```
30
ж
   Initial CMUcam3 (cc3) data ty
ж.
#include <stdbool.h>
#include <stdlib.h>
#include "cc3.h"
#include "cc3_pin_defines.h"
#include "cc3 hal.h"
#include "serial.h"
#include "devices.h"
#include "interrupt.h"
// Globals used by CMUCam functio
cc3_pixel_t cc3_g_current_pixel;
cc3_frame_t_cc3_g_current_frame;
```

cc3.c

CMUcam3 Software Installation Guide

April 29, 2006

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This is the CMUcam3 Software Installation Guide v0.1 for the CMUcam3 Embedded Vision Sensor. For more information go to http://www.cs.cmu.edu/~cmucam or contact us at cmucam@cs.cmu.edu Copyright 2006 Anthony Rowe, Adam Goode and Carnegie Mellon University. All Rights Reserved. Edited by Illah Nourbakhsh

1. INTRODUCTION

The CMUcam3 is an ARM7TDMI based fully programmable embedded computer vision sensor. The main processor is the Philips LPC2106 connected to an Omnivision CMOS camera sensor module. Custom C code can be developed for the CMUcam3 using a port of the GNU toolchain along with a set of open source libraries and example programs. Executables can be flashed onto the board using the serial port with no external downloading hardware required.

The development guide will step through how to install:

- Cygwin
 - Make
 - Subversion
- ARM gcc
- LPC210x FLASH Utility

We describe the process of powering up the CMUcam3, making a new project, compiling the new project and downloading a firmware image to the board.

CMUcam3

2. INSTALLING DEVELOPMENT TOOLS

In order to compile and download code to the CMUcam3 in Windows you will need the following software:

- Cygwin
 - Make
 - Subversion
- ARM gcc
- LPC210x FLASH Utility

Cygwin

Cygwin is a Linux-like environment for Windows. It provides you with a shell and many familiar Linux tools like "make" which you will use to compile CMUcam3 code. If you are using Linux, most of these tools are already standard on your system.

First, download the Cygwin installer from:

<u>http://www.cygwin.com/</u> (Installer: <u>http://www.cygwin.com/setup.exe</u>)

Cygwin Setup - Choose Installation Type	
Choose A Download Source Choose whether to install or download from the internet, or install from files in a local directory.	E
Select Install Stall from Internet From Internet Oownloaded files will be kept for future re-use)	
Install from Local Directory	
Click Next	
< Back Next >	Cancel

CMUcam3

Embedded Vision Processor

installation parameters.	II Cygwin. Also choose a few
Root Directory	
C:\cygwin	Browse
Install For	Default Text File Type
All Users (RECOMMENDED)	Oliver State (Second Second
Cygwin will be available to all users of the system. NOTE: This is required if you wish to run services like sshd, etc.	No line translation done; all files opened in binary mode. Files on disk will have LF line endings.
🔿 Just Me	O DOS / text
Cygwin will only be available to the current user. Only select this if you lack Admin. privileges or you have specific needs.	Line endings will be translated from unix (LF) to DOS (CR-LF) on write and vice versa on read. <u>Read more about file modes</u>

Setup need	nternet Connection Is to know how you want it to connect to the internet. Choose iate settings below.
	Direct Connection
	O Use IE5 Settings O Use HTTP/FTP Praxy:
	Proxy Host Port 80

Choose A Do Choose a si	wnload Site te from this list, or add your own sites to the list		C
	Available Download Sites:		
	http://ftp.uni-kl.de http://ftp.univie.ac.at http://gnu.kookel.org http://kambing.vlsm.org http://linux.rz.ruhr-uni-bochum.de http://mirror.averse.net http://mirror.calvin.edu http://mirror.cpsc.ucalgary.ca http://mirror.mcs.anl.gov http://mirror.pacific.net.au http://mirror.dotsrc.org		
	http://mirrors.kernel.org http://mirrors.sunsite.dk	~	
User URL:		Add	

Pick a mirror that you will use to download the rest of the cygwin software.

Select packag	IS Inco to install				2	
зеестраскау	jes to instali					w Full
New	В.	S.,	Categories	Size	Package	
🕶 Skip	nja	nía	Web	330k		
0 1.9-7	\boxtimes		Base	14k	login: Sign on to a system	
Skip	n/a	nía	Web		lynx: Text-mode WWW Browser	
SKIP	n/a	nía	Interpreters	110k		
G 3.80-1	×	Ū.	Devel	281k	make: The GNU version of the 'make' utility	
31.5p.1	\boxtimes		Base, Doc, System	128k	man: Man, apropos and whatis	
😯 Skip	nía	ηíα	Math	89k		
🕒 Skip	nja	nja	Editors, Shells, Utils	485k	mc: Midnight Commander visual shell	
😯 Skip	nja	n/a	Libs	174k	mhash: Library of hash algorithms	
😯 Skip	n/a	nía	Editors	2,332k	mined: Powerful text editor with extensive Unicode and CJK support.	
😯 Skip	n/a	n/a	Mingw	304k	mingw-bzip2: (mingw version) of bzip2, a high-quality block-sorting file compressor	
🕒 Skip	nja	nía	Mingw	27k	mingw-libbz2_1: (mingw version) shared libraries for bzip2 (runtime)	
😯 Skip	nja	nía	Devel, Libs	214k	mingw-runtime: MinGW Runtime	
😯 Skip	nja	nja	Mingw	74k	mingw-zlib: (mingw version) of the zlib compression and decompression library	
😯 Skip	ηία	nía	Libs	22k	minires: A simple synchronous non caching stub resolver.	
😯 Skip	nja	nía	Devel, Libs	24k	minires-devel: Development tools to build programs using minires.	
€ 1.5-3	\boxtimes		Devel	14k	mktemp: Allows safe temp file/dir creation from shell scripts	
😯 Skip	nja	nía	Devel	2,475k	monotone: Free distributed version control system	
😯 Skip	ηία	nía	Text	15k	more: A primitive pager	
🚱 Skip	nja	nja	Utils	12k	mt: Magnetic Tape manipulation utility	
😯 Skip	ηία	nja	Devel	35k	mtd: Utilities for dealing with flash memory technology devices (mtd)	
🚱 Skip	nja	nía	Mail	951k	mutt: A text mode mail user agent (MUA).	
🚱 Skip	n/a	nía	Net, Web	330k	naim: Console AIM, ICQ, IRC, and Lily client	
🚱 Skip	nja	nía	Editors	202k	nano: A pico clone text editor with extensions	
😯 Skip	nja	nja	Devel	660k		
🚱 Skip	nja	nja	Net	258k		
€ 5.4-4	\boxtimes		Base, Libs		ncurses: Libraries for terminal handling (main package)	
😯 Skip	nja	nía	Libs	119k	ncurses-demo: Demonstration programs for ncurses	
<)

- 1) Maximize the Window
- 2) Click on "View" Full to see a list of all packages in alphabetical order.
- 3) Click on "skip" so that it changes into a version number to select a software package to install. Install the following extra packages:
 - make

subversion

open-ssl

4) Click "Next" to install. This may take about 10 minutes on a fast internet connection.

Continue clicking on next until the installation is complete.

GNU ARM GCC

The compiler choice is left up to the hal. This allows different hardware platforms to use different compilers.

Currently, the only supported hal is "lpc2106-cmucam3", which uses a version of GCC optimized for the ARM processor. To build using this hal, you'll need the arm-none-eabi-* style GCC tools from CodeSourcery. These can be acquired here:

http://www.codesourcery.com/gnu_toolchains/arm/download.html

Get the "EABI" or "Bare Metal" target.

C++ ABI Testsuite QMTest	GNU TOOLCHAINS
	OVERVIEW FAQ DOWNLOADS
Mailing Lists Announcements	Select Package Inst Platform The system on which you will run the CodeSourcery GNU Toolchain. IA32 Windows IA32 GNU/Linux SPARC Solaris Source Inst Platform The system on which the programs you build will run. EABI GNU/Linux GNU/Linux SymbianOS
	Download

Installation

CodeSourcery's Windows packages use standard Windows installation packages. package, you can double-click on the file to start the interactive installation progr

On GNU/Linux and Solaris, download the package and then run the following com

CMUcam3

Once you have downloaded the installer, double click on it and follow the rest of the on-screen instructions to finish the installation. If in doubt, select the default options.

If you feel like using a different compiler, simply change the variables in hal/lpc2106-cmucam3/defs.mk to something else. A popular thing to change is COMPILER_PREFIX, in case you have a custom compiler built under a different name.



Philips LPC210x FLASH Utility

1) Download and install a flash utility program. The "Philips LPC210x FLASH Utility" can be obtained from either the CMUcam (http://www.cs.cmu.edu/~cmucam3) or the Philips website.

http://www.semiconductors.philips.com/files/markets/microcontrollers/philips_flash_utility.zip

2) Double Click on the "philips_flash_utility.zip" icon.

- 3) Next Double Click on "setup.exe"
- 4) Click "Ok"
- 5) Click on the icon of the computer to continue the installation.

LPC2000 Flash Utility Setup	
Begin the installation by clicking the button below.	
Click this button to install LPC2000 Flash Utility software to the specified destination directory.	
C:\Program Files\Philips Flash Utility\	1

The CC3 Source Tree

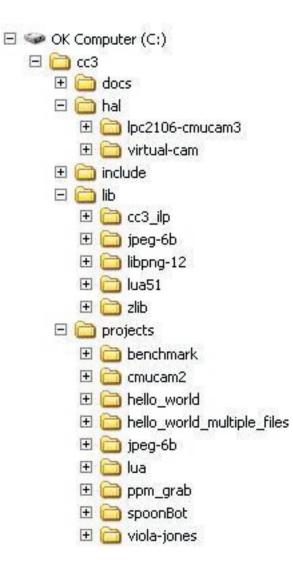
Now that you have the GNU toolchain, and the FLASH utility, you must download the CC3 source tree. This can be found on the CMUcam website or on the CMUcam sourceforge site.

http://www.cs.cmu.edu/~cmucam3/downloads

http://sourceforge.net/projects/cc3

Unzip the directory structure in a convenient location.

The directory structure will look something like this:



5. BUILDING A PROJECT

Building

Once you have the compiler and the CMUcam3 source, you need to build the system. From the top level, invoking "make" will build all the hal libraries, and will build a subset of items in the "projects" directory.

Open a Cygwin shell and type "cd c:" to move to your C drive. Next navigate to the source directory using the "cd my_directory" command. Once in the "cc3" directory, type "make".

Make sure you've built a hal before trying to build any projects!

Changing SUBDIRS in projects/Makefile will change which projects are built. Changing SUBDIRS in hal/Makefile will change which hals are built.

Invoking "make" directly from a particular project or hal directory will build that directory, regardless of SUBDIRS.

Projects

There are a few projects in the projects directory to get you started.

The "hello_world" project should be a nice introduction to LEDs, MMC access, servos, camera use, and serial communication.

If you want to create a project, duplicate the hello_world directory, change the PROJECT variable in Makefile, and start editing code!

Makefiles

When using the cc3 build system, you'll be using a Makefile in your project directory. See projects/hello_world/Makefile for a description of how to use the file for your own projects.

HAL vs. Projects

Generally, you will not need to make any changes to anything in hal, unless you modify or create new hardware, or if the hal you are using is missing some important functionality.

Make sure you've built a hal before trying to build any projects! If you are inside the projects directory, make does not know how to go up and build the hals. Otherwise, you will get an error like this:

No rule to make target `../../hal/lpc2106-cmucam3/libhal-lpc2106-cmucam3.a'

If this happens, go into the hal directory and run make.

Environment

The cc3 system is build upon a standard C99 environment. For the lpc2106-cmucam3 hal, we use Newlib. Information about Newlib is here:

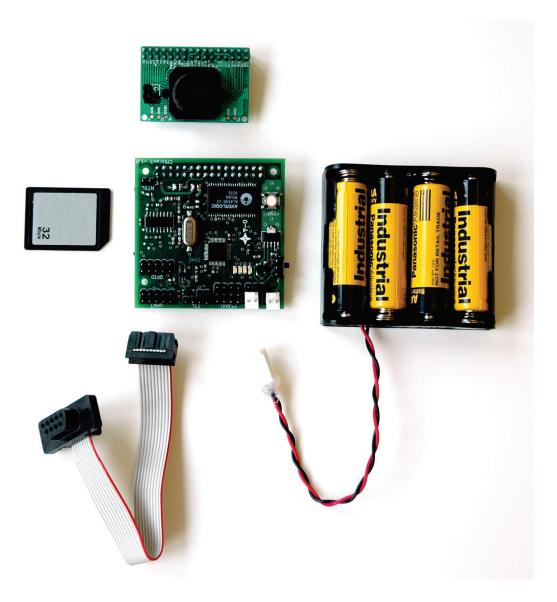
http://sources.redhat.com/newlib/

Newlib provides all the features a C programmer expects: malloc, free, printf, scanf, open, close, read, write, and friends.

CMUcam3

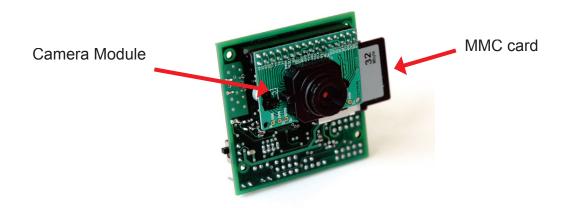
3. HARDWARE SETUP

This section will walk through the process of powering up and connecting your CMUcam3. The image below shows the individual components typically necessary to program the CMUcam3. The MMC card may not be included and the camera may be powered by an alternate power supply such as an AC adapter.



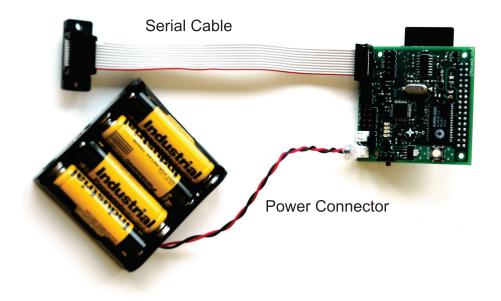
Connect the Camera Module and MMC

Attach the camera module with the main processing board as shown below. If available, connect the MMC card.



Connect Power and Serial Cable

Connect the serial cable and power supply as shown below. Turning on the power switch should cause the red LED to illuminate. Some serial cables may connect in the opposite orientation. If you are having difficulty communicating, try reversing the connection.

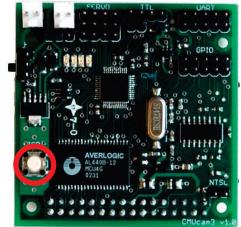


4. INSTALLING FIRMWARE

The CMUcam3 can be loaded with various firmware images. These images may perform different specific tasks. For example, the "cmucam2.hex" file will allow your CMUcam3 to emulate the functionality of the CMUcam2. When you develop your own CMUcam3 applications or would like to experiment with new firmware images, it will be necessary to flash the microprocessor. Flashing the microprocessor can be done over a standard serial port using the downloading utility described in Section 2. The next sections show step by step how to install a new firmware image onto your CMUcam3.

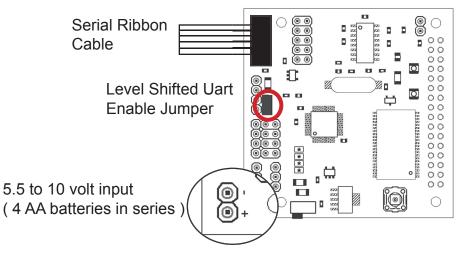
ISP Button

When held down on power up, the ISP button will enable the built in LPC2106 bootloader. After the processor has started up, the button can be read as normal GPIO. It is internally pulled high, and set low when depressed. The button shares the CS pin (P0.14) with the MMC. When using the MMC, CS is active low and hence the button cannot adversely affect data transfers.

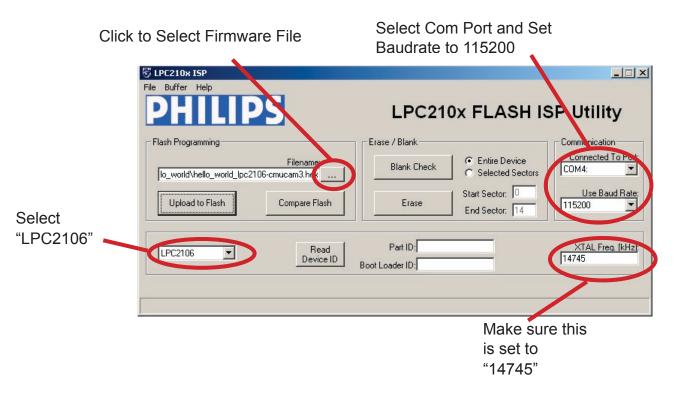


ISP Button

6) Once the Flash Utility is installed, connect the CMUcam3 to your serial port as shown below



6) Go to the Start Menu, "All Programs", "LPC210x ISP" and execute the "LPC210x ISP" application. You should eventually see a screen similiar to this:

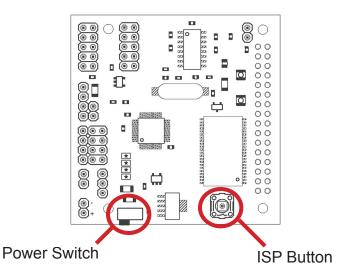


7) Click on the "..." box next to "Filename" to select a hex file to download. As an example, select the "hello_world_lpc2106-cmucam3.hex" file located in the CMUcam3 hello_world project directory. Set the correct Comm Port and Device Selections.

8) Click on the "Upload to Flash" button. You should see a dialog box like below.

LPC210x Reset Message	×
Please reset your LPC210x board now and then pres	s OK!

9) While holding down the "ISP" button on the camera, turn on the camera power. Make sure the button is held in for about a second. If the camera is already on, turn it off and on again while holding in the "ISP" button. If the button is depressed upon startup, the camera will enter its bootloader mode.



10) Press "OK" and wait for the image to download. If it fails check the connectors, reset the power and try again. The Flash Utility will say "File Upload Successfully Completed!" when the download is complete.

Linux

In order to download to the board using linux, you must make sure you have proper access rights to the serial port. You can download a flash utility program from here:

http://guest.engelschall.com/~martin/lpc21xx/isp/ or http://www.cs.cmu.edu/~cmucam3/downloads.html

Follow the procedure outlines in the Windows section for putting the board into its bootloader mode by holding down the ISP button while reseting power to the board.

Once installed, here is a set of sample command line arguement for downloading:

>: cd CMUcam3/projects/hello_world

>: lpc21isp hello_world_lpc2106-cmucam3.hex /dev/ttyS0 115200 14745