Laboratory 7 - Graphics Display Technology

1. Introduction

Modern embedded systems have powerful graphics display capabilities. For example, the CM3 processor has a dedicated Graphics Processing Unit (GPU) included as part of its SoC (System on Chip). This allows it to render graphics quickly without much load to the main CPU. Various graphics libraries are available to display images in high resolutions, in our case through a HDMI port.

2. Objectives

- Setting up VS Code to generate an application that uses graphics and a local filesystem
- Prepare images that can be displayed on a target system
- To transfer images to an embedded system.

3. Simple display application and file transfer

To demonstrate the capabilities of the system, we first show a simple application which displays images through some simple user interaction. To do so, we will transfer some files from our host system to the target system.

We use the Virtual Network Computing (VNC) software to provide control and data transfer between the Windows host computer and the CM3. VNC was first developed by Olivetti labs and the base code is open source and currently the company RealVNC maintains the software. The versions we use here are VNC Viewer on the CM3 and Windows. VNC comes preinstalled on the later versions of the CM3 while for other operating systems, it can be installed separately.

We will use the `/tmp` directory on the CM3 for our labs and projects for convenience in system management.

3.1 Transferring files from host to CM3.

1) From the Windows desktop, click on the VNC icon to enter into the VNC environment. You should see the VNC server display showing the CM3 desktop with a Title bar.

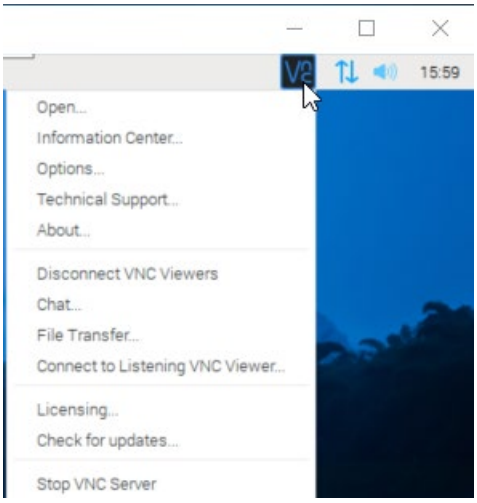
Figure 1 Title bar of VNC server (on target system)

If this is not shown, refer to the Appendix on how to sign into the CM3 using VNC and have the title bar displayed.

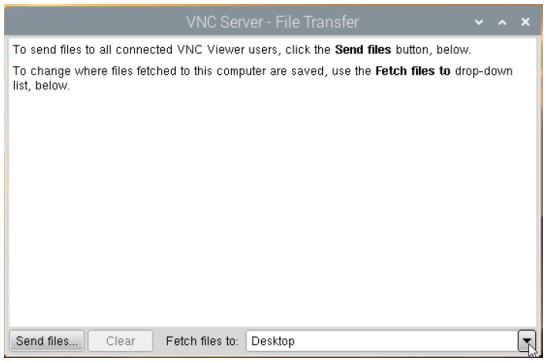
2) Set default transfer directory on CM3.

i. ***Right click*** on the dark VNC icon and a drop down menu appears.

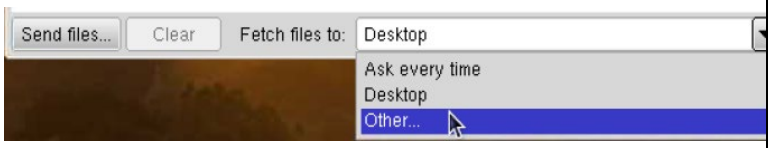
ii. Click on ***File Transfer*** and a file selection dialog will appear.



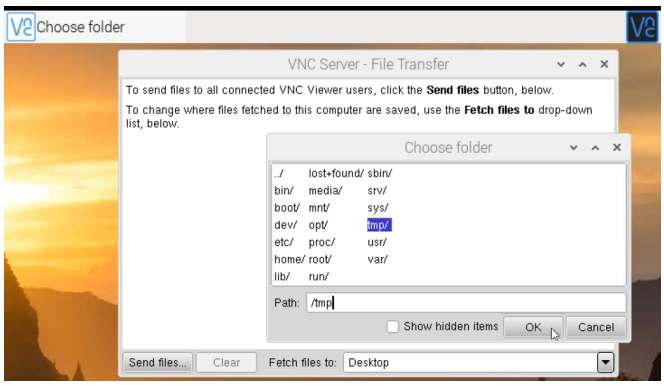
iii. Click on the drop down button at the lower right combo-box ***Fetch files to:***



iv. In the combo-box, select ***Other…*** to open up a dialog.



v. In the directory selection dialog - in the ***Path:*** prompt, type in ***/tmp*** and click OK to set the path.



vi. After this, ***close*** the File Transfer dialog box.

Now all future file transfers from the host will go to the `/tmp` directory by default.

2) To transfer our image files to the CM3, hover the mouse over the ***middle*** of Title Bar of the VNC Viewer. A drop-down menu will appear. Click on the ***Transfer files*** icon and then select ***Send files*** at the lower left of the screen.

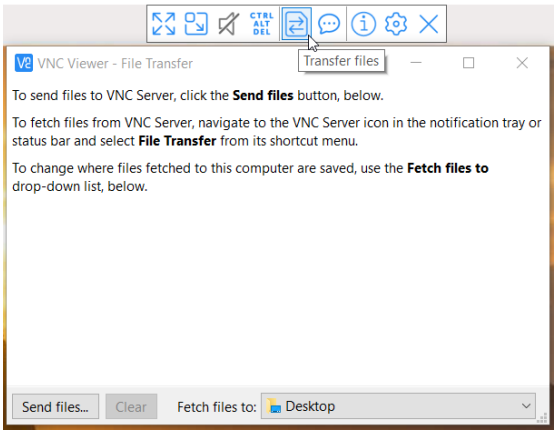
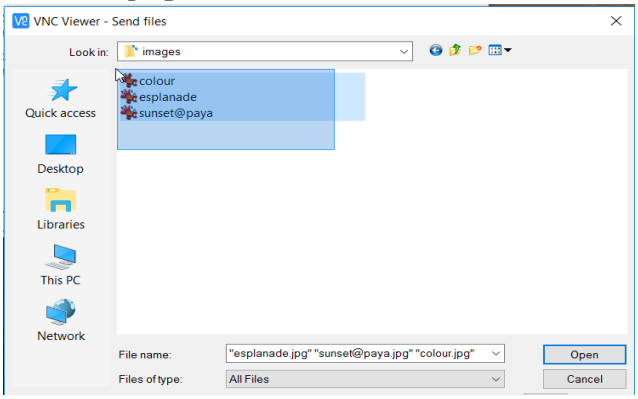
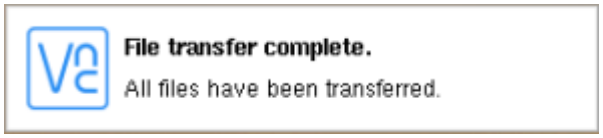


Figure 2 Hover over the middle of Title Bar to activate drop down menu

3) A Windows file selection dialog will open and you will select three images in `D:\ECSLAB\images`. They are the jpeg files : `colour`, `esplanade` and `sunset@paya`.



5) Confirm the selection by clicking ***Open***. VNC will immediately transfer the files to the default directory on the CM3. A confirmatory message box will appear after that.



4) ***Close*** the VNC file transfer dialog.

3.2 Displaying the image files on the CM3

Now that the image files have been transferred over, we will display them under program control. There are two parts to this step which needs some consideration because VS Code and VNC will be sharing the *same* display. Make sure the screens from both programs *do not* obstruct each other totally. First is to establish a connection between the target and host and second is to start a program which will display the images.

i) VNC: In the VNC title bar (section 3.1) click on the terminal icon  to open up a terminal between the target and host system.
DO NOT MAXIMIZE THE SCREEN!

ii) VS Code: Start the VS Code application and open the directory `D:\ECSLAB\lab7`.
DO NOT MAXIMIZE THE SCREEN!
Build and execute the program `lab7.c`.

MAKE SURE YOU ARE ABLE TO VIEW PORTIONS OF BOTH SCREENS!

iii) Follow the prompts on the LCD to display 3 images. Resize and move the screens of VNC and VS Code as needed.

Now we will modify the program to display one more image that we will prepare to show on the CM3.

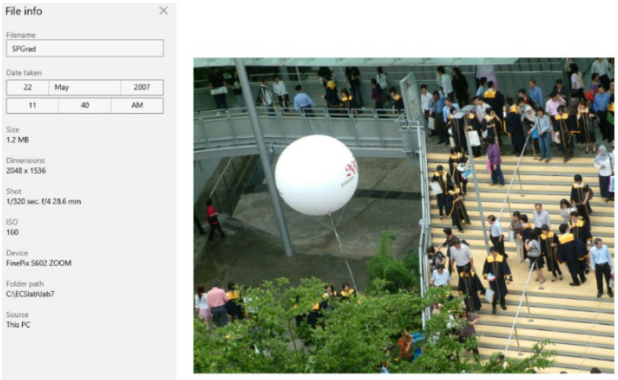
4. Software Used

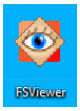
We used an image editing software known as FastStone which is available as free ware, with thanks to the author. This software allows you to resize and change the colour depth of your images. It can also add annotations like text and simple graphics to your image.

To acquaint ourselves with the capabilities of this software, we will prepare an image for use on the embedded system. It is `SPGrad.JPG` and can be found in: `D:\ECSlab\images` directory.

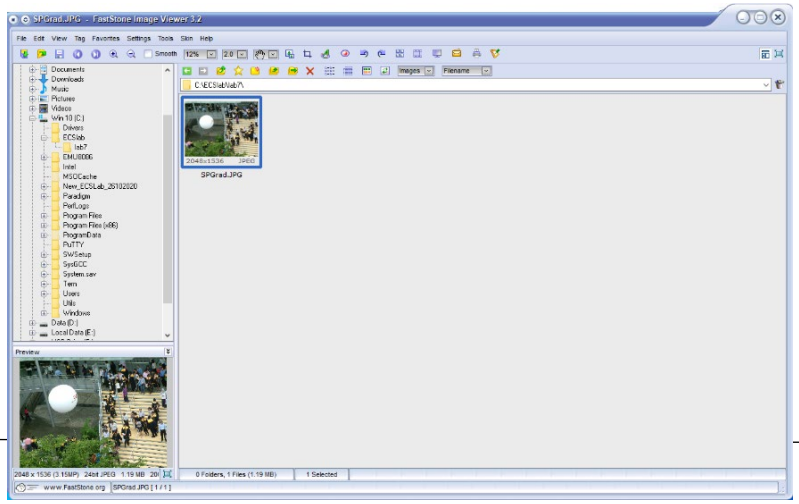
1) The colour depth is 24-bits, by using an image viewer to check the properties of `SPGrad.JPG`, what is the resolution of the image?

_____



2) Start the FastStone program by double-clicking on the icon. 

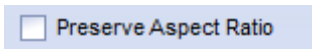
After the application loads, the main display will show. Note that the directory of the program may not be exactly the same as what is shown, as the software will remember the last directory it worked with.

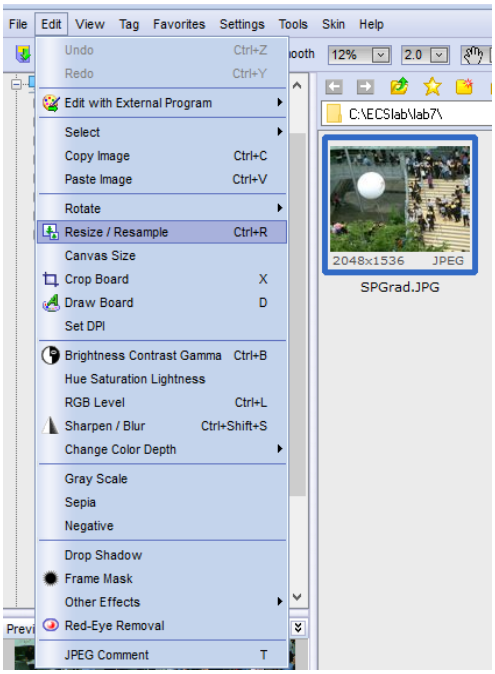


4.1 Resizing the image

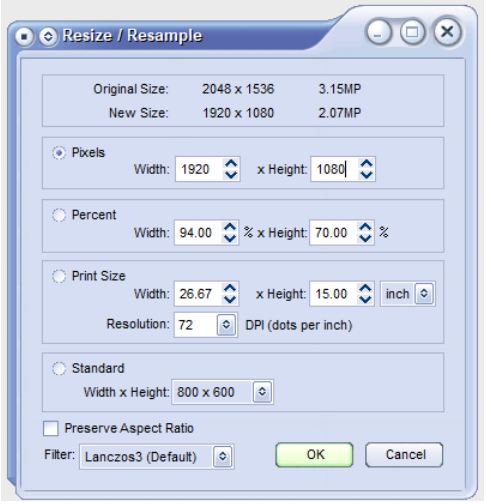
3) To illustrate the issues at hand, we will first resize an image right away.
   The supplied image, named `SPGrad.JPG` needs to be 1920x1080 pixels with 24-bit colour depth, or 16.7 million Colours.
4) Click on `SPGrad.JPG`, make sure the box outside the image is blue.
   Click on the edit option on the top left-hand corner of the application.
5) Then select "Resize / Resample"

   Before changing the aspect ratio, ensure that the "Preserve Aspect Ratio" is unchecked at the bottom of the window.



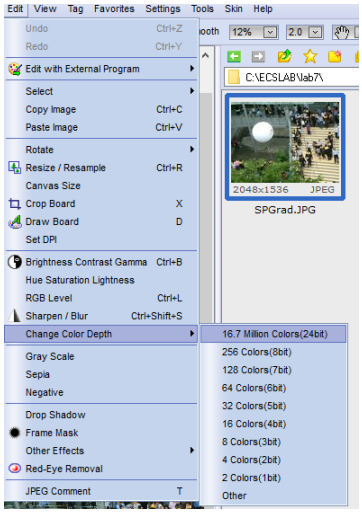


With pixels selected, change the Width to 1920 and Height to 1080 pixels and ***click*** OK.

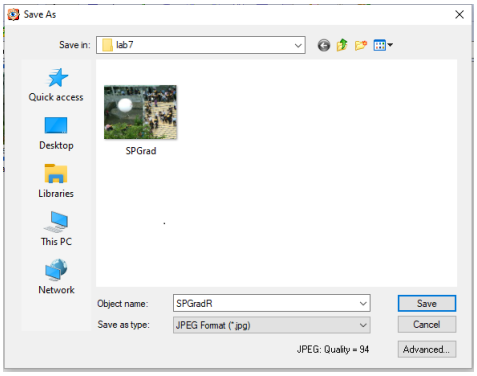


Note: The shortcut for this function is Ctrl+R

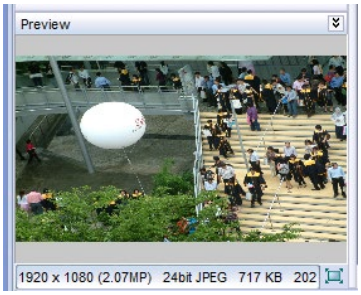
6) Double check that the colour depth is 24bits or 16.7 million Colours by selecting “Change Color Depth” under “Edit” tab.
Make sure “16.7 Million Colors(24bit)” is highlighted.



7) Begin to save the image.
Click on File and select “Save As”
Name the image as SPGradR.jpg in JPEG Format.



The image saved will be shown in the preview window on the bottom left-hand of your window screen.



4.2 Aspect Ratio

The image that has been resized should fit the entire monitor screen as the aspect ratio of the original image is 1.33 (2048 / 1536, 4:3) while that of the new resized image is 1.77 (1920 / 1080, 16:9)

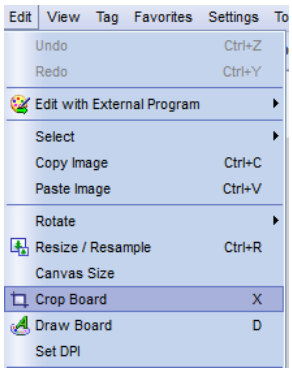
	
SPGrad.jpg (2048 x 1536 / 4:3)	SPGradR.jpg (1920 x 1080 / 16:9)

This resizing step that you have just done is to illustrate the guidelines one has to follow in order to properly prepare an image for display in an LCD screen used by the SBC. However, in some cases, the distorted image is tolerable.

4.3 Cropping an Image

In order to maintain a desired aspect ratio for resizing, one has cut off a part of the original image to achieve the aspect ratio of 1.6 (16:10). This is known as “crop”.
Before doing so, we should do some calculations. Say we want to keep the image width, then the new dimensions for the desired will have to be 2048 / 1280 (16:10).

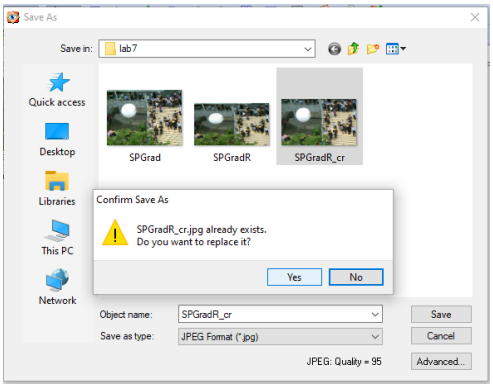
1) Click on SPGrad.JPG, make sure the box highlight outside the image is blue.
   Click on Edit > Crop Board



2) Using the Crop Board tool, Enter "2048 x 1280" as the dimensions at the bottom left-hand corner of the window.

3) The dotted box shown can be moved to indicate which part of the picture to retain.
The dark area outside the dotted box is the part to be cropped away. Afterwards, click Loseless Crop to File > Save it as SPGradCR.jpg

4) Select SPGradCR.jpg, make sure the highlight box is blue around the image, and resize it to 1920x1080. Double-check that the colour depth is 24-bits.
Save the file under the same name as before, a window will pop out saying "Do you want to replace it?"
Select ***Yes***.



You should now see SPGradCR.jpg is 1920 x 1080 and JPEG on the preview window.

The new images now being proportionate and having retained aspect ratio, double-click onto any of the images in FastStone to view them in full screen. The name of the image with the aspect ratio and file size can be seen on the top left-hand corner. To exit, double-click the image again or press ***Esc***. Press Left or Right arrow keys to viewother images while still in full screen.

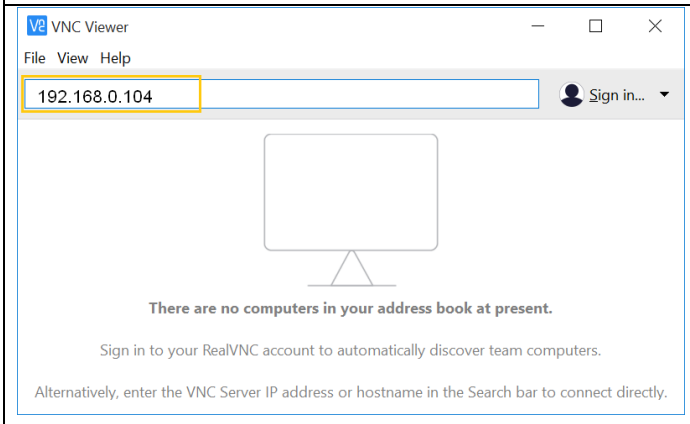
Original – SPGrad.jpg	
Resized, aspect ratio not retained – SPGradR.jpg	
Cropped to aspect ratio, then resized – SPGradRCR.jpg	

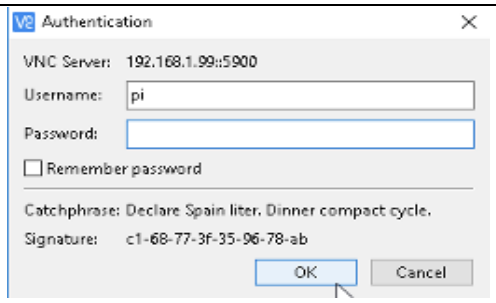
5 Displaying the Edited Image

Now that this image has been correctly resized, transfer it to the CM3 in the directory `/tmp`. Modify lab7.c so it now displays the image together with the rest.

APPENDIX

To log into the CM3 from the development system using VNC, follow these prompts:





Password: ***raspberry***

Introduction to pqiv

In the CM3, we use the program `pqiv` instead of the standard Photo Viewer software because we can call it from a user program in the target system as seen in lab7.c. If pqiv is not available, you may need to install it. The Powerful Quick Image Viewer (pqiv) is written by Phillip Berndt.

However, pqiv can also run from the command line and if you are able to access a Terminal screen connected to a CM3 or Raspberry Pi, you can test its functionality.

If you able to run pqiv when the current directory is `/tmp` you will see the images you uploaded there. The software support various file formats like .bmp, .jpg, .png, .gif but do keep in mind, the bigger the file size, the longer it will take to load.

Using pqiv in a C program

An example of calling pqiv to display the image SPGrad.png in the `/tmp` directory is

```
system("DISPLAY=:0.0 pqiv -f -s --slideshow-interval=1 /tmp/SPGrad.jpg
/tmp/SPGradR.jpg /tmp/SPGradR.jpg &");
```

Here the `system` function will execute the command described in the string and returns from it.

— End of Lab —