Application Note

DCC or DCU USB Camera Script Programming

This is a brief overview of how to get started making a custom MATLAB script to communicate with a Thorlabs DCC or DCU USB camera. While this application note is written for the DCU224C camera, the process is similar for the DCC1545M, DCC1645C, DCC1240M, DCC1240C, DCC3240M, DCC3240C, DCC3240N, DCU223M, DCU223C, or DCU224M. The example script is for reference only; the user is encouraged to extend or modify the script to fit his or her specific needs.

Author: Sean Tanner
Date: 16-06-2015

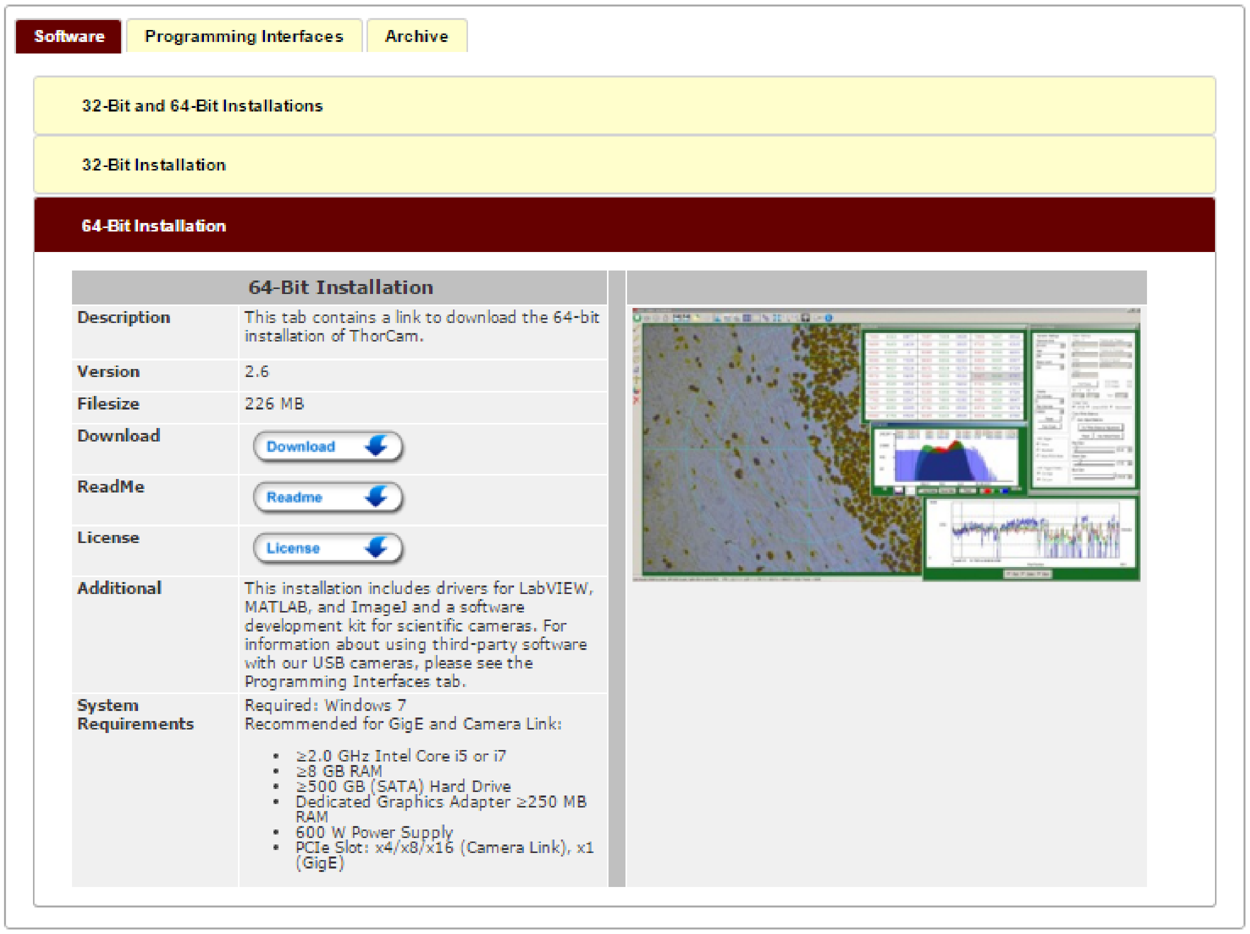
Part 1. Preface

This application note was written for the DCU224C camera using the firmware and software versions detailed below. Functionality and procedures may vary when using other controllers or firmware/software versions.

- ThorCam: Version 2.6.7064
- uc480 Driver: Version 4.60.7
- uc480DotNet: Version 1.6.1.0
- MATLAB: Version R2014a 64-bit

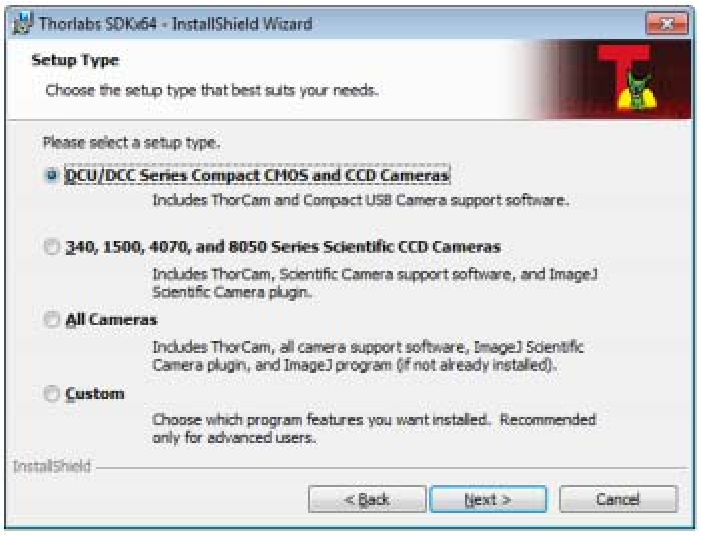
Part 2. Step by Step Instructions

1. Download and install the software for the ThorCam Software for Scientific and USB Cameras located on the Software tab here: http://www.thorlabs.com/software_pages/ViewSoftwarePage.cfm?Code=ThorCam



64-Bit Installation	
Description	This tab contains a link to download the 64-bit installation of ThorCam.
Version	2.6
Filesize	226 MB
Download	Download
ReadMe	Readme
License	License
Additional	This installation includes drivers for LabVIEW, MATLAB, and ImageJ and a software development kit for scientific cameras. For information about using third-party software with our USB cameras, please see the Programming Interfaces tab.
System Requirements	Required: Windows 7 Recommended for GigE and Camera Link: • ≥2.0 GHz Intel Core i5 or i7 • ≥8 GB RAM • ≥500 GB (SATA) Hard Drive • Dedicated Graphics Adapter ≥250 MB RAM • 600 W Power Supply • PCIe Slot: x4/x8/x16 (Camera Link), x1 (GigE)

2. During installation make sure to include support for either the DCU/DCC Series Compact CMOS and CCD Cameras or All Cameras.


Thorlabs SDKx64 - InstallShield Wizard

Setup Type

Choose the setup type that best suits your needs.

Please select a setup type.

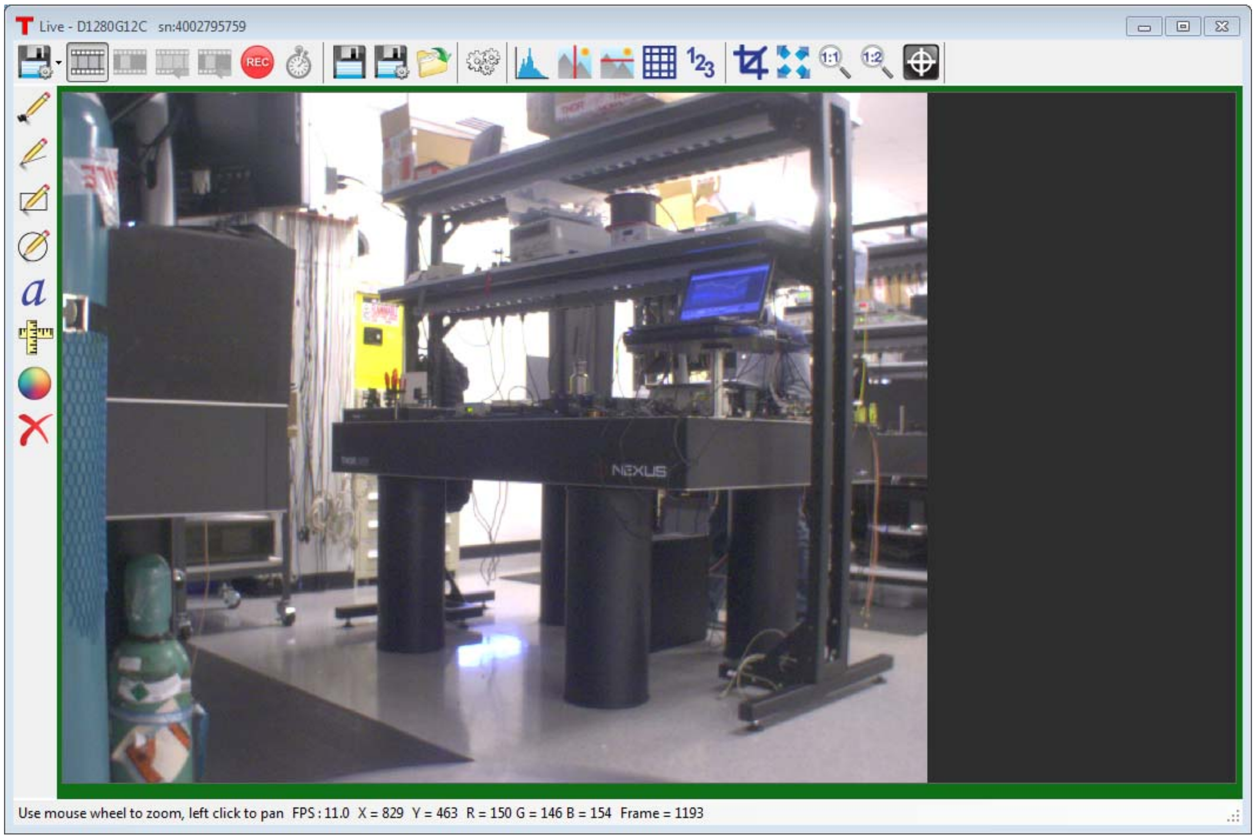
(●) **DCU/DCC Series Compact CMOS and CCD Cameras**
Includes ThorCam and Compact USB Camera support software.

( ) **340, 1500, 4070, and 8050 Series Scientific CCD Cameras**
Includes ThorCam, Scientific Camera support software, and ImageJ Scientific Camera plugin.

( ) **All Cameras**
Includes ThorCam, all camera support software, ImageJ Scientific Camera plugin, and ImageJ program (if not already installed).

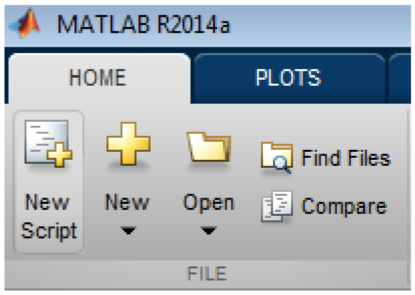
( ) **Custom**
Choose which program features you want installed. Recommended only for advanced users.

3. Run the Thorlabs ThorCam software to verify that your instrument is working with the computer correctly and become familiar with the operation of the device.

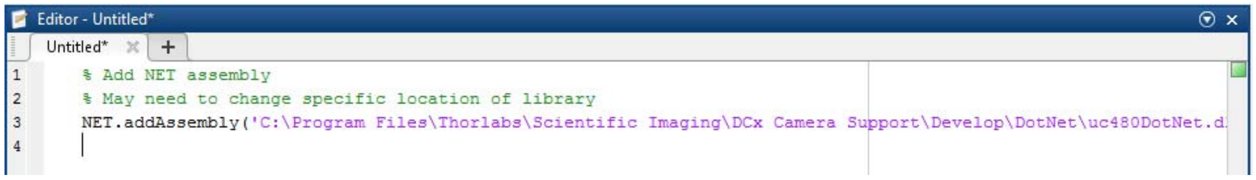


Use mouse wheel to zoom, left click to pan FPS : 11.0 X = 829 Y = 463 R = 150 G = 146 B = 154 Frame = 1193

4. Open MATLAB and start a new script.



5. Make the uc480DotNet assembly visible to MATLAB. If you are using 64 bit MATLAB you will need to use the 64 bit uc480DotNet.dll located in C:\Program Files\Thorlabs\Scientific Imaging\DCx Camera Support\Develop\DotNet (on a 64 bit machine). If you are using 32 bit MATLAB you will need to use the 32 bit uc480DotNet.dll located in C:\Program Files (x86)\Thorlabs\Scientific Imaging\DCx Camera Support\Develop\DotNet (on a 64 bit machine)



```
% Add NET assembly
% May need to change specific location of library
NET.addAssembly('C:\Program Files\Thorlabs\Scientific Imaging\DCx Camera Support\Develop\DotNet\uc480DotNet.d
```

6. Create a camera object handle.

```
% Create camera object handle
cam = uc480.Camera;
```

7. Open a camera. The Init method parameter is an integer which indicates which camera to open. If it is 0 the first available camera will be opened. The integer can also be the Cam.ID from the DCx Camera Manager if a particular camera would like to be used.

```
% Open the 1st available camera
cam.Init(0);
```

8. Set the display mode to bitmap (DiB). The Display.Mode.Set method parameter is a uc480.Defines.DisplayMode enumeration which defines the display mode.

```
% Set display mode to bitmap (DiB)
cam.Display.Mode.Set(uc480.Defines.DisplayMode.DiB);
```

9. Set the color mode to 8-bit RGB. The PixelFormat.Set method parameter is a uc480.Defines.ColorMode enumeration which defines the color mode.

```
% Set color mode to 8-bit RGB
cam.PixelFormat.Set(uc480.Defines.ColorMode.RGBA8Packed);
```

10. Set the trigger mode to software so we can take a single acquisition. The Trigger.Set method parameter is a uc480.Defines.TriggerMode enumeration which defines the trigger mode.

```
% Set trigger mode to software (single image acquisition)
cam.Trigger.Set(uc480.Defines.TriggerMode.Software);
```

11. Allocate memory for the camera image. The Memory.Allocate method parameter is a Boolean which indicates if the created memory is active. The method returns a status indicator (not used in the example) and the memory id as an integer.

```
% Allocate image memory
[~, MemId] = cam.Memory.Allocate(true);
```

12. Obtain the image width, height and bit width. The Memory.Inquire method parameter is the memory id as an integer. The method returns a status indicator (not used in the example), the image width as an integer, the image height as an integer, the image bit width as an integer and the line increment of the image memory (not used in example).

```
% Obtain image information
[~, Width, Height, Bits, ~] = cam.Memory.Inquire(MemId);
```

13. Acquire an image from the camera. The Acquisition.Freeze method parameter is a uc480.Defines.DeviceParameter enumeration which defines if the program should wait or not wait for the image to be acquired.

```
% Acquire image
cam.Acquisition.Freeze(uc480.Defines.DeviceParameter.Wait);
```

14. Copy the image data from the memory buffer to an array. The Memory.CopyToArray method parameter is the memory id as an integer. It returns a status indicator (not used in the example) and the image data as an array of System.Byte.

```
% Copy image from memory
[~, tmp] = cam.Memory.CopyToArray(MemId);
```

15. Reshape the image array to a three dimensional array of RGB images.

```
% Reshape image
Data = reshape(uint8(tmp), [Bits/8, Width, Height]);
Data = Data(1:3, 1:Width, 1:Height);
Data = permute(Data, [3,2,1]);
```

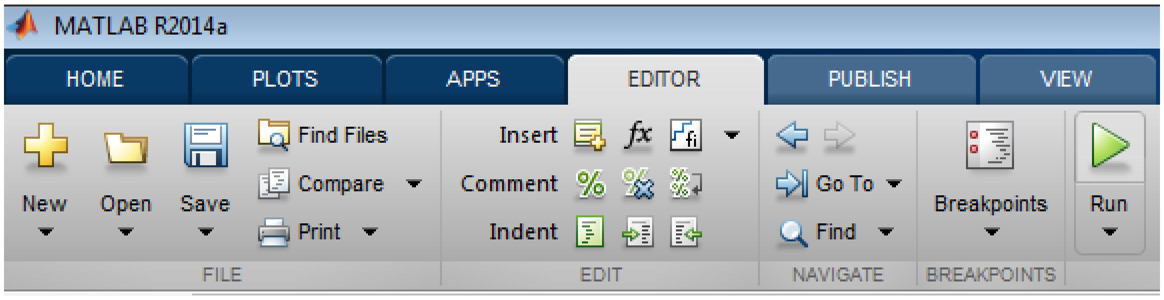
16. Display the image.

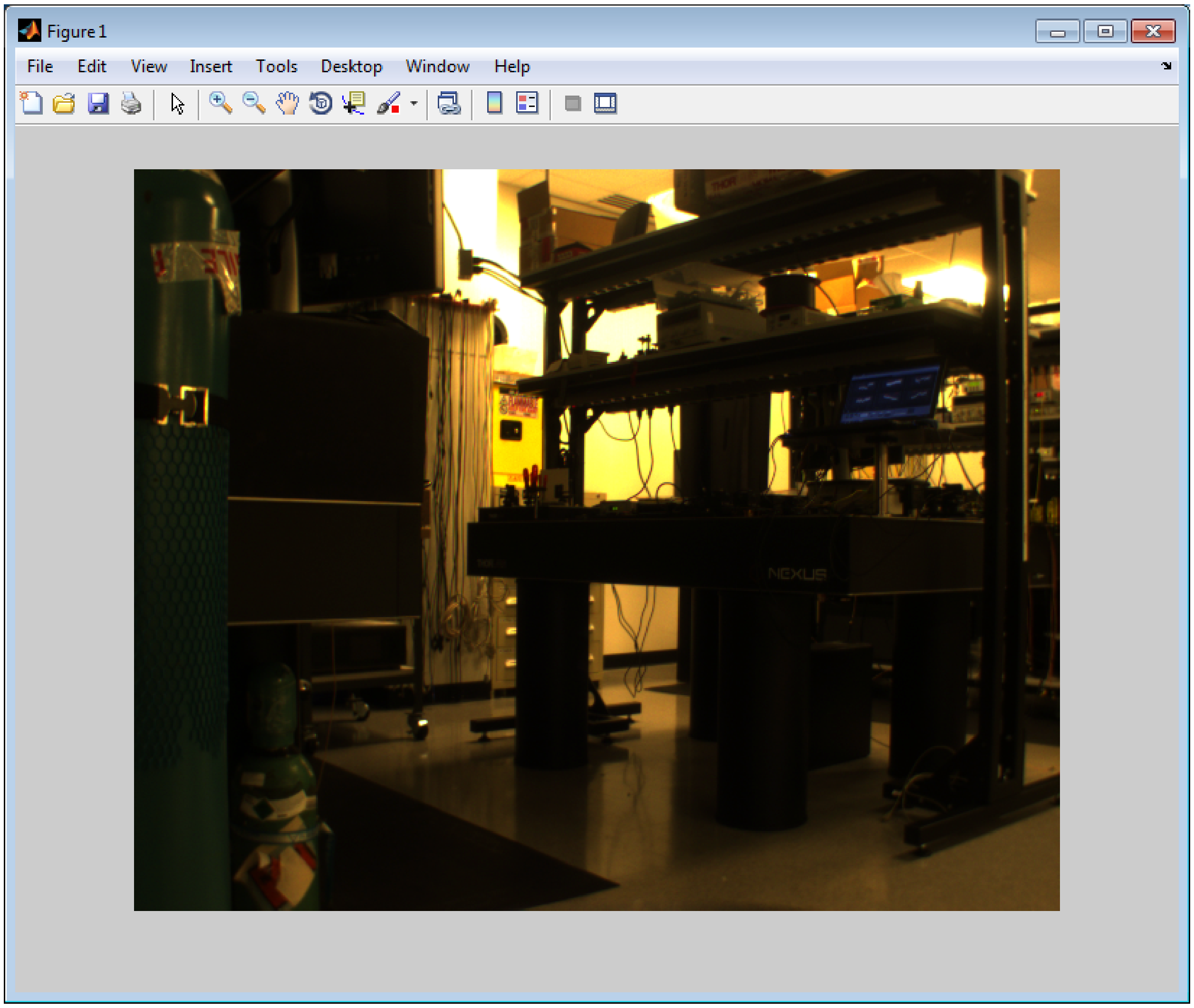
```
% Display Image
himg = imshow(Data);
```

17. Close the camera.

```
% Close camera
cam.Exit;
```

18. Select Run from the Editor menu bar. You will be asked to save your script (if you have not already).





Part 3. Methods Used

uc480.Defines.Status uc480.Camera.Init(int s32Cam)

Summary:
This function starts the driver and establishes the connection to the camera.

Parameters:
s32Cam: This parameter specifies the camera id.
> 0: The first available camera will be initialized or selected.
> 1-254: The camera with the specified camera ID will be initialized or selected. The camera ID can be found in the DCx Camera Manager software.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.DisplayMode.Set(uc480.Defines.DisplayMode mode)

Summary:
This function sets the camera display mode.

Parameters:
mode: This parameter specifies the display mode, see page 103 of the DCx Camera .NET Manual for a full list of display modes.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.PixelFormat.Set(uc480.Defines.ColorMode mode)

Summary:
This function setts the color mode to be used when image data are saved. For this purpose, the allocated image memory must be large enough to accommodate the data with the selected color mode.

Parameters:
mode: This parameter specifies the color mode, see page 205 of the DCx Camera .NET Manual for a full list of color modes.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.Trigger.Set(uc480.Defines.TriggerMode mode)

Summary:
This function sets the camera trigger mode. In software trigger mode, an image is captured immediately when Freeze() is called.

Parameters:
mode: This parameter specifies the trigger mode, see page 258 of the DCx Camera .NET Manual for a full list of trigger modes.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.Memory.Allocate(out int s32MemId, bool bSetAsActiveMem)

Summary:
This function allocates an memory for an image.

Parameters:
s32MemId: This parameter returns the memory id of the allocated memory as an integer. In MATLAB out parameters return on the left side of the function call.
bSetAsActiveMem: This parameter specifies if the allocated memory is active or not as a Boolean.

true: Memory set as active
false: Memory is not set as active

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.Memory.Inquire(int s32MemId, out int s32X, out int s32Y, out int s32BitsPerPixel, out int s32Pitch)

Summary:
This function returns the properties of an allocated image memory.

Parameters:
s32MemId: This parameter specifies the memory id of the allocated memory as an integer.
s32X: This parameter returns the image width (in pixels) used to define the image memory as an integer. In MATLAB out parameters return on the left side of the function call.
s32Y: This parameter returns the image height (in pixels) used to define the image memory as an integer. In MATLAB out parameters return on the left side of the function call.
s32BitsPerPixel: This parameter returns the bit width used to define the image memory as an integer. In MATLAB out parameters return on the left side of the function call.
s32Pitch: This parameter returns the s the line increment of the image memory as an integer. The line increment is defined as the number of bytes from the beginning of a line to the beginning of the next line. In MATLAB out parameters return on the left side of the function call.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.Acquisition.Freeze(uc480.Defines.DeviceParameter param)

Summary:
This function acquires a single image from the camera. In DIB mode, the image is stored in the active image memory.

Parameters:
param: This parameter defines if the program should wait or not wait for the image to be acquired.

  uc480.Defines.DeviceParameter.DontWait: Do not wait for image acquisition
  uc480.Defines.DeviceParameter.Wait: Wait for image acquisition

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.Memory.CopyToArray(int s32MemId, out byte[] u8Image)

Summary:
This function copies the image in the specified image memory id to an array.

Parameter:
s32MemId: This parameter specifies memory id of the allocated memory as an integer.
u8Image: This parameter returns a one dimensional byte array containing the image data. In MATLAB out parameters return on the left side of the function call.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

---

uc480.Defines.Status uc480.Camera.Exit()

Summary:
This function disables the camera handle and releases the data structures and memory areas taken up by the uc480 camera.

Returns:
The function returns a uc480.Defines.Status enumeration which indicates if the operation has been successful or unsuccessful.

Part 4. Full Program

```
% Add NET assembly
% May need to change specific location of library
NET.addAssembly('C:\Program Files\Thorlabs\Scientific Imaging\DCx Camera
Support\Develop\DotNet\uc480DotNet.dll');

% Create camera object handle
cam = uc480.Camera;

% Open the 1st available camera
cam.Init(0);

% Set display mode to bitmap (DiB)
cam.Display.Mode.Set(uc480.Defines.DisplayMode.DiB);

% Set color mode to 8-bit RGB
cam.PixelFormat.Set(uc480.Defines.ColorMode.RGBA8Packed);

% Set trigger mode to software (single image acquisition)
cam.Trigger.Set(uc480.Defines.TriggerMode.Software);

% Allocate image memory
[~, MemId] = cam.Memory.Allocate(true);

% Obtain image information
[~, Width, Height, Bits, ~] = cam.Memory.Inquire(MemId);

% Acquire image
cam.Acquisition.Freeze(uc480.Defines.DeviceParameter.Wait);

% Copy image from memory
[~, tmp] = cam.Memory.CopyToArray(MemId);

% Reshape image
Data = reshape(uint8(tmp), [Bits/8, Width, Height]);
Data = Data(1:3, 1:Width, 1:Height);
Data = permute(Data, [3,2,1]);

% Display Image
himg = imshow(Data);

% Close camera
cam.Exit;
```

Part 5. Other Resources

1) More information about the using the uc480DotNet.dll can be found in the DCx Camera .NET Manual available here: https://www.thorlabs.com/software/THO/ThorCam/Programming/ITN000563-D03.pdf.