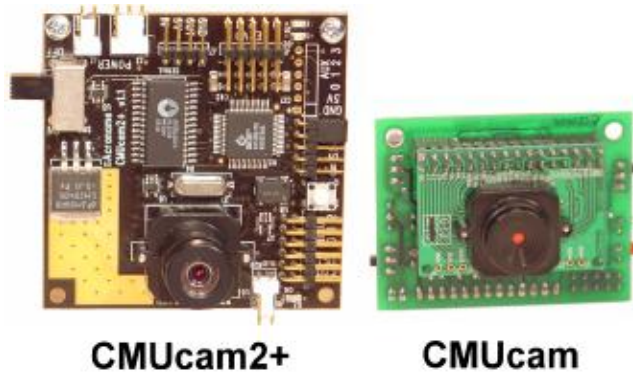


**Important**

**Requires ZeusPro  
V1.70 or later**

Interface your PC to a CMUcam  
as seen in  
July 2006 of Nuts & Volts Magazine

Pick up an issue at  
<http://www.nutsvolts.com>



A while back I was researching sensors for a project I was working on when I came across a little device called a CMUcam. The CMUcam is a low cost vision sensor developed by Carnegie Mellon University. The CMUcam has both an RS232 level interface as well as a TTL level serial interface so you can connect it to your favorite microcontroller or directly to a PC.

There are two versions of the CMUcam being sold now. The original CMUcam and the CMU2cam2. I will concentrate on the lower priced CMUcam, but with slight modifications the code presented here will work with both cameras. The CMUcam has a resolution of 80 x 143 pixels. This low resolution may not be perfect for creating web pictures, but it works great for an image sensor with an RS232 interface.

## Where can I get a CMUcam

You can't get a CMUcam from Carnegie Mellon directly; you must purchase it from a licensed manufacturer/distributor.

The CMUcam fully assembled can be purchased from Images SI Inc at [www.imagesco.com](http://www.imagesco.com). This camera comes with a small cable and will cost you about \$109.

The CMUcam2 camera comes in a couple of variations, which can be purchased from Acroname at [www.acroname.com](http://www.acroname.com). The camera I interfaced was a CMUcam2+, and does not include a RS232 Level converter. The camera and level converter will run you about \$181.

None of the cameras come with a printed manual. You will have to download the latest manual from the web. The manual will have all the connections and jumpers for the camera as well a list of all the interface commands. The CMUcam2+ comes with a hookup sheet since it has a different hardware layout than the CMUcam2.

## The Interface

The camera I purchased came with a very small RS232 cable so you will need a 9-pin male to female straight through cable to connect your PC. The camera has jumpers to set the baud rate to 9600, 19200, 38400 and 115200. All of our programs will use the 115200 rate so set the jumpers accordingly. If you have a slow machine you may want to use one of the slower baud rates. The camera requires 6-9 volts DC to run. There is a single 2-pin header used to connect your power source. I soldered a 2.1 power coax connector to a 2-pin female header so I could use an AC adapter. (See Sidebar) You can also use a 9v battery but you will have to make the connector.



**Tip:** I took a standard 2.1 Coax and soldered it to the 2 power terminals as shown here. This can be done on both the CMUcam and the CMUcam2+.

EndSideBar

To get started let's look at the DF command. This command tells the camera to dump a single frame of data. This will help us focus the camera and is one of those instant gratification things we geeks like to see when we purchase something new.

The DF command dumps a complete frame (80x143 image) of data in the form of 1 2 r g b r g b r g b ... 2 r g b r g b....3

Where:

1=Frame Start

2=New Column

3=Frame End

r=red value 16-240

g=green value 16-20

b=blue value 16-240

Start by loading the program called CMUProgram1.txt. Run the program. If you have the correct comport set you should see the image start to display column by column until it is built.

Figure 2 shows a typical capture. Did you notice the flicker as the image was being drawn? This is typical when you are building a graphic image as we are. One way to create a smooth and clean image is by using a method called double buffering. The free version of ZeusDeskTopNV v1.50 has 2 commands that support double buffering. They are FormUpdateAutoOff and FormUpdate. The FormUpdateAutoOff turns the automatic update system off and the FormUpdate command lets us update the form manually.

Load and run CMUProgram2.txt. This program uses the new commands and updates the form as each column completes. This program also continuously dumps the frame. Notice the difference? In many cases you can't even tell the image is updating unless the image itself changes.



Figure 2

You may have noticed that the actual display resolution was 160x143 not 80x143 as stated earlier. The Column pixels are doubled to correct the aspect ratio during display.

### Turn it Up

As a practical example, let's look at a security application. We can point the camera at an item or entrance scan for a change in pixels. The problem is that it takes nearly 5 seconds to pull in the image using the DF command.

The CMUcam has several built-in commands that let the camera actually analyze much of the data for us. One command is called the GM command which stands for Get Mean. This command constantly dumps 6 values; Red Color Average, Green Color Average, Blue Color Average, Red Deviation, Green Deviation, and Blue Deviation. For our security application we will use the first three. The cool thing here is that we get several readings per second so our program can be very responsive.

Load up and run CMUProgram3.txt. I have included a wave file called Bell.wav. Place it into the same directory as the program code. After a few seconds the average readings will be stored into variables and if there is a deviation of more than 20 units in any one color it will trigger an alarm. The output should look like the form in Figure 3.

### Going Further

Ok, so we can trigger an alarm; Let's take a look at CMUProgram4.txt. Here we made a few slight modifications to the ProcAlarm function. The function now returns 1 when an alarm is triggered and 0 if not.

We also added a function called SnapShot that dumps a frame on to the form when the alarm is triggered. Figure 4 shows such a dump after I turned on a light that caused the alarm to trigger.

You could also modify the ProcAlarm function to return different codes based on which color actually tripped the alarm.

Read the CMUcam manual and take a look at the many other commands. The Camera has a servo connector and commands to control it. You can even set up the camera to track objects.

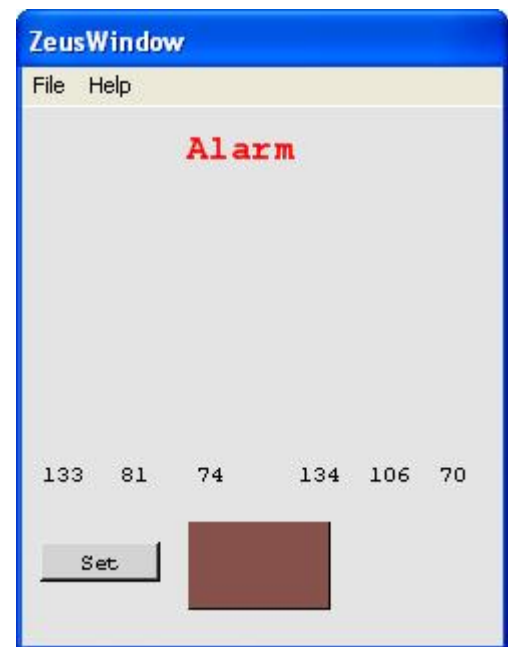


Figure 3

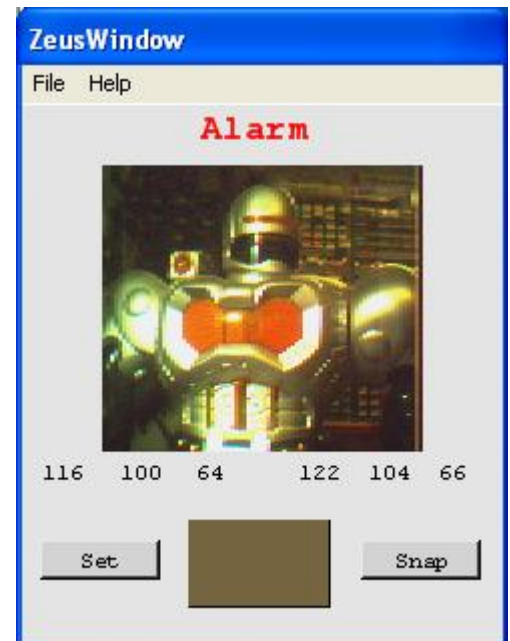


Figure 4

## The CMUcam2+

There are command differences between the CMUcam and the CMUcam2. I have included 3 CMUcam2 program files that will work on a CMUcam2 or CMUcam2+.

I thought it important to describe a few of the differences between the CMUcam and the CMUcam2+. The CMUcam2+ has two resolutions. The lower resolution is 87 x 143 and the higher resolution is effectively 175 x 254 regardless as to what the manual states.

The CMUcam2+ buffers the internal images so that when dumped it will not blur. There are also several more tracking commands for automated tracking as well as feedback to determine the direction the object is moving.

The CMUcam2+ supports 5 servos and 4 I/O ports. The camera also has a sleep mode to conserve power. The CMUcam has only a single servo hookup. The CMUcam2+ is also much faster than the CMUcam and outputs a better quality picture in poor lighting.

The downside to the CMUcam2+ is that if you want to control the camera with a PC or Pocket PC you will need a RS232 level shifter.



Which is better? It all comes down to how much you want to spend. Other than the RS232 level shifter the CMUcam2 will do everything the CMU2cam will do but it costs nearly \$80 more and has a bigger footprint.

I have included 2 CMUcam2 source files. They are called CMU2LowResDump.txt and CMU2HighResDump.txt. This will get you started with the CMUcam2 if you decide to go that route.

As a bonus I created 3 applications with ZeusPro. The first is a fancy version of the CMUcam alarm program for the CMUcam2. This program will dump the image that triggered the alarm to disk in the form of a 350x255 jpeg.

The other two programs are small web servers that will dump an image every 60 seconds and serve it up over the web if requested by a browser. Not to leave anyone out, I created both CMUcam and CMUcam2 versions.

It is already built for you. The applications as well as the source can be found on the KRMicros Website at: <http://www.krmicros.com/Development/ZeusPro/ZeusPro.htm>

## What else can you do?

The CMUcam has 1 servo connector and the CMUcam2+ has 5. By mounting the camera to one or more servos you can utilize some of the built-in auto tracking features or at the very least use Zeus to pan and tilt the camera.

Experiment and have fun, and be sure to visit the "Control Your World" forum at: <http://www.kronosrobotics.com/forums/viewforum.php?f=21>

