build Solution. Once the program has been compiled without any errors, it is ready to be run from MetaMorph

Figure 1.2 Module1.vb Code Addition

```
Option Strict Off
Option Explicit On

Public Interface IUserMethods
    Property mm() As MMAppLib.UserCall
    Property gParentWnd() As Integer
    Property gUserID() As Integer

    Function Startup(ByRef cmdLine As String) As Integer
    Function Docommand(ByRef cmdLin As String) As Integer
    Function Shutdown() As Integer
End Interface


<ComClass(UserMethods.ClassId, UserMethods.InterfaceId)> _
Public Class UserMethods
    Implements IUserMethods
    Private mygParentWnd As Integer
    Private mygUserID As Integer
    Public mymm As MMAppLib.UserCall

    Public Const ClassId As String = "832F34A5-5CF5-403f-B4A8-428C8351FD02"
    Public Const InterfaceId As String = "3D8B5BA4-FB8C-5ff8-8468-
11BF6BD5CF91"

    Property mm() As MMAppLib.UserCall Implements IUserMethods.mm
        Get
            Return mymm
        End Get
        Set(ByVal Value As MMAppLib.UserCall)
            mymm = Value
        End Set
    End Property
    Property gParentWnd() As Integer Implements IUserMethods.gParentWnd
        Get
            Return mygParentWnd
        End Get
        Set(ByVal Value As Integer)
            mygParentWnd = Value
        End Set
    End Property
    Property gUserID() As Integer Implements IUserMethods.gUserID
        Get
            Return mygUserID
        End Get
        Set(ByVal Value As Integer)
            mygUserID = Value
        End Set
    End Property

    Public Function Startup(ByRef cmdLine As String) As Integer Implements
IUserMethods.Startup
        Docommand(cmdLine)
    End Function

    Public Function Docommand(ByRef cmdLine As String) As Integer Implements
IUserMethods.Docommand
    End Function

    Public Function Shutdown() As Integer Implements IUserMethods.Shutdown
    End Function
End Class
```

Creating a user program with Visual Basic 5.0 or 6.0

To create the framework for a user program using Microsoft Visual Basic version 5.0 or 6.0, use the procedure presented in the following table.

Table 1.3 Creating a User Program with Visual Basic 5.0 or 6.0

Step	Action
1	Start the Microsoft Visual Basic program and create a new project by choosing New Project from the File menu.
2	For the type of project to create, select *ActiveX DLL*.
3	From the Project menu, choose Properties, and go to the General pane in the window that appears (it should start with the General pane automatically).
4	From the *Startup Object* drop-down list, select *Sub Main*.
5	In the *Project Name* text box, type the name you want to appear in MetaMorph when selecting a user program to run.
6	For *Project Description*, type the description that you want to appear in MetaMorph when selecting a user program to run. **Note:** The project description is not currently recognized by MetaMorph when using VB 5.0/6.0. MetaMorph will display the *Project Name* in the Run User Program dialog box.
7	Choose *OK*.
8	From the View menu, choose Properties Window.

Continued on next page

Creating a user program with Visual Basic 5.0 or 6.0 or 6.0
(continued)

Step	Action
9	In the Properties window that appears, • Set *Instancing* to *5 – MultiUse*, and • Set *(Name)* to *UserMethods*.
10	From the Project menu, choose References. Then find *MetaMorph Type Library* in the list and select its check box. If you don't see *MetaMorph Type Library*, choose the *Browse* button, select Files of Type Executable, navigate to your MetaMorph directory, and select MMAPP.EXE.
11	Once *MetaMorph Type Library* has been selected, you can choose Object Browser from the View menu and select *MMAppLib* from the top drop-down list. Then select *UserCall* from the Classes list and you will get a list of all the available functions in MetaMorph that you can call with the MM variable, along with their parameters. When you start to type the name of the object in the module window, a list will appear on the screen with all of the available functions for that object, along with their parameters.
12	In the Class Module UserMethods section, insert the code shown in Fig. 1.3, which follows this procedure.
13	From the Project menu, choose Add Module.

14	In the module you just inserted, add the following code:
	`Sub Main()`
	`End Sub`

Compiling the user program

That's the framework for your program. You can now add your personal code to the program, as described in Section 1.4. When you have finished, you are ready to compile your program. From the File menu, choose Make YourProjectName. You can select a name and location for your compiled program, but note that the name you select in this dialog will not be the name that you will use to reference your program in MetaMorph. In MetaMorph, your program will be referenced by the name or description you entered in the *Project Name* text box (Step 5 in table 1.2). Once the program has been compiled without any errors, it is ready to be run from MetaMorph.

Continued on next page

Figure 1.3 Class Module UserMethods Section Code

```
Option   explicit

Public   gUserID As Long
Public   gParentWnd As Long
Public   MM As MMAppLib.UserCall

Public   Function Startup(cmdLine As String) As Long

End Function

Public   Function DoCommand(cmdLine As String) As Long

End Function

Public   Function Shutdown() As Long

End Function
```

1.6 Data Types and Arrays

Introduction

Visual Basic functions in MetaMorph frequently make use of arrays to handle image pixel data, such as edgelist coordinates and intensity or color values. There is a complex interplay between the size of an array, the image bit-depth, and the type of data (Byte, Integer, or Long) being passed. The number of elements in the array and the range of data that can be stored will be determined by both the bit-depth of the image (1, 8, 16, or 24) and by the data type.

Data Types and Arrays

The following table indicates the number of elements in the array as a function of the image depth, data depth, and data type.

Table 1.3 Data Types and Arrays

Image Bit-Depth	Data Bit-Depth	Data Type	# Elements in Array
1	1	Byte	number of pixels / 8
		Integer	number of pixels / 16
		Long	number of pixels / 32
	8	Byte	number of pixels[1]
	16	Integer	number of pixels[2]
1	24	Long	number of pixels[3]
8	1	same as for 1-bit images[4]	
	8	Byte	number of pixels
	16	Integer	number of pixels
	24	Long	number of pixels[3]
16	1	same as for 1-bit images[4]	
	8	Byte	number of pixels[5]
	16	Integer	number of pixels
	24	Long	number of pixels[6]

Continued on next page

Data Types and Arrays
(continued)

Image Bit-Depth	Data Bit-Depth	Data Type	# Elements in Array
24	1	same as for 1-bit images[4]	
	8	Byte	number of pixels[7]
	16	Integer	number of pixels[7]
	24	Long	number of pixels

[1] Pixel values will be converted to 0 or 255.
[2] Pixel values will be converted to 0 or 65535.
[3] Each pixel's values will be packed into three bytes, but each of the 32-bit elements in the array will contain four bytes of data such that element one will contain the three values (red, green, blue) of pixel one and the first value of pixel two, the second element will contain the next two values for pixel two and the first two values of pixel three, and so on. Data from 1-bit (binary) images will be expressed as values of 0,0,0 or 255,255,255. Data from 8-bit images will be expressed as a triplet of the pixel value (Value,Value,Value). Data from 16-bit images will be expressed as a triplet of the low byte value of the pixel (Low,Low,Low).
[4] Pixel values will be converted to 0 or 1.
[5] Only the low byte of each pixel will be stored.
[6] Only the low byte from each of the three values (red, green, blue) will be stored.
[7] Only the intensity value will be stored. This value will be a numeric average of the red, green, and blue intensities.

Chapter 2 – Performing Serial and Digital I/O Communication

2.1 Overview

Introduction

Peripheral devices can be controlled from within MetaMorph by a number of user program functions. This chapter describes two types of functions used for communication with a peripheral device—those that send and receive data streams over a serial port and those that control a digital device.

In this chapter

This chapter contains the following topics:

Topic	See Page
Performing Serial Data Transmission	21
Communicating with a Digital I/O Device	26

2.2 Performing Serial Data Transmission

Introduction

You can control some devices such as VCRs by sending and receiving sequential streams of data over a serial port. A pair of Visual Basic functions, **SendSerialData** and **WaitForSerialData**, can perform the sending and receiving procedures. You will need to install the CUSTOMIO drop-in with the MetaMorph Drop-in Manager and to install and configure a Data Stream MetaDevice before you can take advantage of these two functions. This section describes the two functions, and provides a list of the syntax rules and a table of the serial command codes that are used for serial communication.

SendSerialData

Description

Carries out the Custom I/O: Send Serial Data command, which sends a sequential stream of data from the computer to another device via a serial port.

Syntax

SendSerialData(*sData* As String, *lTimeout* As Long, *bSendWithEcho* As Boolean) As Long

Remarks

This function is a shortcut to the "Send Serial Data" function of the MetaMorph CUSTOMIO drop-in, which provides control over devices that use Data Stream MetaDevices. **SendSerialData** runs without displaying a dialog box. The CUSTOMIO drop-in must be loaded for this function to run.

Parameters

sData Gives the string to be sent to the serial port.

lTimeout Specifies a maximum time, in seconds, that MetaMorph should wait if no echo has been returned before continuing.

bSendWithEcho Determines whether or not MetaMorph is to wait for an echo from the serial device before sending the next character and to warn you if the character is not received. If *bSendWithEcho* is set to TRUE, MetaMorph will wait until the device returns an echo, or until *lTimeout* seconds have transpired, whichever comes first. If *bSendWithEcho* is set to FALSE, MetaMorph will return immediately.

Example

```
' Send the string "TestString" to the serial port with a
' timeout of 5. Do not return until the string has been
' echoed or the timeout has expired.
MM.SendSerialData "TestString", 5, TRUE
```

See also:

WaitForSerialData

Continued on next page

WaitForSerialData

Description Carries out the Custom I/O: Wait for Serial Data command, which waits for a sequential stream of data from another device by way of a serial port.

Syntax **WaitForSerialData**(*sData* As String, *lTimeout* As Long, *bLogData* As Boolean, *sLogFormat* As String) As Long

Remarks This function is a shortcut to the "Wait for Serial Data" function of the MetaMorph CUSTOMIO drop-in, which provides control over devices that use Data Stream MetaDevices. It runs without displaying a dialog. The CUSTOMIO drop-in must be loaded for this function to run.

Parameters

sData Specifies the string from the serial port for which to wait.

lTimeout Specifies the number of seconds **WaitForSerialData** will wait for the string before returning.

bLogData Determines whether or not the received string will be written to a log file. If *bLogData* is set to TRUE and the string that is received matches the one specified in *sData*, the message that you specify with *sLogFormat* will be written to the log file (assuming it is open).

sLogFormat Specifies a message that will be sent to an open log file if the string that is received matches the one specified in *sData* and *bLogData* has been set to TRUE.

Example

```
' Wait for 10 seconds for the string "ok" from the serial port.
' Don't log it to the data file.
MM.WaitForSerialData "ok", 10, FALSE, ""
```

See also: **SendSerialData**

Continued on next page

Syntax rules for serial data transmission

Table 2.1 describes the syntax rules for the command codes used in serial communication. Be sure to consult Table 2.2 for the codes themselves.

Table 2.1 Syntax Rules for Serial Data Transmission

Code	Result
$	"Escape" character, which is ASCII 027 in decimal.
^A thru ^Z	"Control" character, which is ASCII 001 for ^A through ASCII 26 for ^Z.
\c	Sends the character after the slash. In this example, the character "c" would be sent. Useful for sending ^, \, or $ characters.
\ddd	Sends ASCII digits in decimal. EXAMPLE: \192.
\xdd	Sends ASCII digits in hexadecimal. EXAMPLE: \x27.
(dddd)	Delays for specified number of milliseconds. EXAMPLE: (1000)

Continued on next page

ASCII control codes

The following table provides the code strings used in serial communication.

Table 2.2 ASCII Control Codes

Hex	Dec	Key	Name	Description
00	0	^@	NUL	Null
01	1	^A	SOH	Start of Header
02	2	^B	STX	Start of Text
03	3	^C	ETX	End of Text
04	4	^D	EOT	End of Transmission
05	5	^E	ENQ	Inquiry
06	6	^F	ACK	Acknowledge
07	7	^G	BEL	Bell
08	8	^H	BS	Backspace
09	9	^I	HT	Horizontal Tab
0A	10	^J	LF	Line Feed
0B	11	^K	VT	Vertical Tab
0C	12	^L	FF	Form Feed
0D	13	^M	CR	Carriage Return
0E	14	^N	SO	Shift Out
0F	15	^O	SI	Shift In
10	16	^P	DLE	Data Link Escape
11	17	^Q	DC1	Device Control 1
12	18	^R	DC2	Device Control 2
13	19	^S	DC3	Device Control 3
14	20	^T	DC4	Device Control 4
15	21	^U	NAK	Negative Acknowledge
16	22	^V	SYN	Synchronous Idle

Continued on next page

ASCII control codes
(continued)

Hex	Dec	Key	Name	Description
17	23	^W	ETB	End Transmission Block
18	24	^X	CAN	Cancel
19	25	^Y	EM	End of Medium
1A	26	^Z	SUB	Substitute
1B	27		ESC	Escape
1C	28		FS	File Separator
1D	29		GS	Group Separator
1E	30		RS	Record Separator
1F	31		US	Unit Separator

2.3 Communicating with a Digital I/O Device

Introduction

MetaMorph allows you to control digital devices by sending and receiving TTL-level voltage signals through a parallel port or with the use of a digital I/O board. To do so with a user program, you will need to install the CUSTOMIO drop-in with the MetaMorph Drop-in Manager and to install and configure a Digital I/O MetaDevice.

DIGetFirst

Description

Obtains the handle of the first Digital I/O MetaDevice in the current list of Digital I/O MetaDevices.

Syntax

DIGetFirst(*hRetDevice* As Long) As Long

Return values

hRetDevice Returns the handle of the first Digital I/O MetaDevice in the current list. If there are no Digital I/O MetaDevices, *hRetDevice* will return a value of -1.

Example

```
' 'dev' will hold the device handle
Dim dev As Long

' get the handle of the first device and put it in 'dev'
MM.DIGetFirst dev
```

See also:

DIGetNext

DIGetIOStatus

Description

Determines whether a specified I/O line of the given device is an input line or an output line.

Syntax

DIGetIOStatus(*hDevice* As Long, *nLineNumber* As Integer, *nRetInOut* As Integer) As Long

Parameters

hDevice Specifies the handle of the device.

nLineNumber Specifies the number of the I/O line in question. This number will correspond to the pin number on the line's connector.

Return values

nRetInOut Returns a value corresponding to whether the specified line is an input line or an output line. If it is an input line, a value of 0 will be returned. If it is an output line, a value of 1 will be returned.

Continued on next page

DIGetIOStatus
(continued)

Example

```
Dim dev As Long
Dim inout As Integer

' Get the IO status of line 2 of a device and place it in
' 'inout'. 'dev' must have been previously obtained using
' DIGetFirst or DIGetNext
MM.DIGetIOStatus dev, 2, inout
```

See also: **DIGetFirst**, **DIGetLineCount**, **DIGetNext**

DIGetLineCount

Description Obtains the number of I/O lines for a given device.

Syntax **DIGetLineCount**(*hDevice* As Long, *nRetLines* As Integer) As Long

Parameters *hDevice* Specifies the handle of the device.

Return values *nRetLines* Returns the number of I/O lines.

Example

```
Dim dev As Long
Dim numLines As Integer

' Get the number of lines on a device and place it in
' 'numlines'. 'dev' must have been previously obtained using
' DIGetFirst or DIGetNext
MM.DIGetLineCount dev, numLines
```

See also: **DIGetFirst**, **DIGetNext**

Continued on next page

DIGetLineState

Description Obtains the state of a specified I/O line (Low vs. High).

Syntax **DIGetLineState**(*hDevice* As Long, *nLineNumber* As Integer, *nRetState* As Integer) As Long

Parameters *hDevice* Specifies the handle of the device.

nLineNumber Specifies the number of the I/O line in question. This number will correspond to the pin number on the line's connector.

Return values *nRetState* Returns a value corresponding to the state of the I/O line. If the line is Low, a value of 0 will be returned. If the line is High, a value of 1 will be returned.

Example

```
Dim dev As Long
Dim state As Integer

' Get the line state of line 1 of a device and place it in
' 'state'.  'dev' must have been previously obtained using
' DIGetFirst or DIGetNext.
MM.DIGetLineState dev, 1, state
```

See also: **DIGetFirst**, **DIGetNext**

DIGetName

Description Obtains the name of the MetaDevice whose handle you pass to it.

Syntax **DIGetName**(*hDevice* As Long, *sDeviceName* As String) As Long

Parameters *hDevice* Specifies the handle of the device.

Return values *sDeviceName* Returns the name of the selected MetaDevice. This will be given as a text string.

Example

```
Dim dev As Long
Dim name As String

' Get the name of a device and place it in 'name'. 'dev' must
' have been previously obtained using DIGetFirst or DIGetNext.
MM.DIGetName dev, name
```

See also: **DIGetFirst**, **DIGetNext**

Continued on next page

DIGetNext

Description Obtains the handle of the Digital I/O MetaDevice that follows the last one that was read (using either **DIGetNext** or **DIGetFirst**).

Syntax **DIGetNext**(*hRetDevice* As Long) As Long

Return values *hRetDevice* Returns the handle of the Digital I/O MetaDevice that follows the last one read. If there are no more Digital I/O MetaDevices, *hRetDevice* will return a value of -1.

Example

```
Dim dev As Long

' Get the third device and place it in 'dev'.

' Get the first device
MM.DIGetFirst dev
' Get the device after the first device (the second device).
MM.DIGetNext dev
' Get the device after the second device.
MM.DIGetNext dev
```

See also: **DIGetFirst**

SetDigitalIO

Description Carries out the Custom I/O: Set Digital I/O command, which controls a peripheral digital I/O device by sending signals to it from MetaMorph.

Syntax **SetDigitalIO**(*lBitsToSet* As Long, *lState* As Long) As Long

Remarks This function is a shortcut to the "Set Digital I/O" function of the MetaMorph CUSTOMIO drop-in. It runs without displaying a dialog box. The CUSTOMIO drop-in must be loaded for this function to run.

Parameters *lBitsToSet* Provides a 32-bit binary bit pattern that indicates which digital I/O lines will be active. For example, if bit 3 of *lBitsToSet* is set to 1, digital I/O line 3 will be enabled to write to the device. If it is set to 0, line 3 will be disabled from writing.

lState Provides a 32-bit binary bit pattern that sets the state (High vs. Low) of each I/O line identified by the bit pattern in *lBitsToSet*. To continue the preceding example, if bit 3 of *lState* is set to 0 and *lBitsToSet* has assigned a value of 1 to bit 3, this will set the line state for bit 3 to Low. If *lState* assigns a value of 1 to bit 3, this will set the line state for bit 3 to High. If *lBitsToSet* has assigned a value of 0 to bit 3, the setting of bit 3 for *lState* will be ignored, and the line state of bit 3 will be unaffected.

Continued on next page

SetDigitalIO
(continued)

Example

```
' Set bits 3 and 4 of the DIO lines High. 24 in binary is
' 00011000 and 255 is 11111111. Since the lState argument had
' ones in all the first 8 lines, it will set to High whichever
' of those lines were selected by the lBitsToSet argument.
MM.SetDigitalIO 24, 255
```

See also: **WaitForDigitalIO**

WaitForDigitalIO

Description Carries out the Custom I/O: Wait for Digital I/O command, which configures MetaMorph to wait for specific signals from a peripheral digital I/O device.

Syntax **WaitForDigitalIO**(*lBitsToRead* As Long, *lState* As Long, *lMilliseconds* As Long) As Long

Remarks This function is a shortcut to the "Wait for Digital I/O" function of the MetaMorph CUSTOMIO drop-in. It runs without displaying a dialog. The CUSTOMIO drop-in must be loaded for this function to run.

Parameters

lBitsToRead Provides a 32-bit binary bit pattern that indicates which bits in *lState* will be compared to data read from the I/O lines. For example, if bit 3 of *lBitsToRead* is set to 1, **WaitForDigitalIO** will not return until either digital I/O line 3 matches the state (High vs. Low) that has been set for bit 3 by *lState*, or until *lMilliseconds* have elapsed—whichever occurs first.

lState Provides a 32-bit binary bit pattern against which the state (High vs. Low) of each I/O line identified by the bit pattern in *lBitsToRead* will be compared. To continue the preceding example, if bit 3 of *lState* is set to 0 and *lBitsToRead* has assigned a value of 1 to bit 3, this will set the condition to wait until line 3 switches to Low. If *lState* assigns a value of 1 to bit 3, this will set the condition to wait for line 3 to switch to High.

lMilliseconds Specifies the number of milliseconds to wait before timing out.

Example

```
' Wait for bits 3, 4, and 7 to be High, Low, and Low,
' respectively. Timeout if this takes longer than 500
' milliseconds. 98 is 10011000 in binary, and 128 is 10000000.
MM.WaitForDigitalIO 98, 128, 500
```

See also: **SetDigitalIO**

Chapter 3 – Executing Commands and Journals

3.1 Overview

Introduction

Fundamental to the successful deployment of user programs is the ability to set variables and pass parameters to the functions, and then run the functions. Occasionally, you will need to determine a function's handle. You may also want to use message boxes to provide feedback while running or troubleshooting the program. This chapter describes the functions you will need for performing all of these procedures.

WARNING

The parts of the interface that are accessed through the **RunFunction**, **RunFunctionEx**, and **SetFunctionVariable** functions are subject to change. Care should be taken when considering whether to use them. These functions should be used only when there is no alternative way to accomplish your task. Because of this, and because of the great number of functions and variables, not all of the functions and variables that can be accessed through the **RunFunction** and **SetFunctionVariable** functions have been documented. Information for individual functions and their variables will be provided by e-mail on a case-by-case basis. Send inquiries to: **support.dtn@moldev.com** .

In this chapter

This chapter contains the following topics:

Topic	See Page
Executing Commands and Journals	32

3.2 Executing Commands and Journals

GetFunctionHandle

Description Obtains the handle of a specified function.

Syntax **GetFunctionHandle**(*sName* As String, *lRetFunctionHandle* As Long) As Long

Remarks You can use the function handles returned by this function when calling **RunFunctionEx** and **SetFunctionVariable**.

Parameters *sName* Supplies the name of the function.

Return values *lRetFunctionHandle* Returns the function handle.

Example

```
' Run the MetaMorph Deinterlace function on the image 'src'.
' Put the odd and even images in 'destOdd' and 'destEven'.
' 'src', 'destOdd', and 'destEven' should have been previously
' set to valid existing images.
Dim deinterHandle As Long
MM.GetFunctionHandle "Deinterlace", deinterHandle
MM.SetFunctionVariable deinterHandle, "imSource", src
MM.SetFunctionVariable deinterHandle, "imDestOdd", destOdd
MM.SetFunctionVariable deinterHandle, "imDestEven", destEven
MM.RunFunctionEx deinterHandle, 1

' Run Deinterlace again, this time using the current desktop
' image as the source. This time, use RunFunction to run the
' function instead of RunFunctionEx.
MM.GetCurrentImage src
MM.RunFunction "Deinterlace", 1
```

See also: **RunFunctionEx**, **SetFunctionVariable**

PrintMsg

Description Displays a configured message in a diagnostic window in MetaMorph.

Syntax **PrintMsg**(*sMessage* As String) As Long

Remarks This function is useful for the purposes of debugging. You can print diagnostics in a message box without pausing execution. The **SetPrintMsgSizeAndPosition** function allows you to set properties of the window in which the messages appear.

Continued on next page

PrintMsg
(continued)

Parameters

sMessage Specifies the message that is to appear in the message box.

Example

```
' Print the string "Hello" in the print message window. Place
' the window in the upper left corner of the screen and
' make it 100 pixels wide and 30 high.
MM.PrintMsg "Hello"
MM.SetPrintMsgWindowPositionAndSize 1, 1, 100, 30
```

See also:

SetPrintMsgSizeAndPosition

RunFunction

Description

Carries out the function named by the function name *sFunctionName* as if you had chosen it from a menu.

Syntax

RunFunction(*sFunctionName* As String, *nMode* As Integer) As Long

Remarks

This function differs from **RunFunctionEx** in its use of the function's name. **RunFunctionEx** uses the function's handle.

Parameters

sFunctionName Specifies the name of the function to be run.

nMode Determines the execution mode. If *nMode* is 0, the function will run normally. If *nMode* is 1, the function will run in journal playback mode—for most functions this means no user interface will be displayed.

Example

```
' Run the MetaMorph Deinterlace function on the image 'src'.
MM.GetCurrentImage src
MM.RunFunction "Deinterlace", 1
```

Continued on next page

RunFunctionEx

Description Carries out the function named by the function handle *lFunctionHandle* as if you had chosen it from the menu.

Syntax **RunFunctionEx**(*lFunctionHandle* As Long, *nMode* As Integer) As Long

Remarks This function differs from **RunFunction** in its use of the function's handle. **RunFunction** uses the function's name. Function handles are obtained for use with **RunFunctionEx** by calling **GetFunctionHandle**.

Parameters *lFunctionHandle* Specifies the handle of the function to be run.

nMode Determines the execution mode. If *nMode* is 0, the function will run normally. If *nMode* is 1, the function will run in journal playback mode—for most functions this means no user interface will be displayed.

Example

```
' Run the MetaMorph Deinterlace function on the image 'src'.
' Put the odd and even images in 'destOdd' and 'destEven'.
' 'src', 'destOdd', and 'destEven' should have been previously
' set to valid existing images.
Dim deinterHandle As Long
MM.GetFunctionHandle "Deinterlace", deinterHandle
MM.SetFunctionVariable deinterHandle, "imSource", src
MM.SetFunctionVariable deinterHandle, "imDestOdd", destOdd
MM.SetFunctionVariable deinterHandle, "imDestEven", destEven
MM.RunFunctionEx deinterHandle, 1
```

See also: **GetFunctionHandle**

Continued on next page

RunJournal

Description Runs the specified journal.

Syntax **RunJournal**(*sPath* As String) As Long

Remarks *sPath* should contain the full path of the journal along with the extension, ".jnl".

Parameters *sPath* Specifies the path and name of the journal to be run.

Example

```
' Run a journal named 'closeall.jnl' that resides in the
' directory C:\MM\Journals.
MM.RunJournal "c:\mm\journals\closeall.jnl"
```

SetFunctionVariable

Description Sets the value of a variable in a MetaMorph function.

Syntax **SetFunctionVariable**(*lFunctionHandle* As Long, *sVariableName* As String, *value* As Variant) As Long

Remarks You can obtain the handle of the function whose variable you want to set by using **GetFunctionHandle**.

Parameters *lFunctionHandle* Gives the handle of the function whose variable you want to set.

sVariableName Gives the name of the function's variable that you want to set.

value Specifies the new value of the variable—this must be of the same data type as the variable you are setting.

Continued on next page

SetFunctionVariable
(continued)

Example

```
' Run the MetaMorph Deinterlace function on the image 'src'.
' Put the odd and even images in 'destOdd' and 'destEven'.
' 'src', 'destOdd', and 'destEven' should have been previously
' set to valid existing images.
Dim deinterHandle As Long
MM.GetFunctionHandle "Deinterlace", deinterHandle
MM.SetFunctionVariable deinterHandle, "imSource", src
MM.SetFunctionVariable deinterHandle, "imDestOdd", destOdd
MM.SetFunctionVariable deinterHandle, "imDestEven", destEven
MM.RunFunctionEx deinterHandle, 1

' Run Deinterlace again, this time using the current desktop
' image as the source. This time, use RunFunction to run the
' function instead of RunFunctionEx.
MM.GetCurrentImage src
MM.RunFunction "Deinterlace", 1
```

See also: **GetFunctionHandle**

SetPrintMsgWindowPositionAndSize

Description Sets the position and size of the window used by **PrintMsg** to display messages.

Syntax **SetPrintMsgWindowPositionAndSize**(*nXPos* As Integer, *nYPos* As Integer, *nXSize* As Integer, *nYSize* As Integer) As Long

Parameters

nXPos Specifies the X-coordinate for placement of the upper left corner of the message box.

nYPos Specifies the Y-coordinate for placement of the upper left corner of the message box.

nXSize Specifies the width of the message box, in pixels.

nYSize Specifies the height of the message box, in pixels.

Example

```
' Print the string "Hello" in the print message window. Place
' the window in the upper left corner of the screen and
' make it 100 pixels wide and 30 high.
MM.PrintMsg "Hello"
MM.SetPrintMsgWindowPositionAndSize 1, 1, 100, 30
```

See also: **PrintMsg**

Continued on next page

SetMMVariable

Description Sets the value of a MetaMorph custom variable or certain writable built in variables.

Syntax **SetMMVariable** *VariableName, value*

Parameters VariableName can be any existing or undefined custom variable, or a built in variable name, such as *$Camera.Digital.Exposure$*. If it is an undefined custom variable, that variable will be created. *value* can be a string or a number. If it is not the same type as an existing variable, it will not be set.

Examples

```
mm.SetMMVariable "MyComment", "Experiment number 7"
mm.SetMMVariable "$Camera.Digital.Exposure$", 1250
```

See also: **GetMMVariable**

GetMMVariable

Description Gets the value of an existing MetaMorph custom or built in variable.

Syntax **GetMMVariable** *VariableName, var*

Parameters *VariableName* can be any existing custom variable or a built in variable. *var* is a VB variable. If the type of *var* does not match the type of the MetaMorph variable, it will try to convert the type before it assigns it. So, for example, the number 123 assigned to a string will end up as "*123*".

Examples

```
Dim planeNum as Integer
mm.GetMMVariable "$Image.ActivePlane$", planeNum
Dim comment as String
mm.GetMMVariable "MyComment", comment
```

See also: **SetMMVariable**

Chapter 4 – Reading and Manipulating Images and Image Windows

4.1 Overview

Introduction

This chapter deals with the functions that you need for managing image windows and their properties. These functions will be central to any user program that you create.

In this chapter

This chapter contains the following topics:

Topic	See Page
Loading, Creating, Copying, and Closing Images	39
Finding Loaded Images	46
Manipulating Image Windows	49
Reading and Using Image Properties	53

4.2 Loading, Creating, Copying, and Closing Images

Introduction

Image loading, copying, saving, and closing are vital steps in any user program that you will run in MetaMorph. This section describes the functions that are used for these procedures. In particular, you will make frequent use of the **LoadImage**, **SaveImage**, and **CloseImage** functions.

CloneImage

Description

Creates a copy of a specified image.

Syntax

CloneImage(*hImage* As Long, *hRetNewImage* As Long) As Long

Remarks

This function differs from **CopyImage** in that **CopyImage** requires the existence of a destination image that will be overwritten. The information that will be copied by **CloneImage** includes the image data, the annotation, zoom factor, calibration setting, thresholding, position, wavelength, scaling, and image times.

Parameters

hImage Specifies the handle of the image to be copied.

Return values

hRetNewImage Returns the handle for the new image.

Example

```
' Create a copy of the current desktop image and place it in
' 'dest'
Dim src As Long, dest As Long
MM.GetCurrentImage src
MM.CloneImage src, dest
```

See also:

CopyImage, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

Continued on next page

CloseImage

Description Closes a specified image and removes it from the desktop.

Syntax **CloseImage**(*hImage* As Long) As Long

Remarks If the image contains unsaved information, you will be prompted before the image is closed. In this regard, **CloseImage** differs from **ForceCloseImage**, which will close a modified image even if it has not been saved first. This function does not affect any disk-based copies of the image.

Parameters *hImage* Specifies the handle of the image to be closed.

Example

```
' Close the current desktop image
Dim src As Long
MM.GetCurrentImage src
MM.CloseImage src
```

See also: **ForceCloseImage**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

CopyImage

Description Copies a source image, *hSourceImage*, over a destination image, *hDestImage*.

Syntax **CopyImage**(*hSourceImage* As Long, *hDestImage* As Long) As Long

Remarks This function differs from **CloneImage** in that **CopyImage** requires the existence of a destination image, *hDestImage*, that will be overwritten. Only the image data, annotation, Z-position, wavelength, and image times are copied.

Parameters *hSourceImage* Specifies the handle of the source image to be copied.

hDestImage Specifies the handle of the destination image to be overwritten.

Example

```
' Copy the current desktop image to an existing image named
' "Temp"
Dim src As Long, dest As Long
MM.GetCurrentImage src
MM.GetNamedImage "Temp", dest
MM.CopyImage src, dest
```

See also: **CloneImage**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

Continued on next page

CopyImagePlane

Description Copies a specified source image plane to the current plane in a specified destination image.

Syntax **CopyImagePlane**(*hSourceImage* As Long, *hDestImage* As Long, *nSrcPlane* As Integer) As Long

Remarks Plane numbering starts at 0. The information that will be copied includes the image data, the annotation, zoom factor, calibration setting, thresholding, position, wavelength, scaling, and image times.

Parameters *hSourceImage* Specifies the handle of the source image.

hDestImage Specifies the handle of the destination image into which the plane will be copied.

nSrcPlane Specifies the number of the plane that will be copied.

Example

```
' Copy the first plane of the current image to the current
' plane of an existing image named "Stack".
Dim src As Long, dest As Long
MM.GetCurrentImage src
MM.GetNamedImage "Stack", dest
MM.CopyImagePlane src, dest, 0
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

CreateImage

Description Creates a new image, using a specified name, size, and bit-depth.

Syntax **CreateImage**(*width* As Integer, *height* As Integer, *depth* As Integer, *name* As String, *hRetNewImage* As Long) As Long

Remarks The **SetDisplayedImagesWhenCreated** function sets whether or not images will be automatically drawn on the screen when they are created. If you set its *bState* parameter to FALSE, the image will not appear on the screen when **CreateImage** is called, although the image will still be created. This may be useful for performing intermediate work on a temporary work image. In this case, you will need to use **ShowImage** to force the undisplayed image to be displayed.

Continued on next page

CreateImage (continued)

Parameters

width Specifies a width (X-axis size), in pixels, for the new image.

height Specifies a height (Y-axis size), in pixels, for the new image.

depth Specifies a bit-depth for the new image. This must be 1, 8, 16, or 24.

name Specifies a name for the new image. If an image with that name already exists, "-1" will be appended to the name of the new image.

Return values

hRetNewImage Returns the handle of the new image.

Example

```
' Create a 512 x 480 pixel 8-bit image named "myimage" and
' place it in 'im'.
Dim im As Long
MM.CreateImage 512, 480, 8, "myimage", im
```

See also: **SetDisplayImagesWhenCreated**, **ShowImage**

ForceCloseImage

Description Closes a specified image and removes it from the desktop.

Syntax **ForceCloseImage**(*hImage* As Long) As Long

Remarks If the image has not been saved, it will be deleted anyway, and you will lose any unsaved information. In this regard, **ForceCloseImage** differs from **CloseImage**, which will prompt you to save a modified image before closing it. This function does not affect any disk-based copies of the image.

Parameters *hImage* Specifies the handle of the image to be closed.

Example

```
' Close the current desktop image even if it has not yet been
' saved to disk.
Dim im As Long
MM.GetCurrentImage im
MM.ForceCloseImage im
```

See also: **CloseImage**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

Continued on next page

LoadImage

Description Loads a specified image file.

Syntax **LoadImage**(*sFileName* As String, *hRetImage* As Long) As Long

Parameters *sFileName* Specifies the name of the image to be loaded. This should contain the complete path of the image.

Return values *hRetImage* Returns the handle of the loaded image.

Example

```
' Load the image stack Nerve.stk which is stored in the
' directory C:\MM\Images, and place it in nerveIm.
MM.LoadImage "c:\mm\images\nerve.stk", nerveIm
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

SaveImage

Description Saves the specified image to a file on the hard disk.

Syntax **SaveImage**(*hImage* As Long, *sFileName* As String, *bPartial* As Boolean, *nFormat* As Integer) As Long

Remarks *nFormat* is a numeric value which denotes the format in which the image is to be saved. This value may be any of the following:

1	Image-1 File Type (*.img)
2	Windows File Type (*.bmp)
3	TIFF File Type (*.tif)
4	Stack File Type (*.stk)
5	MRC-500 File Type (*.pic)
6	Photometrics CC200 File Type (*.cc2)
7	Hamamatsu File Type (*.ham)
8	RGB TIFF File Type (*.tif)
9	WinView File Type (*.spe)
10	Argus File Type (*.ham)

Continued on next page

SaveImage
(continued)

Parameters

hImage Specifies the handle of the image to be saved.

sFileName Gives the name to be used for the image being saved. This should include the full path.

bPartial For an image with an active region of interest, this Boolean logic variable specifies whether only the image inside the region is to be saved (TRUE) or if the whole image is to be saved regardless of the presence of an active region (FALSE). If there is no active region, the whole image will be saved.

nFormat Supplies a numeric value that indicates what format the image is to be saved. (See Remarks.)

Example

```
' Save the current desktop image as a TIFF file named
' Newimage.tif in the directory C:\MM\Images.
Dim currentIm As Long
MM.GetCurrentImage currentIm
MM.SaveImage currentIm, "c:\mm\images\newimage.tif", FALSE, 3
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

SetDisplayImagesWhenCreated

Description Configures whether or not images are to be drawn automatically on the screen when they are created.

Syntax **SetDisplayImagesWhenCreated**(*bState* As Boolean) As Long

Remarks **SetDisplayedImagesWhenCreated** sets Use **ShowImage** to force an undisplayed image to be displayed.

Parameters

bState This Boolean logic variable specifies whether created images are to be displayed (TRUE) or kept hidden (FALSE). If *bState* is set to FALSE when **CreateImage** or other functions are called which create an image, the image will be created, but will not appear on the screen. This is useful for performing intermediate work on a temporary work image which you don't necessarily want to see. If *bState* is set to TRUE, new images will be displayed upon creation.

Continued on next page

SetDisplayImagesWhenCreated
(continued)

Example

```
' Create an image and do some operations on it.  Don't let the
' user see the image until all the operations are done.
MM.SetDisplayImagesWhenCreated FALSE
Dim im As Long
MM.CreateImage 512, 480, 8, "temp", im

' Do some operations on 'im'
' Cause 'im' to appear on the screen
MM.ShowImage im, 236

' Reset state so images are once again displayed as soon as
' they are created
MM.SetDisplayImagesWhenCreated TRUE
```

See also: **CreateImage**

ShowImage

Description Causes the specified image to be displayed, if it is not already being displayed.

Syntax **ShowImage**(*hImage* As Long, *nPalEntries* As Integer) As Long

Parameters *hImage* Specifies the handle of the image to be displayed.

nPalEntries Gives the number of palette entries to use in displaying the image: 2, 4, 8, 16, 32, 64, 128, or 236.

Example

```
' Create an image and do some operations on it. Don't let the
' user see the image until all the operations are done.
MM.SetDisplayImagesWhenCreated FALSE
Dim im As Long
MM.CreateImage 512, 480, 8, "temp", im

' Do some operations on 'im'
' Cause 'im' to appear on the screen
MM.ShowImage im, 236

' Reset state so images are once again displayed as soon as
' they are created
MM.SetDisplayImagesWhenCreated TRUE
```

See also: **GetCurrentImage**, **GetImage**

4.3 Finding Loaded Images

Introduction

The next set of functions are crucial for control of the procedures being carried out by your user program. These functions are used for finding an image's *handle*, the "indexing tag" that both Visual Basic and MetaMorph use to keep track of the image, as well as for determining how many images are loaded and whether a handle is currently in use. The **GetCurrentImage** and **GetImage** functions, which obtain an image's handle, are particularly important, and you will see these two functions referenced frequently in the "See Also" lists throughout this manual.

GetCurrentImage

Description

Returns the handle of the currently active image.

Syntax

GetCurrentImage(*hRetImage* As Long) As Long

Remarks

A handle is a unique number used by MetaMorph to keep track of the appropriate image while working with it. This number is used extensively as a variable by most of the MetaMorph Visual Basic functions in this manual. The current (active) image is the one at the front of all the loaded images.

Return values

hRetImage Returns the handle of the current image.

Example

```
' Get the current desktop image and put it in 'im'
Dim im As Long
MM.GetCurrentImage im
```

See also:

GetImage

GetImage

Description

All images loaded in MetaMorph have a unique index number, from 0 to (n – 1), where n is the number of loaded images. **GetImage** returns the handle of the image denoted by *nIndex*.

Syntax

GetImage(*nIndex* As Integer, *hRetImage* As Long) As Long

Remarks

The image handle is returned in *nRetImage*. If an error occurs (for example, if *nIndex* is not a valid number), *nRetImage* will contain 0.

Parameters

nIndex Gives the index number of the desired image. (See Description.) If an error occurs (for example, if *nIndex* is not a valid number), MetaMorph will return a handle of "0".

Continued on next page

GetImage
(continued)

Return values

hRetImage Returns the handle of the specified image. If an error occurs (for example, if *hRetImage* is not a valid number), MetaMorph will return a handle of "0".

Example

```
' Print out the names of all loaded images in the message
' window
Dim im As Long
Dim i As Integer
Dim name As String

For i = 0 To MM.GetNumberOfImages
  MM.GetImage i, im
  MM.GetImageName im, name
  MM.PrintMsg name
Next i
```

See also: **GetCurrentImage**

GetNumberOfImages

Description

Returns the number of images loaded in MetaMorph.

Syntax

GetNumberOfImages() As Long

Remarks

A value of 0 will be returned if there are no images or if an error occurred.

Return values

This function returns a value corresponding to the number of images that are currently loaded. If an error has occurred, or if there are no images currently loaded, a value of 0 will be returned.

Example

```
' Print out the names of all loaded images in the message
' window
Dim im As Long
Dim i As Integer
Dim name As String

For i = 0 To MM.GetNumberOfImages
  MM.GetImage i, im
  MM.GetImageName im, name
  MM.PrintMsg name
Next i
```

Continued on next page

IsValidImage

Description Tests whether or not the image handle you pass is valid.

Syntax **IsValidImage**(*hImage* As Long) As Long

Parameters *hImage* Gives the handle of the image being tested. If the handle value that you pass is not valid, **IsValidImage** will return a value of "0".

Return values *hImage* Returns a value of 0 if the handle you pass is not valid.

Example

```
' Determine if the image handle 'im' denotes a valid image.
' 'im' is an image handle that was initialized previously.
If MM.IsValidImage(im) Then
  MM.PrintMsg "image is valid"
Else
  MM.PrintMsg "Image is not valid"
End If
```

See also: **GetCurrentImage**, **GetImage**

4.4 Manipulating Image Windows

Introduction

This section describes the functions that are used for controlling the appearance of your image windows. The following functions are used for changing the size and position of image windows, as well as minimizing (shrinking to a desktop icon) and maximizing (restoring to full size).

GetImageWindowPosition

Description

Obtains the on-screen position of the specified image.

Syntax

GetImageWindowPosition(*hImage* As Long, *nRetXPos* As Integer, *nRetYPos* As Integer) As Long

Parameters

hImage Specifies the handle of the image whose position you want to know.

Return values

nRetXPos Gives the X-coordinate of the upper left corner of the image.

nRetYPos Gives the Y-coordinate of the upper left corner of the image.

Example

```
' Print the size and position of the window holding the current
image
Dim x As Integer, y As Integer, dx As Integer, dy As Integer
Dim im As Long

MM.GetCurrentImage im
MM.GetImageWindowSize im, dx, dy
MM.GetImageWindowPosition im, x, y
MM.PrintMsg "The current image is at " + Str(x) + ", " + Str(y)
MM.PrintMsg "The size of the current image is " + Str(dx) +
  " X " + Str(dy)
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3), **GetImageWindowSize**, **SetImageWindowPosition**

GetImageWindowSize

Description

Obtains the width and height of the specified image.

Syntax

GetImageWindowSize(*hImage* As Long, *nRetXSize* As Integer, *nRetYSize* As Integer) As Long

Parameters

hImage Specifies the handle of the image whose size you want to know.

Continued on next page

GetImageWindowSize
(continued)

Return values

nRetXSize Gives the width, in pixels, of the image.

nRetYSize Gives the height, in pixels, of the image.

Example

```
' Print the size and position of the window holding the current
' image

Dim x As Integer, y As Integer, dx As Integer, dy As Integer
Dim im As Long

MM.GetCurrentImage im
MM.GetImageWindowSize im, dx, dy
MM.GetImageWindowPosition im, x, y
MM.PrintMsg "The current image is at " + Str(x) + ", " + Str(y)
MM.PrintMsg "The size of the current image is " + Str(dx) +
  " X " + Str(dy)
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetImageWindowPosition**, **SetImageWindowSize**

MaximizeImageWindow

Description Expands the window of the specified image to full-size. If the image has been minimized (shrunk to a desktop icon), it will expand the window to its normal size.

Syntax **MaximizeImageWindow**(*hImage* As Long) As Long

Parameters *hImage* Specifies the handle of the image you want to maximize.

Example

```
' Maximize the current image
Dim im As Long
MM.GetCurrentImage im
MM.MaximizeImageWindow im
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **MinimizeImageWindow**

Continued on next page

MinimizeImageWindow

Description Shrinks the window of the specified image to a desktop icon.

Syntax **MinimizeImageWindow**(*hImage* As Long) As Long

Parameters *hImage* Specifies the handle of the image you want to minimize.

Example

```
' Minimize the current image
Dim im As Long
MM.GetCurrentImage im
MM.MinimizeImageWindow im
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **MaximizeImageWindow**

SetImageWindowPosition

Description Sets the position of the window for the specified image.

Syntax **SetImageWindowPosition**(*hImage* As Long, *nXPos* As Integer, *nYPos* As Integer)

Remarks This function dictates the position of the upper left corner of the image window.

Parameters *hImage* Specifies the handle of the image whose position you want to set.

nXPos Specifies the X-coordinate of the upper left corner of the image window.

nYPos Specifies the Y-coordinate of the upper left corner of the image window.

Example

```
' Make the window holding the current image 100 X 100 and put
' it in the upper left corner of the screen
Dim im As Long
MM.GetCurrentImage im
MM.SetImageWindowPosition im, 0, 0
MM.SetImageWindowSize im, 100, 100
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetImageWindowSize**

Continued on next page

SetImageWindowSize

Description Sets the size of the window for the specified image.

Syntax **SetImageWindowSize**(*hImage* As Long, *nXSize* As Integer, *nYSize* As Integer) As Long

Parameters

hImage Specifies the handle of the image whose size you want to set.

nXSize Specifies the width, in pixels, of the image.

nYSize Specifies the height, in pixels, of the image.

Example

```
' Make the window holding the current image 100 X 100 and put
' it in the upper left corner of the screen
Dim im As Long
MM.GetCurrentImage im
MM.SetImageWindowPosition im, 0, 0
MM.SetImageWindowSize im, 100, 100
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetImageWindowPosition**

4.5 Reading and Using Image Properties

Introduction

It is frequently necessary or useful to change certain characteristics about an image, such as its dimensions, bit-depth, or name. The functions that follow can be used to read or configure such image properties, as well as to read or create an annotation, change zoom factor, or switch to a different plane in a stack. One programming example is given for all of the image "Get" functions (see Figure 4.1 on page 56).

GetActivePlane

Description Obtains the number of the currently active plane in the specified image.

Syntax **GetActivePlane**(*hImage* Long, *nRetPlaneNumber* As Integer) As Long

Parameters *hImage* Specifies the handle of the image in which the plane resides.

Return values *nRetPlaneNumber* Returns the number of the active plane.

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetNumberOfPlanes**, **SetActivePlane**

GetDepth

Description Obtains the bit-depth of a specified image.

Syntax **GetDepth**(*hImage* As Long, *nRetDepth* As Integer) As Long

Parameters *hImage* Specifies the handle of the image.

Return values *nRetDepth* Returns the bit-depth—1, 8, 16, or 24.

See also: **GetCurrentImage** (Section 4.3), **GetHeight**, **GetImage** (Section 4.3), **GetWidth**

GetHeight

Description Obtains the height (Y-axis size) of a specified image. (**Note:** This may differ from the height of the image *window*.)

Syntax **GetHeight**(*hImage* As Long, *nRetHeight* As Integer) As Long

Parameters *hImage* Specifies the handle of the image.

Continued on next page

GetHeight
(continued)

Return values *nRetHeight* Returns the Y-axis size, in pixels, of the image.

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetImageWindowSize**, **GetWidth**

GetImageAnnotation

Description Obtains the annotation of the specified image.

Syntax **GetImageAnnotation**(*hImage* As Long, *planeNumber* As Integer, *sRetAnnotation* As String) As Long

Remarks Returns the annotation of the given plane of the given image. The annotation is returned in *sRetAnnotation*.

Parameters *hImage* Specifies the handle of the image.

planeNumber Specifies the number of the plane in a stack whose annotation you want to obtain. If the image is a single plane, this variable must be 0.

Return values *sRetAnnotation* Returns the annotation text.

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetImageAnnotation**

GetImageName

Description Obtains the name of a specified image.

Syntax **GetImageName**(*hImage* As Long, *sRetName* As String) As Long

Parameters *hImage* Specifies the handle of the image.

Return values *sRetName* Returns the name of the image.

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetImageName**

Continued on next page

GetNumberOfPlanes

Description Obtains the number of planes in a specified image or stack of images.

Syntax **GetNumberOfPlanes**(*hImage* As Long, *nRetNumberOfPlanes* As Integer) As Long

Parameters *hImage* Specifies the handle of the image.

Return values *nRetNumberOfPlanes* Returns the number of planes

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetActivePlane**

GetWidth

Description Obtains the width (X-axis size) of the specified image. (**Note:** This may differ from the width of the image *window*.)

Syntax **GetWidth**(*hImage* As Long, *nRetWidth* As Integer) As Long

Parameters *hImage* Specifies the handle of the image.

Return values *nRetWidth* Returns the X-axis size, in pixels, of the image.

See also: **GetCurrentImage** (Section 4.3), **GetHeight**, **GetImage** (Section 4.3), **GetImageWindowSize**

GetZoom

Description Obtains the zoom factor level of the specified image.

Syntax **GetZoom**(*hImage* As Long, *nRetZoom* As Integer) As Long

Parameters *hImage* Specifies the handle of the image.

Return values *nRetZoom* Returns the zoom level, expressed as a percentage of the full size (100 = normal size).

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetZoom**

Continued on next page

Figure 4.1 Image "Get" Function Programming Example

```
' Print information about the current image

Dim im As Long
MM.GetCurrentImage im

Dim name As String
MM.GetImageName im, name

Dim w As Integer, h As Integer, d As Integer
MM.GetWidth im, w
MM.GetHeight im, h
MM.GetDepth im, d

MM.PrintMsg "The image " + name + " is " + Str(w)
  + " X " + Str(h)
MM.PrintMsg "and has a depth of " + Str(d)

Dim nPlanes As Integer
Dim curPlane As Integer
MM.GetNumberOfPlanes im, nPlanes
MM.GetActivePlane im, curPlane
MM.PrintMsg "It has " + Str(nPlanes) +
  " planes, and the current plane is " + Str(curPlane)

Dim ann As String
MM.GetImageAnnotation im, curPlane, ann
MM.PrintMsg "The annotation of the current plane is "
  + ann

Dim z As Integer
MM.GetZoom im, z
MM.PrintMsg "and the zoom is " + Str(z)
```

Continued on next page

SetActivePlane

Description Selects a plane in a specified image stack and makes it the active plane.

Syntax **SetActivePlane**(*hImage* As Long, *planeNumber* As Integer) As Long

Remarks Planes are numbered starting at 0.

Parameters *hImage* Specifies the handle of the image.

planeNumber Specifies the number of the plane to be made active.

Example

```
' Set the active plane of the current image to 3 if it has
' that many planes

Dim im As Long
MM.GetCurrentImage im
Dim nPlanes As Integer
MM.GetNumberOfPlanes im, nPlanes

If nPlanes > 3 Then
  MM.SetActivePlane im, 3
Else
  PrintMsg "Error! Image only has " + Str(nPlanes) + " planes"
End If
```

See also: **GetActivePlane**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

SetImageAnnotation

Description Assigns an annotation to an image or stack plane.

Syntax **SetImageAnnotation**(*hImage* As Long, *planeNumber* As Integer, *annotation* As String) As Long

Parameters *hImage* Specifies the handle of the image.

planeNumber Specifies the number of the plane to be made active.

annotation Provides the annotation text to be assigned to the selected image or plane.

Example

```
' Set the annotation of plane 0 of the current image
Dim im As Long
MM.GetCurrentImage im
MM.SetImageAnnotation im, 0, "This is the first plane"
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetImageAnnotation**

Continued on next page

SetImageName

Description Assigns a new name to a selected image.

Syntax **SetImageName**(*hImage* As Long, *name* As Long) As Long

Parameters *hImage* Specifies the handle of the image.

name Specifies the name for the image.

Example

```
' Set the name of the current image to "Fred"
Dim im As Long
MM.GetCurrentImage im
MM.SetImageName im, "Fred"
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetImageName**

SetImageTimestamp

Description Sets the timestamp (either creation time or last saved time) for a given image to the specified date and time.

Syntax **SetImageTimestamp**(*hImage* As Long, *nStampType* As Integer, *nMonth* As Integer, *nDay* As Integer, *nYear* As Integer, *nHours* As Integer, *nMinutes* As Integer, *nSeconds* As Integer, *nMilliseconds* As Integer)

Parameters *hImage* Specifies the handle of the image.

nStampType Specifies which timestamp will be set, 0 for creation time and non-0 for last saved time.

nMonth Specifies the month, with 1 signifying January, 6 signifying June, etc.

nDay Specifies the date, from 1 to 31.

nYear Specifies the year, using four digits.

nHours Specifies the hour, from 0 to 23, counting forward from midnight.

nMinutes Specifies the minute, from 0 to 59.

nSeconds Specifies the seconds, from 0 to 59.

nMilliseconds Specifies the milliseconds, from 0 to 999.

Continued on next page

SetImageTimestamp
(continued)

Example

```
' Set the creation timestamp of the current image to 2:33:20.68
' PM on November 3, 2001.

Dim im As Long
MM.GetCurrentImage im
MM.SetImageTimestamp im, 0, 11, 3, 2001, 14, 33, 20, 680
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

SetZoom

Description Sets the zoom factor of a specified image.

Syntax **SetZoom**(*hImage* As Long, *zoom* As Integer, *nXCenter* As Integer, *nYCenter* As Integer) As Long

Remarks Full size is assigned a numeric value of 100. Numbers smaller than 100 will make the image smaller, and those greater than 100 will make the image larger. If the image becomes larger than its display window, *nXCenter* and *nYCenter* give the pixel coordinates at which to center the image.

Parameters

hImage Specifies the handle of the image.

zoom Specifies the zoom level, as a percent of the full-sized image.

nXCenter Specifies the X-coordinate for the pixel at which the zoomed image is to be centered.

nYCenter Specifies the Y-coordinate for the pixel at which the zoomed image is to be centered.

Example

```
' Set the zoom of the current image to 200 and center the image
' at 100, 100
Dim im As Long
MM.GetCurrentImage im
MM.SetZoom im, 200, 100, 100
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetZoom**

Chapter 5 – Adjusting Image Display

5.1 Overview

Introduction

Image display can be modified in a number of ways—you can increase image contrast, you can brighten or darken the image, you can adjust the grayscale or color resolution by altering the number of entries in the image's palette, or you can modify the values in the image's look-up table. This chapter covers the functions you will need to use to accomplish these tasks.

In this chapter

This chapter contains the following topics:

Topic	See Page
Updating the Image After Changing the Display	61
Adjusting Brightness and Contrast	62
Autoscaling 16-Bit Images	66
Working with Look-up Tables and Palettes	71

5.2 Updating the Image After Changing the Display

Introduction

The first function in this chapter is of such vital importance that we feel it warrants a separate section of its own. Any time you execute a function that makes a change to an image, such as when you create a region of interest, alter the brightness or contrast, switch look-up tables, or assign a set of intensity values to a row or column of pixels, you will need to update the image display. The **UpdateDisplay** function carries out this operation.

UpdateDisplay

Description

Redraws any parts of the image that need updating. This function should be called after pixel modification operations to cause those changes to be drawn.

Syntax

UpdateDisplay(*hImage* As Long) As Long

Parameters

hImage Specifies the handle of the image to be updated.

Example

```
' Draw a white box on the current image and then update the
' display so the changed pixels are shown

Dim i As Integer
Dim im As Long
Dim data(20) As Byte

For i = 1 To 20
  data(i) = 255
Next i

MM.GetCurrentImage im

For i = 1 To 20
  MM.WriteRow im, 0, i, 20, 8, data
Next i

MM.UpdateDisplay im
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3)

5.3 Adjusting Brightness and Contrast

Introduction

The image display adjustments you are most often likely to perform are those which modify an image's brightness and contrast. Brightness settings can range from 0 to 100, with 50 representing the brightness value of the original, unaltered image. Contrast settings range from 50 to 100. (MetaMorph can only *increase* image contrast from the original.) The following functions are used for reading the current settings and changing them to suit your needs. If you need to adjust the brightness or contrast of a 16-bit image, you will need to use the functions described in Section 5.4.

AutoEnhance

Description

Automatically enhances the brightness and contrast of a specified image.

Syntax

AutoEnhance(*hImage* As Long) As Long

Parameters

hImage Specifies the handle of the image to be autoenhanced.

Example

```
' Autoenhance the image contrast then fix it
Dim im As Long
MM.GetCurrentImage im
MM.AutoEnhance im
MM.FixImage im
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3), **SetBrightness**, **SetContrast**

FixImage

Description

Makes changes to the brightness and/or contrast of an image permanent.

Syntax

FixImage(*hImage* As Long) As Long

Parameters

hImage Specifies the handle of the image in which brightness and/or contrast changes are to be made permanent.

Example

```
' Autoenhance the image contrast then fix it
Dim im As Long
MM.GetCurrentImage im
MM.AutoEnhance im
MM.FixImage im
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3), **SetBrightness**, **SetContrast**

Continued on next page

GetBrightness

Description Obtains the brightness setting of a specified image.

Syntax **GetBrightness**(*hImage* As Long, *nRetBrightness* As Double) As Long

Parameters *hImage* Specifies the handle of the image whose brightness setting you want to obtain.

Example

```
' Double the brightness and contrast of the current image
Dim im As Long
Dim bright As Double
Dim contrast As Long
MM.GetCurrentImage im
MM.GetBrightness im, bright
MM.GetContrast im, contrast
MM.SetBrightness im, bright * 2
MM.SetContrast im, contrast * 2
```

Return values *nRetBrightness* Returns the brightness setting value.

See also: **GetContrast**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

GetContrast

Description Obtains the contrast setting of a specified image.

Syntax **GetContrast**(*hImage* As Long, *nRetContrast* As Double) As Long

Parameters *hImage* Specifies the handle of the image whose contrast setting you want to obtain.

Return values *nRetContrast* Returns the contrast setting value.

Example

```
' Double the brightness and contrast of the current image
Dim im As Long
Dim bright As Double
Dim contrast As Long
MM.GetCurrentImage im
MM.GetBrightness im, bright
MM.GetContrast im, contrast
MM.SetBrightness im, bright * 2
MM.SetContrast im, contrast * 2
```

See also: **GetBrightness**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

Continued on next page

ResetContrast

Description Resets the contrast and brightness of a specified image to the settings it had when last saved or "fixed."

Syntax **ResetContrast**(*hImage* As Long) As Long

Parameters *hImage* Specifies the handle of the image whose brightness and/or contrast settings you want to reset.

Example

```
' Reset the contrast of the current image
Dim im As Long
MM.GetCurrentImage im
MM.ResetContrast im
```

See also: **FixImage**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

SetBrightness

Description Sets the brightness of an image to a specified intensity value.

Syntax **SetBrightness**(*hImage* As Long, *brightness* As Double) As Long

Parameters *hImage* Specifies the handle of the image whose brightness you want to set.

brightness Specifies a new intensity setting.

Example

```
' Double the brightness and contrast of the current image
Dim im As Long
Dim bright As Double
Dim contrast As Long
MM.GetCurrentImage im
MM.GetBrightness im, bright
MM.GetContrast im, contrast
MM.SetBrightness im, bright * 2
MM.SetContrast im, contrast * 2
```

See also: **AutoEnhance**, **FixImage**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetContrast**

Continued on next page

SetContrast

Description Sets the contrast of an image to a specified setting.

Syntax **SetContrast**(*hImage* As Long, *contrast* As Double) As Long

Parameters *hImage* Specifies the handle of the image whose contrast you want to set.

contrast Specifies a new contrast setting.

Example

```
' Double the brightness and contrast of the current image
Dim im As Long
Dim bright As Double
Dim contrast As Long
MM.GetCurrentImage im
MM.GetBrightness im, bright
MM.GetContrast im, contrast
MM.SetBrightness im, bright * 2
MM.SetContrast im, contrast * 2
```

See also: **AutoEnhance**, **FixImage**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetBrightness**

5.4 Autoscaling 16-Bit Images

Introduction

Sixteen-bit images require a different approach when it comes to adjusting brightness and contrast. Because of the greater range of intensity values that are involved, autoscaling a 16-bit image relies on a different set of functions from those described in the preceding section.

GetAutoScale

Description

Obtains the current autoscaling state of a specified 16-bit image.

Syntax

GetAutoScale(*hImage* As Long, *bRetOnOff* As Boolean) As Long

Parameters

hImage Specifies the handle of the image whose autoscaling state you want to obtain.

Return values

bRetOnOff Returns the current autoscaling state. A value of TRUE means it is currently enabled, and FALSE means it is currently disabled.

Example

```
' Get the autoscale properties of the current image

Dim im As Long
Dim onoff As Boolean
Dim min As Integer
Dim max As Integer

MM.GetCurrentImage im
MM.GetAutoScale im, onoff
MM.GetMinScale im, min
MM.GetMaxScale im, max

MM.PrintMsg "The min and max scale of the current image is "
  + Str(min) + " and " + Str(max)
If onoff = TRUE Then
  MM.PrintMsg "The autoscaling of the current image is ON"
Else
  MM.PrintMsg "The autoscaling of the current image is OFF"
End If
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3), **SetAutoScale**

Continued on next page

GetMaxScale

Description Obtains the maximum scaling value of a specified 16-bit image.

Syntax **GetMaxScale**(*hImage* As Long, *nRetMaxScale* As Integer) As Long

Parameters *hImage* Specifies the handle of the image whose maximum scaling value you want to obtain.

Return values *nRetMaxScale* Returns the maximum scaling grayscale value.

Example

```
' Get the autoscale properties of the current image

Dim im As Long
Dim onoff As Boolean
Dim min As Integer
Dim max As Integer

MM.GetCurrentImage im
MM.GetAutoScale im, onoff
MM.GetMinScale im, min
MM.GetMaxScale im, max

MM.PrintMsg "The min and max scale of the current image is "
  + Str(min) + " and " + Str(max)
If onoff = TRUE Then
  MM.PrintMsg "The autoscaling of the current image is ON"
Else
  MM.PrintMsg "The autoscaling of the current image is OFF"
End If
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetMinScale**

Continued on next page

GetMinScale

Description Obtains the minimum scaling value of a specified 16-bit image.

Syntax **GetMinScale**(*hImage* As Long, *nRetMinScale* As Integer) As Long

Parameters *hImage* Specifies the handle of the image whose minimum scaling value you want to obtain.

Return values *nRetMinScale* Returns the minimum scaling grayscale value.

Example

```
' Get the autoscale properties of the current image

Dim im As Long
Dim onoff As Boolean
Dim min As Integer
Dim max As Integer

MM.GetCurrentImage im
MM.GetAutoScale im, onoff
MM.GetMinScale im, min
MM.GetMaxScale im, max

MM.PrintMsg "The min and max scale of the current image is "
  + Str(min) + " and " + Str(max)
If onoff = TRUE Then
  MM.PrintMsg "The autoscaling of the current image is ON"
Else
  MM.PrintMsg "The autoscaling of the current image is OFF"
End If
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetMaxScale**

SetAutoScale

Description Enables or disables autoscaling for the specified 16-bit image.

Syntax **SetAutoScale**(*hImage* as Long, *bOnOff* As Boolean) As Long

Parameters *hImage* Specifies the handle of the image for which you want to enable or disable autoscaling.

bOnOff Sets the scaling state. If you set *bOnOff* to TRUE, autoscaling will be enabled. To disable autoscaling, set *bOnOff* to FALSE.

Continued on next page

SetAutoScale
(continued)

Example

```
' Enable autoscaling for the current image and set the
' range from 0 to 4095
Dim im As Long
MM.GetCurrentImage im
MM.SetAutoScale im, TRUE
MM.SetMinScale im, 0
MM.SetMaxScale im, 4095
```

See also: **GetAutoScale**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

SetMaxScale

Description Sets the maximum value for the grayscale range being used to autoscale a specified 16-bit image.

Syntax **SetMaxScale**(*hImage* As Long, *nMaxScale* As Integer) As Long

Parameters *hImage* Specifies the handle of the image for which you want to set the maximum autoscaling value.

nMaxScale Defines the maximum grayscale value for the autoscaling range.

Example

```
' Enable autoscaling for the current image and set the
' range from 0 to 4095
Dim im As Long
MM.GetCurrentImage im
MM.SetAutoScale im, TRUE
MM.SetMinScale im, 0
MM.SetMaxScale im, 4095
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetAutoScale**, **SetMinScale**

Continued on next page

SetMinScale

Description Sets the minimum value for the grayscale range being used to autoscale a specified 16-bit image.

Syntax **SetMinScale**(*hImage* As Long, *nMinScale* As Integer) As Long

Parameters *hImage* Specifies the handle of the image for which you want to set the minimum autoscaling value.

nMinScale Defines the minimum grayscale value for the autoscaling range.

Example

```
' Enable autoscaling for the current image and set the
' range from 0 to 4095
Dim im As Long
MM.GetCurrentImage im
MM.SetAutoScale im, TRUE
MM.SetMinScale im, 0
MM.SetMaxScale im, 4095
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetAutoScale**, **SetMaxScale**

5.5 Working with Look-up Tables and Palettes

Introduction

A *look-up table*, or LUT, is a "table" of values that translates each original grayscale value in an image to another intensity or to a color. This allows you to change the display of an image without affecting its data. The functions in this section can be used for making changes to the current LUT or for switching to another LUT. In addition, you can change the number of grayscale levels or colors that are displayed by changing the number of *palette* entries with the **SetNumPaletteEntries** function.

GetLut – for Visual Basic 6 & earlier

GetLutEx2 – for Visual Basic .NET (2002 – 2008)

Description

Reads the elements from the given look-up table (LUT) into the red, green, and blue arrays that are passed.

Syntax

GetLut(*hImage* As Long, *lutNumber* As Integer, *startElement* As Integer, *nElements* As Integer, *red()* As Byte, *green()* As Byte, *blue()* As Byte) As Long
GetLutEx2(*hImage* As Long, *lutNumber* As Integer, *startElement* As Integer, *nElements* As Integer, *red()* As Byte, *green()* As Byte, *blue()* As Byte) As Long

Remarks

The LUT that you want to read is specified by *lutNumber*. Use one of the following constants:

0 = Monochrome
1 = Pseudocolor
2 = Red
3 = Green
4 = Blue

or use a user LUT number from 5 to 15.

Parameters

hImage Specifies the handle of the image for which you want to read the LUT values.

lutNumber Specifies the LUT to be read. (See Remarks.)

startElement Indicates the number of the element in the LUT where reading is to start.

nElements Specifies the number of LUT elements to read. This will determine the size of the *red()*, *green()*, and *blue()* arrays (see Return values).

Return values

red() Passes the values of the elements from the red channel of the LUT. The size of this array will be determined by the number of elements in the look-up table.

green() Passes the values of the elements from the green channel of the LUT. The size of this array will be determined by the number of elements in the look-up table.

blue() Passes the values of the elements from the blue channel of the LUT. The size of this array will be determined by the number of elements in the look-up table.

Continued on next page

GetLut
(continued)

Example

```
' Read the first user lut of the current image into memory.
' Since LUTs 0 through 4 are the fixed LUTs, the first user
' LUT is LUT number 5
Dim im As Long
Dim r(256) As Byte
Dim g(256) As Byte
Dim b(256) As Byte
MM.GetCurrentImage im
MM.GetLut im, 5, 0, 256, r, g, b
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetLutModel**, **SetLut**

GetLutModel

Description Obtains a value that indicates the look-up table (LUT) currently being used to display the given image.

Syntax **GetLutModel**(*hImage* As Long, *nRetLutModel* As Integer) As Long

Remarks The LUT that is in use is indicated by a numeric value. The values returned in *nRetLutModel* are

0 = Monochrome
1 = Pseudocolor
2 = Red
3 = Green
4 = Blue

or a user-defined LUT, with a number between 5 and 15.

Parameters *hImage* Specifies the handle of the image for which you want to determine the LUT.

Return values *nRetLutModel* Returns the LUT value. (See Remarks.)

Continued on next page

GetLutModel
(continued)

Example

```
' Determine which LUT is currently being used on the current
' image

Dim im As Long
Dim lutnum As Integer

MM.GetCurrentImage im
MM.GetLutModel im, lutnum

If lutnum = 0 Then
  MM.PrintMsg "LUT is Monochrome"
ElseIf lutnum = 1 Then
  MM.PrintMsg "LUT is Pseudocolor"
ElseIf lutnum = 2 Then
  MM.PrintMsg "LUT is Red"
ElseIf lutnum = 3 Then
  MM.PrintMsg "LUT is Green"
ElseIf lutnum = 4 Then
  MM.PrintMsg "LUT is Blue"
Else
  MM.PrintMsg "LUT is user LUT number " + Str(lutnum = 5)
End If
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetLut**, **SetLutModel**

Continued on next page

SetLut

Description Writes the contents of the red, green, and blue arrays passed into the elements of the given look-up table (LUT).

Syntax **SetLut**(*hImage* As Long, *lutNumber* As Integer, *startElement* As Integer, *nElements* As Integer, *red()* As Byte, *green()* As Byte, *blue()* As Byte) As Long

Parameters

hImage Specifies the handle of the image for which you want to set the LUT.

lutNumber Denotes the user-defined LUT to which you want to write (5 to 15). You cannot write to the predefined LUTs (Monochrome, etc).

startElement Indicates the number of the element in the LUT where writing is to start.

nElements Specifies the number of LUT elements to write.

red() Indicates the array for the red channel of the LUT. LUTs have a maximum possible total of 256 elements. The red array must contain at least *nElements* elements.

green() Indicates the array for the green channel of the LUT. LUTs have a maximum possible total of 256 elements. The green array must contain at least *nElements* elements.

blue() Indicates the array for the blue channel of the LUT. LUTs have a maximum possible total of 256 elements. The blue array must contain at least *nElements* elements.

Example

```
' Configure user LUT 0 on the current image as an inverted
' contrast monochrome LUT and then use it

Dim im As Long
Dim i As Integer
Dim lut(256) As Byte

For i = 0 To 255
  lut(i) = 255 - i
Next i

MM.GetCurrentImage im
MM.SetLut im, 5, 0, 256, lut, lut, lut
MM.SetLutModel im, 5
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetLutModel**, **SetNumPaletteEntries**

Continued on next page

SetLutModel

Description Specifies a look-up table (LUT) to use to display the given image.

Syntax **SetLutModel**(*hImage* As Long, *nLutModel* As Integer) As Long

Remarks The model of LUT to use is specified with *nLutModel*. Values you can use are

0 = Monochrome
1 = Pseudocolor
2 = Red
3 = Green
4 = Blue

or a user-defined LUT, with a number between 5 and 15.

Parameters *hImage* Specifies the handle of the image for which you want to set the LUT model.

nLutModel Specifies the value of the LUT you want to use. (See Remarks.)

Example

```
' Configure user LUT 0 on the current image as an inverted
' contrast monochrome LUT and then use it

Dim im As Long
Dim i As Integer
Dim lut(256) As Byte

For i = 0 To 255
  lut(i) = 255 - i
Next i

MM.GetCurrentImage im
MM.SetLut im, 5, 0, 256, lut, lut, lut
MM.SetLutModel im, 5
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetLut**, **SetNumPaletteEntries**

Continued on next page

SetNumPaletteEntries

Description Specifies the number of palette entries to use for displaying an image.

Syntax **SetNumPaletteEntries**(*hImage* As Long, *newNumEntries* As Integer) As Long

Remarks The maximum possible number of palette entries is 236. This is because the Windows operating system reserves 20 palette colors for use by such interface elements as dialog box buttons, title bars, and the like.

Parameters *hImage* Specifies the handle of the image for which you want to set the number of palette entries.

newNumEntries Specifies the number of palette entries: 2, 4, 8, 16, 32, 64, 128, or 236.

Example

```
' Set the number of palette entries on the current image to 8.
' This will make the image appear as if it is quantized.
Dim im As Long
MM.GetCurrentImage im
MM.SetNumPaletteEntries im, 8
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetLut**, **SetLutModel**

Chapter 6 – Reading and Using Image Pixel Data

6.1 Overview

Introduction

Digital images are constructed of individual points, or *pixels*, each of which has a specific, quantifiable intensity value or color. Because each pixel can be represented in memory by a set of numeric values that encode its location (X and Y coordinates) and brightness or color (grayscale or color value), a variety of manipulations can be applied that analyze and process the information contained in an image. This chapter deals with the functions that read and manipulate image pixel data.

In this chapter

This chapter contains the following topics:

Topic	See Page
Applying Thresholding	78
Reading and Manipulating Image Data	82

6.2 Applying Thresholding

Introduction

Most procedures in image analysis require that a distinction be made between the objects to be measured and the rest of the image. MetaMorph makes this distinction on the basis of the intensity values of pixels in the object vs. those in the background regions. This procedure, which is called *segmentation* or *thresholding*, involves defining a range of intensity values that will be considered as belonging to the objects being measured. A threshold range can be inclusive or exclusive. An *inclusive* threshold is one which considers all grayscale values between the upper and lower limits of the threshold range as belonging to the objects being measured. Conversely, an *exclusive* threshold considers all grayscale values that are equal to, or outside of, the upper and lower limits as belonging to the objects being measured. The four functions described in this section are used for determining the current threshold settings and for defining a new set of threshold settings.

GetThresholdRange

Description

Obtains the current threshold range (maximum and minimum grayscale settings) of the specified image.

Syntax

GetThresholdRange(*hImage* As Long, *nRetLow* As Integer, *nRetHigh* As Integer) As Long

Parameters

hImage Specifies the handle of the image whose threshold range you want to obtain.

Return values

nRetLow Returns the grayscale value of the lower threshold limit.

nRetHigh Returns the grayscale value of the upper threshold limit.

Example

```
' Get the threshold range and state of the current image
Dim im As Long
Dim low As Integer, high As Integer, state As Integer

MM.GetCurrentImage im
MM.GetThresholdRange im, low, high
MM.GetThresholdState im, state

MM.PrintMsg "The low and high threshold values of the current
  image are " + Str(low) + " and " + Str(high)
If state = 0 Then
  MM.PrintMsg "Thresholding is currently off"
ElseIf state = 1 Then
  MM.PrintMsg "Thresholding is set to 'On-Inclusive' mode"
ElseIf state = 2 Then
  MM.PrintMsg "Thresholding is set to 'On-Exclusive' mode"
End If
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3), **GetThresholdState**, **SetThresholdRange**

Continued on next page

GetThresholdState

Description Obtains the threshold state of the specified image

Syntax **GetThresholdState**(*hImage* As Long, *nRetState* As Integer) As Long

Parameters *hImage* Specifies the handle of the image whose thresholding state you want to obtain.

Return values *nRetState* Returns the current thresholding state of the given image. If thresholding is disabled, *nRetState* will return a value of 0. If the threshold state is set to On-Inclusive (pixels with grayscale values between the upper and lower threshold limits are included), *nRetState* will be set to 1. If the threshold state is set to On-Exclusive (pixels with grayscale values equal or lower than the lower threshold limit, and those with values equal or higher than the upper limit, are included), *nRetState* will return a value of 2.

Example

```
' Get the threshold range and state of the current image
Dim im As Long
Dim low As Integer, high As Integer, state As Integer

MM.GetCurrentImage im
MM.GetThresholdRange im, low, high
MM.GetThresholdState im, state

MM.PrintMsg "The low and high threshold values of the current
  image are " + Str(low) + " and " + Str(high)
If state = 0 Then
  MM.PrintMsg "Thresholding is currently off"
ElseIf state = 1 Then
  MM.PrintMsg "Thresholding is set to 'On-Inclusive' mode"
ElseIf state = 2 Then
  MM.PrintMsg "Thresholding is set to 'On-Exclusive' mode"
End If
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetThresholdRange**, **SetThresholdState**

Continued on next page

SetThresholdRange

Description Sets the upper and lower limit of a threshold range for a specified image.

Syntax **SetThresholdRange**(*hImage* As Long, *low* As Integer, *high* As Integer) As Long

Parameters

hImage Specifies the handle of the image whose thresholding range you want to set.

low Specifies the grayscale value of the lower threshold limit.

high Specifies the grayscale value of the upper threshold limit.

Example

```
' Enable thresholding in the current image, and highlight
pixels
' between grayscale values 50 and 187
Dim im As Long
MM.GetCurrentImage im
MM.SetThresholdRange im, 50, 187
MM.SetThresholdState im, 1
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetThresholdState**

SetThresholdState

Description Sets the threshold state of the specified image.

Syntax **SetThresholdState**(*hImage* As Long, *state* As Integer) As Long

Remarks The threshold state is set with the *state* variable. Possible values are

- 0: Disables thresholding (Off).
- 1: Enables inclusive thresholding, in which all pixels with grayscale values between the *high* and *low* values (see **SetThresholdRange**) are highlighted.
- 2: Enables exclusive thresholding, in which all pixels with grayscale values equal to or outside the *high* and *low* values are highlighted.

Parameters

hImage Specifies the handle of the image whose thresholding state you want to set.

state Indicates the thresholding state for the image. (See Remarks.)

Continued on next page

SetThresholdState
(continued)

Example

```
' Enable thresholding in the current image, and highlight
pixels
' between grayscale values 50 and 187
Dim im As Long
MM.GetCurrentImage im
MM.SetThresholdRange im, 50, 187
MM.SetThresholdState im, 1
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetThresholdRange**

6.3 Reading and Manipulating Image Data

Introduction

Pixel intensities are represented by numeric values in computer memory, and can be easily read and manipulated. This section describes the functions that perform such "read" and "write" procedures. The **BinarizeImage** and **WriteText** functions are included here because the process of converting all pixels to black or white and the process of adding a text label to an image are little more than a reassignment of the intensity values of the underlying pixels.

BinarizeImage

Description

Creates a binarized (1-bit) version of a selected image.

Syntax

BinarizeImage(*hImage* As Long, *hDest* As Long) As Long

Remarks

This function places a binarized version of *hImage* in the image given by *hDest*. *hImage* should be thresholded before this function is called, or you will get a blank result image.

Parameters

hImage Specifies the handle of the image you want to binarize.

hDest Specifies the handle of a destination image that will be overwritten with the binarized version of *hImage*. The destination image must exist before you can apply this function. Typically, you will create an image with the **CreateImage** command.

Example

```
' Binarize the current image and place it in "Binarized"

Dim curIm As Long
Dim binIm As Long

MM.GetCurrentImage curIm
MM.CreateImage 512, 512, 1, "Binarized", binIm

' curIm must be thresholded before it can be binarized
MM.SetThresholdState curIm, 1
MM.SetThresholdRange im, 50, 150

MM.BinarizeImage curIm, binIm
```

See also:

GetCurrentImage (Section 4.3), **CreateImage** (Section 4.2), **GetImage** (Section 4.3)

Continued on next page

ReadColumn

Description Reads the intensity values of a vertical line of pixels from a selected image and writes them into an array.

Syntax **ReadColumn**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be read.

xPos Specifies the X-coordinate of the pixel where reading should start.

yPos Specifies the Y-coordinate of the pixel where reading should start.

nPixels Specifies the number of pixels to be read, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

pixelBuffer() Defines a buffer into which the pixel values will be read. If *depth* is 8, *pixelBuffer* should be defined as *Byte*. If *depth* is 16, *pixelBuffer* should be *Integer*. If *depth* is 24, *pixelBuffer* should be *Byte*.

Return values

pixelBuffer() The pixel values will be read into this predefined buffer. If the source image is 24-bit, the array will be read out in the format B, G, R, B, G, R, etc. Thus, array(0) will be the first blue pixel, array(1) will be the first green pixel, and so forth. (See Parameters.)

Example

```
' Read a column of 50 pixels starting at location (10, 0) from
' the current image
Dim im As Long
Dim buf(50) As Byte
MM.GetCurrentImage im
MM.ReadColumn im, 10, 0, 50, 8, buf
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **ReadColumnEx**, **ReadPixel**, **ReadRow**

Continued on next page

ReadColumnEx – for Visual Basic 6 & earlier
ReadColumnEx2 – for Visual Basic .NET (2002 – 2008)

Description

Reads the intensity values of a vertical line of pixels from a selected image and writes the values into an array, starting at a specified starting location in the array.

Syntax

ReadColumnEx(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long
ReadColumnEx2(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be read.

xPos Specifies the X-coordinate of the pixel where reading should start.

yPos Specifies the Y-coordinate of the pixel where reading should start.

nPixels Specifies the number of pixels to be read, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

xStart Specifies the X-coordinate of the position in the array where writing should start.

yStart Specifies the Y-coordinate of the start position in the array for writing.

pixelBuffer() Defines a buffer into which the pixel values will be read. This is a two-dimensional array. Data are always placed in the array in "column-major" fashion. If *depth* is 8, *pixelBuffer* should be defined as *Byte*. If *depth* is 16, *pixelBuffer* should be *Integer*. If *depth* is 24, *pixelBuffer* should be *Byte*.

Return values

pixelBuffer() The pixel values will be read into this predefined buffer. If the source image is 24-bit, the array will be read out in the format B, G, R, B, G, R, etc. Thus, array(0) will be the first blue pixel, array(1) will be the first green pixel, and so forth. (See Parameters.)

Example

```
' Read a 50 x 50 block of pixels from the current image
' and write it back rotated 90 degrees counterclockwise
Dim im As Long
Dim x As Integer
Dim buf(50, 50) As Byte
MM.GetCurrentImage im

For x = 0 To 49
  MM.ReadColumnEx im, x, 0, 50, 8, 0, x, buf
  MM.WriteRowEx im, 0, x + 50, 50, 8, 0, x, buf
Next x
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **ReadColumn**, **ReadPixel**, **ReadRowEx**

Continued on next page

ReadPixel

Description Reads the intensity value of a specified pixel in a selected image.

Syntax **ReadPixel**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nRetPixelValue* As Integer) As Long

Remarks This function does not operate on 24-bit color images.

Parameters

hImage Specifies the handle of the image to be read.

xPos Specifies the X-coordinate of the pixel to be read.

yPos Specifies the Y-coordinate of the pixel to be read.

Return values *nRetPixelValue* Returns the grayscale value of the pixel.

Example

```
' Read a pixel at location 43, 98 on the current image
Dim im As Long
Dim pix As Integer
MM.GetCurrentImage im
MM.ReadPixel im, 43, 98, pix
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **ReadColumn**, **ReadRow**

ReadRow – for Visual Basic 6 & earlier

Description Reads the intensity values of a horizontal line of pixels from a selected image and writes them into an array.

Syntax **ReadRow**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be read.

xPos Specifies the X-coordinate of the pixel where reading should start.

yPos Specifies the Y-coordinate of the pixel where reading should start.

nPixels Specifies the number of pixels to be read, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

Continued on next page

ReadRow
(continued)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

pixelBuffer() This is a defined buffer into which the pixel values will be read. If *depth* is 8, *pixelBuffer* should be defined as *Byte*. If *depth* is 16, *pixelBuffer* should be *Integer*. If *depth* is 24, *pixelBuffer* should be *Byte*.

Return values

pixelBuffer() The pixel values will be read into this predefined buffer. If the source image is 24-bit, the array will be read out in the format B, G, R, B, G, R, etc. Thus, array(0) will be the first blue pixel, array(1) will be the first green pixel, and so forth. (See Parameters.)

Example

```
' Read a row of 50 pixels from the current image
Dim im As Long
Dim buf(50) As Byte
MM.GetCurrentImage im
MM.ReadRow im, 0, 0, 50, 8, buf
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **ReadColumn**, **ReadPixel**, **ReadRowEx**

ReadRowEx – for Visual Basic 6 & earlier
ReadRowEx2 – for Visual Basic .NET (2002 – 2008)

Description

Reads the intensity values of a horizontal line of pixels from a selected image and writes the values into an array, starting at a specified starting location in the array.

Syntax

ReadRowEx(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be read.

xPos Specifies the X-coordinate of the pixel where reading should start.

yPos Specifies the Y-coordinate of the pixel where reading should start.

nPixels Specifies the number of pixels to be read, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

xStart Specifies the X-coordinate (row) of the position in the array where writing should start.

Continued on next page

ReadRowEx 2
(continued)

yStart Specifies the Y-coordinate (column) of the position in the array where writing should start.

pixelBuffer() This is a defined buffer into which the pixel values will be read. This is a two-dimensional array. Data are always placed in the array in "column-major" fashion. If *depth* is 8, *pixelBuffer* should be defined as *Byte*. If *depth* is 16, *pixelBuffer* should be *Integer*. If *depth* is 24, *pixelBuffer* should be *Byte*.

Return values

pixelBuffer() The pixel values will be read into this predefined buffer. If the source image is 24-bit, the array will be read out in the format B, G, R, B, G, R, etc. Thus, array(0) will be the first blue pixel, array(1) will be the first green pixel, and so forth. (See Parameters.)

Example

```
' Read a 50 x 50 block of pixels from the current image
' and write it back rotated 90 degrees counterclockwise
Dim im As Long
Dim x As Integer
Dim buf(50, 50) As Byte
MM.GetCurrentImage im

For x = 0 To 49
  MM.ReadColumnEx im, x, 0, 50, 8, 0, x, buf
  MM.WriteRowEx im, 0, x + 50, 50, 8, 0, x, buf
Next x
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **ReadColumnEx**, **ReadPixel**, **ReadRow**

WriteColumn – for Visual Basic 6 & earlier

Description Reads a set of intensity values from an array and writes them to a vertical line of pixels in a selected image.

Syntax **WriteColumn**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be written to.

xPos Specifies the X-coordinate of the pixel where writing should start.

yPos Specifies the Y-coordinate of the pixel where writing should start.

nPixels Specifies the number of pixels to be written, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

Continued on next page

WriteColumn
(continued)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

pixelBuffer() This is a buffer from which the pixel values will be read. If *depth* is 8, *pixelBuffer* should be defined as *Byte.* If *depth* is 16, *pixelBuffer* should be *Integer.* If *depth* is 24, *pixelBuffer* should be *Byte*.

Example

```
' Write a white vertical line on the current image

Dim im As Long
Dim buf(50) As Byte
Dim x As Integer

For x = 0 To 49
  buf(x) = 255
Next x

MM.GetCurrentImage im
MM.WriteColumn im, 50, 0, 50, 8, buf
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **WriteColumnEx**, **WritePixel**, **WriteRow**

WriteColumnEx – for Visual Basic 6 & earlier
WriteColumnEx2 – for Visual Basic .NET (2002 – 2008)

Description Reads a set of intensity values from a specified starting location in an array and writes them to a vertical line of pixels in a selected image

Syntax **WriteColumnEx**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long
WriteColumnEx2(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long

Parameters *hImage* Specifies the handle of the image to be written to.

xPos Specifies the X-coordinate of the pixel where writing should start.

yPos Specifies the Y-coordinate of the pixel where writing should start.

nPixels Specifies the number of pixels to be written, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

Continued on next page

WriteColumnEx
(continued)

xStart Specifies the X-coordinate (row) of the position in the array where reading should start.

yStart Specifies the Y-coordinate (column) of the position in the array where reading should start.

pixelBuffer() This is a buffer from which the pixel values will be read. If *depth* is 8, *pixelBuffer* should be defined as *Byte.* If *depth* is 16, *pixelBuffer* should be *Integer.* If *depth* is 24, *pixelBuffer* should be *Byte*.

Example

```
' Read a 50 x 50 block of pixels from the current image
' and write it back rotated 90 degrees clockwise
Dim im As Long
Dim x As Integer
Dim buf(50, 50) As Byte

MM.GetCurrentImage im

For x = 0 To 49
  MM.ReadRowEx im, 0, x, 50, 8, 0, x, buf
  MM.WriteColumnEx im, x + 50, 0, 50, 8, 0, x, buf
Next x
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **WriteColumn**, **WritePixel**, **WriteRowEx**

WritePixel

Description Writes a specified intensity value to a selected image pixel.

Syntax **WritePixel**(*hImage* As Long, *xPos* As Integer , *yPos* As Integer, *pixelValue* As Integer) As Long

Remarks No pixel conversion occurs in this function. This function does not operate on 24-bit color images.

Parameters

hImage Specifies the handle of the image to be written to.

xPos Specifies the X-coordinate of the pixel where writing should start.

yPos Specifies the Y-coordinate of the pixel where writing should start.

pixelValue Provides the intensity value to be written to the selected pixel.

Continued on next page

WritePixel
(continued)

Example

```
' Write a white pixel at location 50, 50 on the current image
Dim im As Long
MM.GetCurrentImage im
MM.WritePixel im, 50, 50, 255
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **ReadPixel**, **WriteColumn**, **WriteRow**

WriteRow – for Visual Basic 6 & earlier

Description Reads a set of intensity values from an array and writes them to a horizontal line of pixels in a selected image.

Syntax **WriteRow**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be written to.

xPos Specifies the X-coordinate of the pixel where writing should start.

yPos Specifies the Y-coordinate of the pixel where writing should start.

nPixels Specifies the number of pixels to be written, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

pixelBuffer() This is a buffer from which the pixel values will be read. If *depth* is 8, *pixelBuffer* should be defined as *Byte*. If *depth* is 16, *pixelBuffer* should be *Integer*. If *depth* is 24, *pixelBuffer* should be *Byte*.

Continued on next page

WriteRow
(continued)

Example

```
' Write a white horizontal line on the current image
Dim im As Long
Dim buf(50) As Byte
Dim x As Integer

For x = 0 To 49
  buf(x) = 255
Next x

MM.GetCurrentImage im
MM.WriteRow im, 50, 0, 50, 8, buf
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **WriteColumn**, **WritePixel**, **WriteRowEx**

WriteRowEx – for Visual Basic 6 & earlier
WriteRowEx2 – for Visual Basic .NET (2002 – 2008)

Description Reads a set of intensity values from a specified starting location in an array and writes them to a horizontal line of pixels in a selected image

Syntax **WriteRowEx**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long
WriteRowEx2(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *nPixels* As Integer, *depth* As Integer, *xStart* As Integer, *yStart* As Integer, *pixelBuffer()* As Variant) As Long

Parameters

hImage Specifies the handle of the image to be written to.

xPos Specifies the X-coordinate of the pixel where writing should start.

yPos Specifies the Y-coordinate of the pixel where writing should start.

nPixels Specifies the number of pixels to be written, starting at the position given by *xPos* and *yPos*. The size of the array will depend on the image bit-depth and the data type used for the array buffer. (See Section 1.6, *Data Types and Arrays*.)

depth Specifies what the bit-depth of the pixel data values should be. (See Section 1.6, *Data Types and Arrays*.)

xStart Specifies the X-coordinate (row) of the position in the array where reading should start.

yStart Specifies the Y-coordinate (column) of the position in the array where reading should start.

pixelBuffer() This is a buffer from which the pixel values will be read. If *depth* is 8, *pixelBuffer* should be defined as *Byte*. If *depth* is 16, *pixelBuffer* should be *Integer*. If *depth* is 24, *pixelBuffer* should be *Byte*.

Continued on next page

WriteRowEx2
(continued)

Example

```
' Read a 50 x 50 block of pixels from the current image
' and write it back rotated 90 degrees clockwise
Dim im As Long
Dim x As Integer
Dim buf(50, 50) As Byte

MM.GetCurrentImage im

For x = 0 To 49
  MM.ReadRowEx im, 0, x, 50, 8, 0, x, buf
  MM.WriteColumnEx im, x + 50, 0, 50, 8, 0, x, buf
Next x
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **WriteColumnEx**, **WritePixel**, **WriteRow**

WriteText

Description Writes a specified string of text onto an image.

Syntax **WriteText**(*hImage* As Long, *xPos* As Integer, *yPos* As Integer, *text* As String, *fillBackground* As Boolean, *foreColor* As Integer, *backColor* As Integer) As Long

Parameters

hImage Specifies the handle of the destination image.

xPos Specifies the X-coordinate where writing of the text is to start.

yPos Specifies the Y-coordinate where writing of the text is to start.

text Provides the string of text that will be written onto the image.

fillBackground Selects whether the area behind the text is to be filled in with an opaque background of a grayscale value selected by *backColor*. If *fillBackground* is set to TRUE, a background "fill" will be used. If *fillBackground* is set to FALSE, no "fill" will be used, and *backColor* will be ignored.

foreColor Specifies the grayscale value of the text.

backColor Specifies the grayscale value of the "fill" behind the text on the image.

Example

```
' Write "Nerve Cell" at the top of the current image
Dim im As Long
MM.GetCurrentImage im
MM.WriteText im, 50, 20, "Nerve Cell", TRUE, 255, 0
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

Chapter 7 – Working with Regions of Interest

7.1 Overview

Introduction

A *region of interest*, or *ROI*, is an area in an image window that you define and specify for subsequent processing and analysis. For the purposes of user programs, MetaMorph only uses rectangular regions. If you need to use elliptical, linear, or irregularly shaped regions, you will need to use a journal to manipulate them. This chapter presents the Visual Basic functions that you will need for creating and manipulating regions and for measuring and obtaining data from regions.

In this chapter

This chapter contains the following topics:

Topic	See Page
Creating and Removing Regions	97
Finding Regions	99
Reading and Manipulating Region Properties	103
Reading Image Data from Regions	109

7.2 Creating and Removing Regions

Introduction

The following functions are used for creating and removing regions of interest. At the time you create an ROI, MetaMorph assigns it a handle, just as it assigns handles to functions and entire image windows. All of the remaining functions that involve regions in this chapter will need to be supplied with the region handle. If you need to obtain the handle after you have already created the region, you will need to use the **GetRegion** or **GetActiveRegion** functions which are covered in Section 7.3.

CreateRectRegion

Description

Creates a rectangular region of interest in a specified image. You can specify the size and placement of a region you create simply by dictating the locations of its four corners.

Syntax

CreateRectRegion(*hImage* As Long, *x1* As Integer, *y1* As Integer, *x2* As Integer, *y2* As Integer, *hRetRegion* As Long) As Long

Parameters

hImage Specifies the handle of the image in which the region is to be created.

x1 Specifies the X-coordinate of the upper left corner of the region.

y1 Specifies the Y-coordinate of the upper left corner of the region.

x2 Specifies the X-coordinate of the lower right corner of the region.

y2 Specifies the Y-coordinate of the lower right corner of the region.

Return values

hRetRegion Returns the handle for the created region.

Example

```
' Create a recangular region on the current image
Dim im As Long
Dim r As Long
MM.GetCurrentImage im
MM.CreateRectRegion im, 10, 10, 50, 50, r
```

See also:

DestroyRegion, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **SetActiveRegion** (Section 6.4)

Continued on next page

DestroyRegion

Description Removes the specified region of interest.

Syntax **DestroyRegion**(*hRegion* As Long) As Long

Parameters *hRegion* Specifies the handle of the region to be removed. The handle can be obtained with the **GetRegion** function.

Example

```
' Delete the active region on the current image, if there
' is one
Dim im As Long
Dim r As Long

MM.GetCurrentImage im
MM.GetActiveRegion im, r

If r <> 0 Then
  MM.DestroyRegion r
Else
  MM.PrintMsg "No active region on the current image"
End If
```

See also: **GetRegion** (Section 7.3), **GetActive Region** (Section 7.3)

7.3 Finding Regions

Introduction

The functions in this section are essential for the control of procedures involving regions. These functions are used for finding a region's *handle*, the "indexing tag" that both Visual Basic and MetaMorph use to keep track of the region, as well as for determining how many regions have been defined and whether a handle is currently in use. The **GetActiveRegion** and **GetRegion** functions, which obtain a region's handle, are particularly important, and you will see these two functions referenced in the "See Also" lists throughout the rest of this chapter.

GetActiveRegion

Description

Obtains the handle number of the active region, if any, in a specified image.

Syntax

GetActiveRegion(*hImage* As Long, *lRetActiveRegion* As Long) As Long

Parameters

hImage Specifies the handle of the image.

Return values

lRetActiveRegion Returns the handle of the active region. If there is no active region, the value will be returned as 0. **Note:** An image can contain regions without any of them being active.

Example

```
' Delete the active region on the current image, if there
' is one
Dim im As Long
Dim r As Long

MM.GetCurrentImage im
MM.GetActiveRegion im, r

If r <> 0 Then
  MM.DestroyRegion r
Else
  MM.PrintMsg "No active region on the current image"
End If
```

See also:

GetCurrentImage (Section 4.3), **GetImage** (Section 4.3), **GetRegion**, **SetActiveRegion**

Continued on next page

GetNumberOfRegions

Description Returns the number of regions that exist on a specified image.

Syntax **GetNumberOfRegions**(*hImage* As Long, *nRetNumberOfRegions* As Integer) As Long

Parameters *hImage* Specifies the handle of the image.

Return values *nRetNumberOfRegions* Returns the number of regions that currently exist on the image.

Example

```
' Get the number of regions on the current image

Dim im As Long
Dim rCount As Integer

MM.GetCurrentImage im

MM.GetNumberOfRegions im, rCount
MM.PrintMsg "There are " + Str(rCount) + " regions on the
  current image"
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

GetRegion

Description Obtains the handle number of a specified region.

Syntax **GetRegion**(*hImage* As Long, *index* As Integer, *lRetRegion* As Long) As Long

Remarks All of the regions loaded in MetaMorph have an index number, from 0 to (n – 1), where n is the number of loaded regions. Regions are numbered according to their order of creation; thus, the first region is 0, the next is 1, and so on.

Parameters *hImage* Specifies the handle of the image.

index Specifies the number of the region. (See Remarks.)

Return values *lRetRegion* Returns the handle of the selected region. (**Note:** The handle is a number used by MetaMorph to carry out programmatic functions. This differs from the *index* number associated with the region.) If an error occurs, for example, if *index* is not a valid number, *lRetRegion* will contain 0.

Continued on next page

GetRegion
(continued)

Example

```
' Get the first region on the current image
Dim im As Long
Dim r As Long
MM.GetRegion im, 0, r
```

See also: **GetActiveRegion**, **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3)

IsValidRegion

Description Tests whether or not the region handle you pass is valid.

Syntax **IsValidRegion**(*hRegion* As Long) As Long

Parameters *hRegion* Specifies the handle of the region in question. If the handle value that you pass is not valid, **IsValidRegion** returns a value of "0". The function will return a nonzero value if the region handle is valid.

Example

```
' Check if some region is valid, and if it is, make it the
' active region.  'r' and 'im' are region and image handles
' that were declared and used previous to the code here.

If MM.IsValidRegion(r) <> 0 Then
  MM.PrintMsg "Region is valid"
  MM.SetActiveRegion im, r
Else
  MM.PrintMsg "Region is no longer valid"
End If
```

See also: **GetRegion**

Continued on next page

SetActiveRegion

Description Makes a selected region the active region.

Syntax **SetActiveRegion**(*hImage* As Long, *hRegion* As Long) As Long

Parameters *hImage* Specifies the handle of the image.

hRegion Specifies the handle of the region to be made active.

Example

```
' Check if some region is valid, and if it is, make it the
' active region.  'r' and 'im' are region and image handles
' that were declared and used previous to the code here.

If MM.IsValidRegion(r) <> 0 Then
  MM.PrintMsg "Region is valid"
  MM.SetActiveRegion im, r
Else
  MM.PrintMsg "Region is no longer valid"
End If
```

See also: **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetRegion**

7.4 Reading and Manipulating Region Properties

Introduction

It is often necessary or useful to obtain information about a region, such as its width, height, area, perimeter, or location. The functions that follow can be used to read or configure such region properties, as well as to obtain the X and Y coordinates of the region's outline. One programming example is given for all of the region property "Get" functions (see Figure 7.1 on page 106).

GetRegionArea

Description Obtains the area, expressed as the number of pixels, of a specified region of interest.

Syntax **GetRegionArea**(*hRegion* As Long, *lRetArea* As Long) As Long

Parameters *hRegion* Specifies the handle of the region in question.

Return values *lRetArea* Returns the number of pixels in the region.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionSize**

GetRegionDistance

Description Obtains the perimeter of a specified region of interest. The distance measurement will be reported in calibrated units.

Syntax **GetRegionDistance**(*hRegion* As Long, *dRetDistance* As Double) As Long

Remarks This function differs from **RegionGetNumEdgePixels** in its expression of the perimeter in calibrated units. **RegionGetNumEdgePixels** expresses the perimeter in terms of the number of pixels.

Parameters *hRegion* Specifies the handle of the region in question.

Return values *dRetDistance* Returns the perimeter of the region, in calibrated units.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **RegionGetNumEdgePixels**

Continued on next page

GetRegionPosition

Description Obtains the on-screen position of a specified region of interest.

Syntax **GetRegionPosition**(*hRegion* As Long, *nRetXPos* As Integer, *nRetYPos* As Integer) As Long

Parameters *hRegion* Specifies the handle of the region in question.

Return values *nRetXPos* Returns the starting (upper left) X-coordinate of the specified region.

nRetYPos Returns the starting Y-coordinate of the specified region.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionSize**, **SetRegionPosition**

GetRegionSize

Description Obtains the width and height of a specified region of interest.

Syntax **GetRegionSize**(*hRegion* As Long, *nRetXSize* As Integer, *nRetYSize* As Integer) As Long

Parameters *hRegion* Specifies the handle of the region in question.

Return values *nRetXSize* Returns the width, in pixels, of the specified region.

nRetYSize Returns the height, in pixels, of the specified region.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionArea**, **GetRegionPosition**, **SetRegionSize**

Continued on next page

RegionGetNumEdgePixels

Description Obtains the perimeter of a specified region of interest. The distance measurement will be reported in terms of the number of pixels.

Syntax **RegionGetNumEdgePixels**(*hRegion* As Long, *lNumPixels* As Long) As Long

Remarks **RegionGetNumEdgePixels** returns in *lNumPixels* the number of pixels comprising the edge of the given region. This function will usually be used in conjunction with **RegionGetEdgePixelCoordinates**. You would call **RegionGetNumEdgePixels** first to determine how big to make the arrays you pass to **RegionGetEdgePixelCoordinates**.

Parameters *hRegion* Specifies the handle of the region in question.

Return values *lNumPixels* Returns the perimeter of the region, in pixels.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionDistance**

RegionGetEdgePixelCoordinates – for Visual Basic 6 & earlier
RegionGetEdgePixelCoordinatesEx2 – for Visual Basic .NET (2002 – 2008)

Description Obtains the X and Y coordinates of all the pixels lying under the edge of a region.

Syntax **RegionGetEdgePixelCoordinates**(*hRegion* As Long, *lBufferSize* As Long, *aRetXBuffer()* As Integer, *aRetYBuffer()* As Integer) As Long
RegionGetEdgePixelCoordinatesEx2(*hRegion* As Long, *lBufferSize* As Long, *aRetXBuffer()* As Integer, *aRetYBuffer()* As Integer) As Long

Parameters *hRegion* Specifies the handle of the region in question.

lBufferSize Sets the size of the array into which the X and Y coordinates will be read. You can use **RegionGetNumEdgePixels** to determine how many pixels that should be.

Return values *aRetXBuffer()* Returns the X-coordinates of the pixels lying under the edge of the region. The size of this array will be determined by the number of pixels in the edgelist.

aRetYBuffer() Returns the Y-coordinates of the pixels lying under the edge of the region. The size of this array will be determined by the number of pixels in the edgelist.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **RegionGetNumEdgePixels**

Continued on next page

Figure 7.1 Region Property "Get" Function Programming Example

```
' Get property information about the active region

Dim im As Long
Dim r As region

MM.GetCurrentImage im
MM.GetActiveRegion im, r

Dim area As Long
MM.GetRegionArea r, area
MM.PrintMsg "Pixel area of the active region is " + Str(area)

Dim distance As Double
MM.GetRegionDistance r, distance
MM.PrintMsg "Calibrated perimeter of the active region is "
  + Str(distance)

Dim x As Integer, y As Integer
MM.GetRegionPosition r, x, y
Dim dx As Integer, dy As Integer
MM.GetRegionSize r, dx, dy
MM.PrintMsg "Position of the region is " + Str(x) + ", "
  + Str(y)
MM.PrintMsg "Size of the region is " + Str(dx) + ", "
  + Str(dy)

Dim numpix As Long
' First find out how many pixels are in the edge of
' the region
MM.RegionGetNumEdgePixels r, numpix

' Then get the coordinates of all the edge pixels
Dim x(numpix) As Integer, y(numpix) As Integer
MM.RegionGetEdgePixelCoordinates r, numpix, x, y
```

Continued on next page

SetRegionPosition

Description Moves a selected region of interest to a specified position.

Syntax **SetRegionPosition**(*hRegion* As Long, *xPos* As Integer, *yPos* As Integer) As Long

Parameters *hRegion* Specifies the handle of the region in question.

xPos Specifies the X-coordinate of the new starting point (upper left corner) of the selected region.

yPos Specifies the Y-coordinate of the new starting point of the selected region.

Example

```
' Move the active region to the upper left corner of the image
' and make it 100 x 100 pixels in size

Dim im As Long
Dim r As Long

MM.GetCurrentImage im
MM.GetActiveRegion im, r

MM.SetRegionPosition r, 0, 0
MM.SetRegionSize r, 100, 100
```

See also: **GetRegion** (Section 7.3), **GetRegionPosition**

SetRegionSize

Description Resizes a selected region of interest to a specified width and height.

Syntax **SetRegionSize**(*hRegion* As Long, *xSize* As Integer, *ySize* As Integer) As Long

Parameters *hRegion* Specifies the handle of the region in question.

xSize Specifies the new width, in pixels, of the selected region.

ySize Specifies the new height, in pixels, of the selected region.

Continued on next page

SetRegionSize
(continued)

Example

```
' Move the active region to the upper left corner of the image
' and make it 100 x 100 pixels in size

Dim im As Long
Dim r As Long

MM.GetCurrentImage im
MM.GetActiveRegion im, r

MM.SetRegionPosition r, 0, 0
MM.SetRegionSize r, 100, 100
```

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionSize**

SwapRegionNumbers

Description Exchanges the numbers associated with two selected regions.

Syntax **SwapRegionNumbers**(*rhRegion1* As Long, *rhRegion2* As Long)

Parameters

rhRegion1 Specifies the handle of one of the two selected regions.

rhRegion2 Specifies the handle of the other selected region.

See also: **GetActiveRegion** (Section 7.3), **GetRegion** (Section 7.3)

7.5 Reading Image Data from Regions

Introduction

This section describes a number of functions which are invaluable for obtaining grayscale information from a region of interest. You can derive the minimum, maximum, and average intensity value in a region, as well as the standard deviation around the mean. One programming example is given for all of the region data "Get" functions (see Figure 7.2 on page 112). You will need to apply the **MeasureRegion** function as a preliminary step to obtaining these data. If your images have been calibrated in MetaMorph with the Calibrate Distances or Calibrate Gray Levels commands, the "read" functions in this section will return data expressed in calibrated units, rather than as numbers of pixels or as grayscale levels.

GetRegionAverageValue

Description Obtains the average of all of the grayscale values in a specified region of interest.

Syntax **GetRegionAverageValue**(*hRegion* As Long, *dRetAverageValue* As Double) As Long

Remarks Before you apply this function, the region must first be measured with the **MeasureRegion** function.

Parameters *hRegion* Specifies the handle of the region.

Return values *dRetAverageValue* Returns the average intensity value from the region.

See also: **GetActive Region** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionMaximumValue**, **GetRegionMinimumValue**, **GetRegionStdDeviation**, **MeasureRegion**

GetRegionMinimumValue

Description Obtains the lowest grayscale value in a specified region of interest.

Syntax **GetRegionMinimumValue**(*hRegion* As Long, *dRetMinValue* As Double) As Long

Remarks Before you apply this function, the region must first be measured with the **MeasureRegion** function.

Parameters *hRegion* Specifies the handle of the region.

Return values *dRetMinValue* Returns the minimum intensity value in the region.

See also: **GetActive Region** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionAverageValue**, **GetRegionMaximumValue**, **GetRegionStdDeviation**, **MeasureRegion**

Continued on next page

GetRegionMaximumValue

Description Obtains the highest grayscale value in a specified region of interest.

Syntax **GetRegionMaximumValue**(*hRegion* As Long, *dRetMaxValue* As Double) As Long

Remarks Before you apply this function, the region must first be measured with the **MeasureRegion** function.

Parameters *hRegion* Specifies the handle of the region.

Return values *dRetMaxValue* Returns the maximum intensity value in the region.

See also: **GetActive Region** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionAverageValue**, **GetRegionMinimumValue**, **GetRegionStdDeviation**, **MeasureRegion**

GetRegionStdDeviation

Description Obtains the standard deviation of the grayscale values in a specified region of interest.

Syntax **GetRegionStdDeviation**(*hRegion* As Long, *dRetStdDeviation* As Double) As Long

Remarks Before you apply this function, the region must first be measured with the **MeasureRegion** function.

Parameters *hRegion* Specifies the handle of the region.

Return values *dRetStdDeviation* Returns the standard deviation of the intensity values in the region.

See also: **GetActive Region** (Section 7.3), **GetRegion** (Section 7.3), **GetRegionAverageValue**, **GetRegionMaximumValue**, **GetRegionMinimumValue**, **MeasureRegion**

Continued on next page

GetRegionThresholdArea

Description Obtains the number of pixels in a specified region that are inside the current threshold.

Syntax **GetRegionThresholdArea**(*hRegion* As Long, *lRetArea* As Long) As Long

Remarks Before you apply this function, the region must first be measured with the **MeasureRegion** function.

Parameters *hRegion* Specifies the handle of the region.

Return values *lRetArea* Returns the number of thresholded pixels in the region.

See also: **GetActive Region** (Section 7.3), **GetRegion** (Section 7.3), **MeasureRegion**

MeasureRegion

Description Measures the grayscale data in a specified region of interest of an image.

Syntax **MeasureRegion**(*hRegion* As Long, *hImage* As Long, *bUseThreshold* As Boolean) As Long

Parameters *hRegion* Specifies the handle of the region.

hImage Specifies the handle of the image.

bUseThreshold Determines whether the measurement will be made of just those pixels that are thresholded, or if all pixels are to be measured. If only thresholded pixels are to be measured, *bUseThreshold* should be set to TRUE. If all pixels are to be measured, set *bUseThreshold* to FALSE.

See also: **GetActive Region** (Section 7.3), **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **GetRegion** (Section 7.3)

Continued on next page

Figure 7.2 Region Data “Get” Function Programming Example

```
' Measure the active region on the current image and print
' out the information that was measured

Dim im As Long
Dim r As region

MM.GetCurrentImage im
MM.GetActiveRegion r

MM.MeasureRegion r, im, FALSE       ' Do not use threshold
Dim average As Double
Dim min As Double
Dim max As Double
Dim stddev As Double
Dim area As Long
MM.GetRegionAverageValue r, average
MM.GetRegionMinimumValue r, min
MM.GetRegionMaximumValue r, max
MM.GetRegionStdDeviation r, stddev
MM.GetRegionThresholdArea r, area

MM.PrintMsg "Average is " + Str(average)
MM.PrintMsg "Minimum is " + Str(min)
MM.PrintMsg "Maximum is " + Str(max)
MM.PrintMsg "Standard deviation is " + Str(stddev)
MM.PrintMsg "Threshold area should be 0, because the
  region was"

MM.PrintMsg "Measured without thresholding.  The area is: "
  + Str(area)
```

Chapter 8 – Performing Morphometry

8.1 Overview

Introduction

As the premier morphometric analysis system, MetaMorph offers an extensive array of functions for measurement and analysis of image objects. This chapter discusses the Visual Basic functions that you will need for configuring your morphometric measurements, creating classifier filters, and measuring objects. The operative function that measures your image, **MorphMeasureObjects**, is covered in Section 8.5. Before you can apply this function, however, please remember to define a threshold range, as detailed in Section 6.2, *Applying Thresholding*.

In this chapter

This chapter contains the following topics:

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Configuring Measurement Preferences	114
Configuring Object Measurements	115
Configuring Classifier Filters	119
Measuring All Objects in an Image	121
Measuring Single Objects	126

8.2 Configuring Measurement Preferences

Introduction

Before you measure your images, you may want to configure MetaMorph's behavior during the measurement procedure. The settings you use for the two functions that follow will determine two types of behavior: whether objects that "fail" a classifier filter (see Section 8.4) are redrawn in the result image, and whether "holes" (unthresholded areas in the middle of an object) are "filled" prior to measurement.

MorphSetDrawFailedObjectsFlag

Description

Sets whether objects that fail to pass any classifiers should be drawn in the resultant measurement image.

Syntax

MorphSetDrawFailedObjectsFlag(*bRedraw* As Boolean) As Long

Parameters

bRedraw Determines whether failed objects will be drawn. If *bRedraw* is set to TRUE, failed objects will be drawn. If *bRedraw* is set to FALSE, failed objects will not be drawn.

Example

```
' The next time measurements are performed, don't draw objects
' that don't pass any classifiers and fill holes in objects
MM.MorphSetDrawFailedObjectsFlag FALSE
MM.MorphSetFillHoleFlag TRUE
```

MorphSetFillHoleFlag

Description

Sets whether "holes" (unthresholded areas enclosed within thresholded areas) will be filled in (treated as thresholded) when measurement occurs.

Syntax

MorphSetFillHoleFlag(*bRedraw* As Boolean) As Long

Remarks

If *bRedraw* is TRUE, they will be filled in. If FALSE, they will not be.

Parameters

bRedraw Determines whether or not holes are to be filled. If *bRedraw* is set to TRUE, holes will be filled and subsequent measurements will include their areas. If *bRedraw* is set to FALSE, holes will not be filled.

Example

```
' The next time measurements are performed, don't draw objects
' that don't pass any classifiers and fill holes in objects
MM.MorphSetDrawFailedObjectsFlag FALSE
MM.MorphSetFillHoleFlag TRUE
```

8.3 Configuring Object Measurements

Introduction

Just as image windows, functions, and regions are manipulated by their handles, so too are object parameters manipulated by using an index number, the *parameter number*. Several configuration and measurement functions depend on the correct parameter number being passed to them. In this section, we discuss several functions that allow you to obtain a parameter's number, or to obtain other information about a parameter based on the number you pass. In addition, another measurement configuration function, **MorphSetupMeasurements**, is used for specifying the image to be measured and a second image, the mask image, which will be used to define the distribution of the thresholding overlay.

MorphFindParmIndex

Description

Obtains the number of a specified parameter.

Syntax

MorphFindParmIndex(*sParmName* As String, *nRetParmNumber* As Integer) As Long

Parameters

sParmName Specifies the name of the parameter for which you want to obtain a parameter number. The parameter names that you can use consist of those used for the MetaMorph morphometry functions. You can see these names in the Configure Object Classifiers, Configure Object Measurements, or Integrated Morphometry Analysis dialog boxes.

Return values

nRetParmNumber Returns the number of the parameter specified by *sParmName*. If no parameter by that name exists, *nRetParmNumber* will be returned as -1.

Example

```
' Find the width of object 5.  This code assumes that
' measurements have already been made.
Dim I As Integer
Dim nWidth As Single
MM.MorphFindParmIndex "Width", n
MM.MorphGetParmMeasurement 5, n, nWidth
MM.PrintMsg "The width of object 5 is " + Str(nWidth)
```

See also:

MorphGetParmDescription, **MorphGetParmMeasurement** (Section 8.6), **MorphGetParmName**

Continued on next page

MorphGetNumberOfParms

Description Obtains the total number of measurable parameters.

Syntax **MorphGetNumberOfParms**(*nRetParms* As Integer) As Long

Return values *nRetParms* Returns the total number of measurable parameters.

Example

```
' Print out the names and descriptions of all the measurement
' parameters

Dim nParms As Integer
Dim i As Integer
Dim parmName As String
Dim desc As String

MM.MorphGetNumberOfParms nParms
For i = 0 To nParms - 1
  MM.MorphGetParmName i, parmName
  MM.MorphGetParmDescription i, desc
  MM.PrintMsg parmName + ": " + desc
Next i
```

MorphGetParmDescription

Description Obtains a description of a parameter for which you have a parameter number.

Syntax **MorphGetParmDescription**(*nParmNumber* As Integer, *sRetParmDescription* As String) As Long

Parameters *nParmNumber* Specifies the number of the parameter for which you want to obtain a description. This number can be obtained with the **MorphFindParmIndex** function.

Return values *sRetParmDescription* Returns a textual description of the parameter in question.

Continued on next page

MorphGetParmDescription
(continued)

Example

```
' Print out the names and descriptions of all the measurement
' parameters

Dim nParms As Integer
Dim i As Integer
Dim parmName As String
Dim desc As String

MM.MorphGetNumberOfParms nParms
For i = 0 To nParms - 1
  MM.MorphGetParmName i, parmName
  MM.MorphGetParmDescription i, desc
  MM.PrintMsg parmName + ": " + desc
Next i
```

See also: **MorphFindParmIndex**, **MorphGetParmName**

MorphGetParmName

Description Obtains the name of a parameter for which you have a parameter number.

Syntax **MorphGetParmName**(*nParmNumber* As Integer, *sRetParmName* As String) As Long

Parameters *nParmNumber* Specifies the number of the parameter for which you want to obtain a description. This number can be obtained with the **MorphFindParmIndex** function.

Return values *sRetParmName* Returns the name of the parameter in question.

Example

```
' Print out the names and descriptions of all the measurement
' parameters

Dim nParms As Integer
Dim i As Integer
Dim parmName As String
Dim desc As String

MM.MorphGetNumberOfParms nParms
For i = 0 To nParms - 1
  MM.MorphGetParmName i, parmName
  MM.MorphGetParmDescription i, desc
  MM.PrintMsg parmName + ": " + desc
Next i
```

See also: **MorphFindParmIndex**, **MorphGetParmDescription**

Continued on next page

MorphSetupMeasurements

Description Selects images to be used as measurement and mask images for subsequent measurement with **MorphMeasureObjects**.

Syntax **MorphSetupMeasurements**(*hGrayImage* As Long, *hMaskImage* As Long, *fStdArea* As Single) As Long

Remarks This function selects the measurement image and mask image for use in subsequent measurements with **MorphMeasureObjects**. Also, if you want to count objects, this function allows you to define and make measurements with a *standard area*. Counting objects can sometimes be difficult because they may overlap or are poorly defined in the image. A standard area is a value that you believe represents the area of a standard object, based on the assumption that the objects being measured are of a fairly uniform size. The clumps of objects will be counted by dividing the area of the clump by the standard area.

If you are not interested in using a standard area, you can set *fStdArea* to 1.

Parameters *hGrayImage* Specifies the handle of the image to be used for measurement. Image handles can be obtained with **GetImage**.

hMaskImage Specifies the handle of the image to be used as a mask image. Typically, *hMaskImage* is an image created by setting a threshold on *hGrayImage* and then using **BinarizeImage** to create a binary image from that.

fStdArea Defines the size of the standard area. The units used depends on whether you have calibrated the image for distance.

Example

```
' Create a binary mask of the current image and then measure
' the image
Dim im As Long

' Put a threshold on the current image
MM.GetCurrentImage im
MM.SetThresholdState im, 1
MM.SetThresholdRange im, 50, 150

' Create the binarized image
Dim bin As Long
MM.CreateImage 512, 512, 1, "binary image", bin
MM.BinarizeImage im, bin

' Measure
MM.MorphSetupMeasurements im, bin, 1#
MM.MorphMeasureObjects TRUE
```

See also: **BinarizeImage** (Section 6.3), **GetCurrentImage** (Section 4.3), **GetImage** (Section 4.3), **MorphMeasureObjects** (Section 8.5)

8.4 Configuring Classifier Filters

Introduction

Classifier filters are morphometric measurement ranges through which an object's measurements must "pass" to be included in the final set. Using a classifier filter, you can restrict your measurements to just those objects that meet your set criteria, while excluding other classes of objects. The two functions which follow are used for reading the current settings of a classifier filter for a specified parameter and for configuring those settings.

MorphGetFilter

Description

Obtains the settings of the classifier filter for a specified parameter.

Syntax

MorphGetFilter(*nClassifierNumber* As Integer, *nParmNumber* As Integer, *fRetMinVal* As Single, *fRetMaxVal* As Single, *bRetInclusive* As Boolean, *bRetEnableFilter* As Boolean) As Long

Parameters

nClassifierNumber Specifies the number of the classifier filter in question (0 – 7). This classifier is one you will have defined, and the number is one you will have assigned with the **MorphSetFilter** function.

nParmNumber Specifies the parameter number of the classifier for which the filter is being configured. This number can be obtained with the **MorphFindParmIndex** function. These predefined classifiers are those that correspond to the parameters used for the MetaMorph morphometry functions. You can see these parameters in the Configure Object Classifiers, Configure Object Measurements, or Integrated Morphometry Analysis dialog boxes.

Return values

fRetMinVal Returns the minimum value of the filter.

fRetMaxVal Returns the maximum value of the filter.

bRetInclusive Indicates whether the range minimum and maximum are inclusive (that is, the filter "passes" objects if they have values between the minimum and maximum) or exclusive (that is, the filter "passes" objects if they have values equal to or outside the minimum and maximum). If the filter has been set to the inclusive state, a *bRetInclusive* value of TRUE will be returned. If the filter is exclusive, a value of FALSE will be returned.

bRetEnableFilter Indicates whether the filter is active or not. If the filter is active, *bRetEnableFilter* will return with a value of TRUE. If the filter is inactive, a value of FALSE will be returned.

Continued on next page

MorphGetFilter
(continued)

Example

```
' Tell the first filter to stop filtering on total area, while
' leaving the filtering parameters unchanged.
Dim min As Single, max As Single
Dim inclusive As Boolean, enable As Boolean
MM.MorphGetFilter 0, 0, min, max, inclusive, enable
MM.MorphSetFilter 0, 0, min, max, inclusive, FALSE
```

See also: **MorphFindParmIndex** (Section 8.3), **MorphSetFilter**

MorphSetFilter

Description Configures the settings of a classifier filter for a specified parameter.

Syntax **MorphSetFilter**(*nClassifierNumber* As Integer, *nParmNumber* As Integer, *fMinVal* As Single, *fMaxVal* As Single, *bInclusive* As Boolean, *bEnableFilter* As Boolean) As Long

Parameters

nClassifierNumber Specifies a number for the classifier (0 – 7). Typically, this number will be based on the order of configuration.

nParmNumber Specifies the parameter number of the classifier for which the filter is being configured. This number can be obtained with the **MorphFindParmIndex** function.

fMinVal Specifies the minimum value of the filter.

fMaxVal Specifies the maximum value of the filter.

bInclusive Specifies whether the range minimum and maximum are to be inclusive (that is, the filter will "pass" objects that have values between the minimum and maximum) or exclusive (that is, the filter will "pass" objects that have values equal to or outside the minimum and maximum). To set the filter to the inclusive state, assign a value of TRUE to *bInclusive*. To make the filter exclusive, assign a value of FALSE.

bEnableFilter Specifies whether the filter will be active or inactive. To activate the filter, set *bEnableFilter* to TRUE. To deactivate the filter, assign a value of FALSE.

Example

```
' Set the first filter to only pass objects whose total area
' is between 10 and 50.
MM.MorphSetFilter 0, 0, 10, 50, TRUE, TRUE
```

See also: **MorphFindParmIndex** (Section 8.3), **MorphGetFilter**

8.5 Measuring All Objects in an Image

Introduction

MetaMorph automatically measures all objects in an image, but the resulting data are managed either as a group or on an object-by-object basis. Data for the entire group are presented as a statistical summary, and can be saved in a summary log. The functions in this section deal with obtaining and managing group measurement data. This includes the important **MorphMeasureObjects** function. (For a discussion of single object measurement functions, see Section 8.6.)

MorphDeleteObject

Description

Removes a specified object from the list of measured objects.

Syntax

MorphDeleteObject(*nObjectID* As Integer) As Long

Remarks

You can prevent a specific object from having a contribution to the summary data by using this function in conjunction with **MorphRecalc**.

Parameters

nObjectID Specifies the number of the object to be deleted. Objects are numbered from 0 to (*n* – 1), where *n* is the total number of objects.

Example

```
' Delete object 4 from the morph summary data. This code
' assumes measurements have already been performed.
MM.MorphDeleteObject 4
MM.MorphRecalc
```

See also:

MorphRecalc

MorphGetNumberOfObjects

Description

Obtains the number of objects that were last measured by **MorphMeasureObjects**.

Syntax

MorphGetNumberOfObjects(*nRetObjects* As Integer) As Integer

Return values

nRetObjects Returns the number of objects that were measured.

See also:

MorphMeasureObjects

Continued on next page

MorphGetParmAccumSummary

Description

Obtains the cumulative statistics for all objects that passed a specified classifier filter for a selected parameter. This function returns the same information as **MorphGetParmSummary**, but combines the information with all previous measurements that have been made using the selected classifier filter.

Syntax

MorphGetParmAccumSummary(*nClassifierNumber* As Integer, *nParmNumber* As Integer, *lRetCount* As Long, *fRetAverage* As Single, *fRetMinVal* As Single, *fRetMaxVal* As Single, *fRetStdDeviation* As Single, *fRetTotal* As Single) As Long

Parameters

nClassifierNumber Specifies the classifier number (0 – 7). This number is one that you will have assigned with the **MorphSetFilter** function.

nParmNumber Specifies the parameter number of the classifier filter. This number can be obtained with the **MorphFindParmIndex** function.

Return values

lRetCount Returns the total number of objects which passed the classifier.

fRetAverage Returns the average value of the given parameter for all passed objects.

fRetMinVal Returns the lowest value of the parameter for all objects.

fRetMaxVal Returns the highest value of the parameter for all objects.

fRetStdDeviation Returns the standard deviation of the parameter for all objects.

fRetTotal Returns the sum of the values for all objects.

Example

```
' Get the parameter summary and the accumulated summary data of
' the first filter for total area
MM.MorphGetParmSummary 0, 0, count, average, min, max, stddev,
  total

Dim count As Long
Dim average As Single, min As Single, max As Single
Dim stddev As Single, total As Single

MM.PrintMsg "The count is " + Str(count)
MM.PrintMsg "The average is " + Str(average)
MM.PrintMsg "The min is " + Str(min)
MM.PrintMsg "The max is " + Str(max)
MM.PrintMsg "The standard deviation is " + Str(stddev)
MM.PrintMsg "The total is " + Str(total)

MM.MorphGetParmAccumSummary 0, 0, count, average, min, max,
  stddev, total
```

Continued on next page

MorphGetParmAccumSummary
(continued)

```
MM.PrintMsg "The accumulated count is " + Str(count)
MM.PrintMsg "The accumulated average is " + Str(average)
MM.PrintMsg "The accumulated min is " + Str(min)
MM.PrintMsg "The accumulated max is " + Str(max)
MM.PrintMsg "The accumulated standard deviation is "
  + Str(stddev)
MM.PrintMsg "The accumulated total is " + Str(total)
```

See also: **MorphFindParmIndex** (Section 8.3), **MorphGetParmSummary, MorphSetFilter** (Section 8.4)

MorphGetParmSummary

Description Obtains the statistics for all objects that passed a specified classifier filter for a selected parameter.

Syntax **MorphGetParmSummary**(*nClassifierNumber* As Integer, *nParmNumber* As Integer, *lRetCount* As Long, *fRetAverage* As Single, *fRetMinVal* As Single, *fRetMaxVal* As Single, *fRetStdDeviation* As Single, *fRetTotal* As Single) As Long

Parameters

nClassifierNumber Specifies the classifier number (0 – 7). This number is one that you will have assigned with the **MorphSetFilter** function.

nParmNumber Specifies the parameter number of the classifier filter. This number can be obtained with the **MorphFindParmIndex** function.

Return values

lRetCount Returns the total number of objects which passed the classifier.

fRetAverage Returns the average value of the given parameter for all passed objects.

fRetMinVal Returns the lowest value of the parameter for all objects.

fRetMaxVal Returns the highest value of the parameter for all objects.

fRetStdDeviation Returns the standard deviation of the parameter for all objects.

fRetTotal Returns the sum of the values for all objects.

Continued on next page

MorphGetParmSummary
(continued)

Example

```
' Get the parameter summary and the accumulated summary data of
' the first filter for total area
MM.MorphGetParmSummary 0, 0, count, average, min, max, stddev,
  total

Dim count As Long
Dim average As Single, min As Single, max As Single
Dim stddev As Single, total As Single

MM.PrintMsg "The count is " + Str(count)
MM.PrintMsg "The average is " + Str(average)
MM.PrintMsg "The min is " + Str(min)
MM.PrintMsg "The max is " + Str(max)
MM.PrintMsg "The standard deviation is " + Str(stddev)
MM.PrintMsg "The total is " + Str(total)

MM.MorphGetParmAccumSummary 0, 0, count, average, min, max,
  stddev, total

MM.PrintMsg "The accumulated count is " + Str(count)
MM.PrintMsg "The accumulated average is " + Str(average)
MM.PrintMsg "The accumulated min is " + Str(min)
MM.PrintMsg "The accumulated max is " + Str(max)
MM.PrintMsg "The accumulated standard deviation is "
  + Str(stddev)
MM.PrintMsg "The accumulated total is " + Str(total)
```

See also: **MorphFindParmIndex** (Section 8.3), **MorphGetParmAccumSummary, MorphSetFilter** (Section 8.4)

MorphMeasureObjects

Description Measures the *hGrayImage* image that was last specified by **MorphSetupMeasurements**.

Syntax **MorphMeasureObjects**(*bMeasureAll* As Boolean) As Long

Parameters *bMeasureAll* Determines whether object measurements will be handled on a single basis only or as a whole. If you set *bMeasureAll* to TRUE, all of the objects in the image will be measured and their data made available to the various summary data functions, as well as to the object data functions. If you set this variable to FALSE, data will be passed only to the object data functions.

Continued on next page

MorphMeasureObjects
(continued)

Example

```
' Create a binary mask of the current image and then measure
' the image

Dim im As Long

' Put a threshold on the current image
MM.GetCurrentImage im
MM.SetThresholdState im, 1
MM.SetThresholdRange im, 50, 150

' Create the binarized image
Dim bin As Long
MM.CreateImage 512, 512, 1, "binary image", bin
MM.BinarizeImage im, bin

' Measure
MM.MorphSetupMeasurements im, bin, 1#
MM.MorphMeasureObjects TRUE
```

See also: **MorphSetupMeasurements** (Section 8.3)

MorphRecalc

Description Recomputes the statistical summary data for the current list of objects to be measured.

Syntax **MorphRecalc**() As Long

Remarks If any objects have been deleted (using **MorphDeleteObject**), those objects will be eliminated from the measurement of summary data.

Example

```
' Delete object 4 from the morph summary data.  This code
' assumes measurements have already been performed.
MM.MorphDeleteObject 4
MM.MorphRecalc
```

See also: **MorphDeleteObject**

8.6 Measuring Single Objects

Introduction

Data for individual objects are measured for all objects in an image simultaneously, but can be obtained and used on an object-by-object basis. This section describes the functions that you can use to obtain measurement data for an individual object. (For a discussion of group object measurement functions, see Section 8.5.) One programming example is given for all of the single object data "Get" functions (see Figure 8.1 on page 132).

MorphGetCentroid

Description

Obtains the coordinates of the centroid (point that represents the center of mass) of a specified object. The centroid will be given in fractional pixel coordinates.

Syntax

MorphGetCentroid(*nObjectID* As Integer, *fRetX* As Single, *fRetY* As Single) As Long

Remarks

This function differs from **MorphGetCentroidPixel** in its use of fractional coordinates. **MorphGetCentroidPixel** expresses coordinates as integer values by locating the pixel nearest to the "fractional" centroid.

Parameters

nObjectID Specifies the number of the object. Objects are numbered from 0 to (n – 1), where n is the total number of objects.

Return values

fRetX Returns the X-coordinate of the object centroid.

fRetY Returns the Y-coordinate of the object centroid.

See also:

MorphGetCentroidPixel

MorphGetCentroidPixel

Description

Obtains the coordinates of the pixel nearest to the centroid (the point that represents the center of mass) of a specified object.

Syntax

MorphGetCentroidPixel(*nObjectID* As Integer, *nRetX* As Integer, *nRetY* As Integer) As Long

Remarks

This function differs from **MorphGetCentroid** in that it expresses coordinates as integer values by locating the pixel nearest to the "fractional" centroid. **MorphGetCentroid** expresses the exact location of the centroid using fractional coordinates.

Parameters

nObjectID Specifies the number of the object. Objects are numbered from 0 to (n – 1), where n is the total number of objects.

Continued on next page

MorphGetCentroidPixel
(continued)

Return values

fRetX Returns the X-coordinate of the pixel nearest to the object centroid.

fRetY Returns the Y-coordinate of the pixel nearest to the object centroid.

See also: **MorphGetCentroid**

MorphGetClassifiersPassed

Description Obtains the number of classifier filters that a specified object has passed.

Syntax **MorphGetClassifiersPassed**(*nObjectID* As Integer, *nRetClassifiersPassed* As Integer) As Long

Parameters

nObjectID Specifies the number of the object. Objects are numbered from 0 to (*n* – 1), where *n* is the total number of objects.

Return values

nRetClassifiersPassed Returns the number of classifier filters that the object has passed.

Example

```
' Find out how many classifiers object 9 passed
Dim n As Integer
MM.MorphGetClassifiersPassed 9, n
```

MorphGetClosestObject

Description Obtains the number of the object closest to a specified set of X and Y coordinates.

Syntax **MorphGetClosestObject**(*nX* As Integer, *nY* As Integer, *nRetObjectID* As Integer) As Long

Parameters

nX Specifies the X-coordinate.

nY Specifies the Y-coordinate.

Return values

nRetObjectID Returns the object number of the object closest to the specified coordinates.

Example

```
' Get the object number of the object nearest to coordinate
' 100, 100
Dim obj As Integer
MM.MorphGetClosestObject 100, 100, obj
```

Continued on next page

MorphGetInternalPoint

Description Obtains the set of coordinates of some pixel within a specified object.

Syntax **MorphGetInternalPoint**(*nObjectID* As Integer, *nRetX* As Integer, *nRetY* As Integer) As Long

Parameters *nObjectID* Specifies the number of the object. Objects are numbered from 0 to (*n* – 1), where *n* is the total number of objects.

Return values *nRetX* Returns the X-coordinate of a randomly selected pixel in the object.

nRetY Returns the Y-coordinate of the same randomly selected pixel.

MorphGetMeasurements – for Visual Basic 6 & earlier
MorphGetMeasurementsEx2 – for Visual Basic .NET (2002 – 2008)

Description Fills a defined array with all measurement data for a specified object.

Syntax **MorphGetMeasurements**(*nObjectID* As Integer, *aMeasurements()* As Single) As Long
MorphGetMeasurementsEx2(*nObjectID* As Integer, *aMeasurements()* As Single) As Long

Parameters *nObjectID* Specifies the number of the object. Objects are numbered from 0 to (*n* – 1), where *n* is the total number of objects.

Return values *aMeasurements()* Defines an array into which the object's measurement data will be read. The array should have at least the number of elements returned by **MorphGetNumberOfParms**.

Example

```
' Get all the measurements for object number 12.  This code
' assumes measurements have already been made.
Dim n As Integer
MM.MorphGetNumberOfParms nParms
Dim measurements(nParms) As Single
MM.MorphGetMeasurements 12, measurements
```

See also: **MorphGetNumberOfParms** (Section 8.3), **MorphMeasureObjects** (Section 8.5)

Continued on next page

MorphGetNumberOfRuns

Description Obtains the number of horizontal rows that compose a specified object.

Syntax **MorphGetNumberOfRuns**(*nObjectID* As Integer, *nRetNumberOfRuns* As Integer) As Long

Parameters *nObjectID* Specifies the number of the object. Objects are numbered from 0 to (*n* – 1), where *n* is the total number of objects.

Return values *nRetNumberOfRuns* Returns the number of horizontal rows in the object.

MorphGetNumberOfVertices

Description Obtains the number of vertices that make up the edgelist of a specified object.

Syntax **MorphGetNumberOfVertices**(*nObjectID* As Integer, *nRetNumVertices* As Integer) As Long

Parameters *nObjectID* Specifies the number of the object. Objects are numbered from 0 to (*n* – 1), where *n* is the total number of objects.

Return values *nRetNumVertices* Returns the number of vertices in the object's edgelist.

See also: **MorphGetVertexList**

MorphGetObjectBoundingRect

Description Obtains the coordinates of the upper left and lower right corners of a specified object's bounding rectangle.

Syntax **MorphGetObjectBoundingRect**(*nObjectID* As Integer, *nRetX1* As Integer, *nRetY1* As Integer, *nRetX2* As Integer, *nRetY2* As Integer) As Long

Remarks A *bounding rectangle* is a device used by MetaMorph to work with irregularly shaped objects. This contrivance is created by placing an imaginary rectangle over the object's outline. The sides of the rectangle will be perfectly horizontal and vertical, and the smallest rectangle possible will be used. The **MorphGetObjectBounding-Rect** function provides the coordinates of the starting point (upper left corner) and ending point (lower right corner).

Continued on next page

MorphGetObjectBoundingRect
(continued)

Parameters

nObjectID Specifies the number of the object. Objects are numbered from 0 to (n – 1), where n is the total number of objects.

Return values

nRetX1 Returns the X-coordinate of the upper left corner of the bounding rectangle.

nRetY1 Returns the Y-coordinate of the upper left corner of the bounding rectangle.

nRetX2 Returns the X-coordinate of the lower right corner of the bounding rectangle.

nRetY2 Returns the Y-coordinate of the lower right corner of the bounding rectangle.

See also: **MorphGetVertexList**

MorphGetParmMeasurement

Description

Obtains the measured value of a selected parameter for a specified object.

Syntax

MorphGetParmMeasurement(*nObjectID* As Integer, *nParmNumber* As Integer, *fRetMeasurement* As Single) As Long

Parameters

nObjectID Specifies the number of the object. Objects are numbered from 0 to (n – 1), where n is the total number of objects.

nParmNumber Specifies the parameter number. This number can be obtained with the **MorphFindParmIndex** function.

Example

```
' Find the width of object 5.  This code assumes that
' measurements have already been made.
Dim n As Integer
Dim nWidth As Single
MM.MorphFindParmIndex "Width", n
MM.MorphGetParmMeasurement 5, n, nWidth
MM.PrintMsg "The width of object 5 is " + Str(nWidth)
```

Return values

fRetMeasurement Returns the measured value of the selected parameter.

See also: **MorphFindParmIndex** (Section 8.3)

Continued on next page

MorphGetPixelArea

Description Obtains the number of pixels in a specified object.

Syntax **MorphGetPixelArea**(*nObjectID* As Integer, *lRetNumberOfPixels* As Long) As Long

Parameters *nObjectID* Specifies the number of the object. Objects are numbered from 0 to (n – 1), where n is the total number of objects.

Return values *lRetNumberOfPixels* Returns the number of pixels in the object.

MorphGetVertexList – for Visual Basic 6 & earlier
MorphGetVertexListEx2 – for Visual Basic .NET (2002 – 2008)

Description Obtains the X and Y coordinates of all vertices in the edgelist of a specified object.

Syntax **MorphGetVertexList**(*nObjectID* As Integer, *aX()* As Integer, *aY()* As Integer) As Long
MorphGetVertexListEx2(*nObjectID* As Integer, *aX()* As Integer, *aY()* As Integer) As Long

Remarks returns the coordinates of the vertices making up the edge list of the given object. The number of elements in the arrays *aX* and *aY* should at least the number of vertices in the object. use **MorphGetNumberOfVertices** to obtain this number.

Parameters *nObjectID* Specifies the number of the object. Objects are numbered from 0 to (n – 1), where n is the total number of objects.

aX() Defines a buffer into which the X-coordinates of the vertices will be read.

aY() Defines a buffer into which the Y-coordinates of the vertices will be read.

Return values *aX()* The X-coordinates of the vertices will be read into this predefined buffer. (See Parameters.)

aY() The Y-coordinates of the vertices will be read into this predefined buffer. (See Parameters.)

See also: **MorphGetNumberOfVertices**

Continued on next page

Figure 8.1 Single Object Data "Get" Function Programming Example

```
' For all the measured objects, print out some information
' obtained during measurement about each one.  This code
' assumes object measurements were previously performed.

Dim nObjects As Integer
MM.MorphGetNumberOfObjects nObjects

Dim i As Integer

For i = 0 To nObjects - 1
  MM.PrintMsg "Object " + Str(i) + " information:"

  Dim area As Long
  MM.MorphGetPixelArea i, area
  MM.PrintMsg " Pixel area is " + Str(area)

  Dim x As Single, y As Single
  MM.MorphGetCentroid i, x, y
  MM.PrintMsg " Centroid is at " + Str(x) + ", " + Str(y)

  Dim nx As Integer, ny As Integer
  MM.MorphGetCentroidPixel i, nx, ny
  MM.PrintMsg " Centroid pixel is at " + Str(nx) + ", "
    + Str(y)

  MM.MorphGetInternalPoint i, nx, ny
  MM.PrintMsg " The coordinates of a point inside the object
    are " + Str(nx) + ", " + Str(ny)

  Dim n As Integer
  MM.MorphGetNumberOfVertices i, n
  MM.PrintMsg " The object has " + Str(n) + " vertices"

  Dim ax(n) As Integer, ay(n) As Integer
  MM.MorphGetVertexList i, ax, ay

  Dim j As Integer
  For j = 0 To n
  MM.PrintMsg " Vertex " + Str(j) + " is " + Str(ax(j))
    + ", " + Str(ay(j))
  Next j
```

Continued on next page

Single Object Data "Get" Function Programming Example
(continued)

```
  MM.MorphGetNumberOfRuns i, n
  MM.PrintMsg " There are " + Str(n) + " runs in the object"

  Dim x1 As Integer, y1 As Integer, x2 As Integer,
    y2 As Integer
  MM.MorphGetObjectBoundingRect i, x1, y1, x2, y2
  MM.PrintMsg " The bounding rectangle coordinates are "
    + Str(x1) + ", " + Str(y1) + " and " + Str(x2) + ", "
    + Str(y2)
Next i
```

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