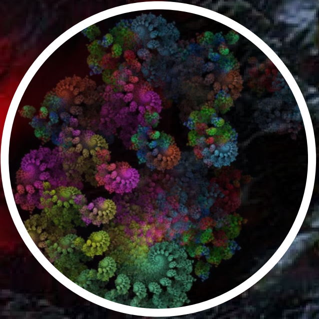
The Mathematical Function Atan2 • Resizing your Android partitions

# ODROID Magazine

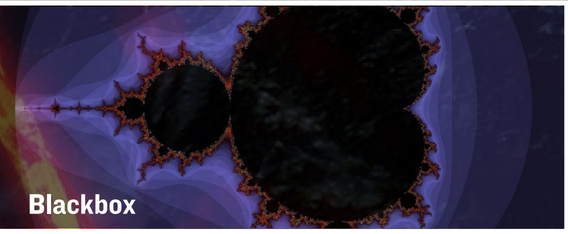
Year One
Issue #6
Jun 2014

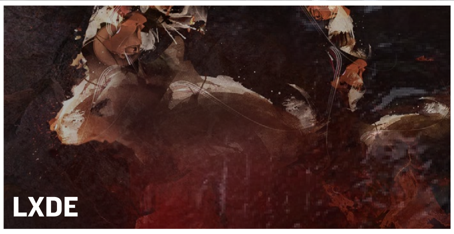
## DREAM MACHINE AND WHISPER

AN INSIDE LOOK AT PREBUILT UBUNTU 13.04 AND 13.10 DISK IMAGES THAT GET YOUR ODROID UP AND RUNNING FAST!


Ubuntu Mathematics Tools

Lubuntu Whisper 13.10 Saucy Salamander

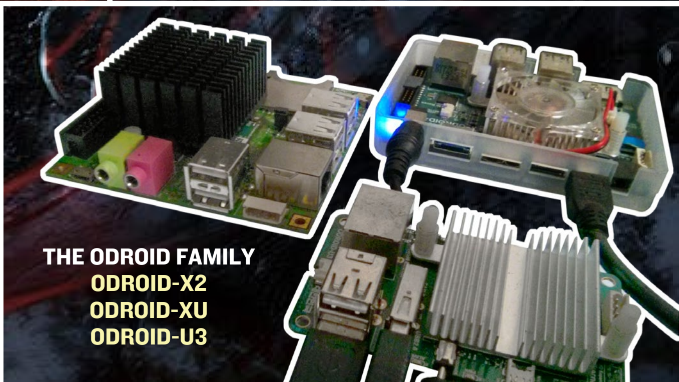

Blackbox


LXDE

XBMC

**PLUS:**

- PACKAGE YOUR OWN CUSTOM COMPILED SOFTWARE
- PROGRAM YOUR ODROID SHOW WITH REBOL
- ENABLE MULTI-CHANNEL AUDIO OUTPUT WITH XBMC


THE ODROID FAMILY
ODROID-X2
ODROID-XU
ODROID-U3

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sortieren nach: Relevanz (gewählt) Seite: 1 von

1 - 18 von 18 Ergebnissen

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**ODROID- Linux**
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Ever since we began publishing ODROID Magazine, we've been receiving some great articles from our international contributors involving their innovative hardware projects, including the Giant Android Tablet, ODROID Truck PC, and the Unmanned Ground Vehicle. The worldwide maker community has shown that there is almost no limit as to what an ODROID can do.

Because many ODROIDians are involved in software projects as well, we plan to feature some of the many excellent OS images and software that the ODROID community and Hardkernel developer team have been producing in an ongoing series called OS Spotlight. We kicked off the column last month with an overview of the software included with the Fully Loaded Ubuntu 12.11 image, and this month we are highlighting Dream Machine, which is ideal for office work, programming, media playback, and anything else where a traditional desktop PC would be used.

As of June 1st, there are now over 5000 members in the ODROID forums at `http://forum.odroid.com`, showing a phenomenal growth of 500% over the last 1.5 years. With so much interest in the ODROID platform, the original version of U3 actually sold out last month, most likely due to its small footprint and very affordable price. To respond to the increased demand for the compact model, Hardkernel will soon begin shipping its newest generation of the U series hardware called the ODROID-U3+, containing several new features: `http://bit.ly/1p8zi6L`.

For Android enthusiasts, Hardkernel published a sneak peek Beta version of Android KitKat 4.4, which you can download and test at `http://bit.ly/1hsFdRB`. It's still a work in progress, so make sure to post any bugs and/or feedback on the ODROID forums.

In response to many requests for HDMI Passthrough DTS audio, there is a new inexpensive piece of hardware, now available from the Hardkernel Store, called the USB-S/PDIF. The USB-S/PDIF sends DTS and AC3 digital encoding via the HDMI cable to your audio receiver, delivering crisp 5.1 surround sound to your living room or office via your ODROID running Linux and XBMC 13. It's now available for $16 at `http://bit.ly/1kIt8aC`.

Hardkernel has not only been upgrading its Ubuntu images to 14.04, but has also improved the XBMC experience with their long-awaited official 1080p release of the popular XBMC-based Media Center image. The new version of XBMC for Linux, available on all platforms, takes advantage of the recent improvements to video decoding in the 3.8 kernel and delivers smooth 720p and 1080p video for all of the encodings supported by the Mali GPU and VPU hardware. Keep in mind that it is an experimental build, but has been reported to work very well. It's a great distribution for those who previously used OpenElec or Xbox as a set-top box. Check out the build at `http://bit.ly/1lfkYpN`.

ODROID Magazine, published monthly at http://magazine.odroid.com, is your source for all things ODROIDian.
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HARDKERNEL

# ODROID Magazine

**Rob Roy, Chief Editor**

I'm a computer programmer living and working in San Francisco, CA, designing and building web applications for local clients on my network cluster of ODROIDs. My primary languages are jQuery, Angular JS and HTML5/CSS3. I also develop pre-built operating systems, custom kernels and optimized applications for the ODROID platform based on Hardkernel's official releases, for which I have won several Monthly Forum Awards. I use my ODROIDs for a variety of purposes, including media center, web server, application development, workstation, and gaming console. You can check out my 100GB collection of ODROID software, prebuilt kernels and OS images at `http://bit.ly/1fsaXQs`.

**Bo Lechnowsky, Editor**

I am President of Respectech, Inc., a technology consultancy in Ukiah, CA, USA that I founded in 2001. From my background in electronics and computer programming, I manage a team of technologists, plus develop custom solutions for companies ranging from small businesses to worldwide corporations. ODROIDs are one of the weapons in my arsenal for tackling these projects. My favorite development languages are Rebol and Red, both of which run fabulously on ARM-based systems like the ODROID-U3. Regarding hobbies, if you need some, I'd be happy to give you some of mine as I have too many. That would help me to have more time to spend with my wonderful wife of 23 years and my 4 beautiful children.

**Bruno Doiche, Art Editor**

Secured his computing necromancy skills after bringing a fiber optics switch back to life, getting his Macintosh back from death, getting a PS3 back from death, getting his fiancee's T400 back from death (which was a old-style dd data transfer), and managing how to handle the cold innards of his steady job data center.

**News from Art Editor Bruno:**

Getting back to our regular schedule is no small task. After a couple of minor setbacks, we throttled hard to get to a speedier rhythm, but not without having, as usual, the best fun! What were our trade offs? Well... we didn't manage to pack our astounding amount of tips, but now we nailed the code color palette and type size!. It's easy to read and good looking!

The cover was also a challenging idea, as when we were chatting and defined that the centerpiece cover article would be Rob's Linux distros. I had this micro obsession on getting all current production ODROIDS together, but believe or not, I don't have the actual production triad (U3, X2, XU). But as easy as it seems to get them side by side in a single photo, there are plenty of ODROIDians that have never seen them together. But no longer! I have a trusty friend that has three of them, and sent me a photo of three of his ODROIDS for me to put on the cover. So here is my thanks Patola, and I hope to feature you in an interview regarding 3D printing using ODROIDS!

What else is new? Now, Rob is working directly on the art master files! We have gotten so much more agile on the revision process, and are as ever, working hard to deliver to you, our trusty readers a hard-fact, spot-on magazine that we love to do! Not that we don't get some crazy issues now and then!

# INDEX

# PROGRAMMING YOUR ODROID-SHOW

## USING THE REBOL PROGRAMMING LANGUAGE TO IMPROVE THE HARDWARE INTERFACE

By Bo Lechnowsky

The ODROID-Show module is incredibly useful for many tasks. For instance, it is a great device to display information that can be viewed at a glance. However, it can be cumbersome to display the information you want in an easy manner.

To make things simpler, I used the incredible capabilities of Rebol to create an easy dialect to allow displaying many types of information on the ODROID-Show. Because Rebol is cross-platform, the same scripts will run on any operating system.

You can also connect multiple ODROID-Show modules to a single ODROID, or any other computer with USB ports. This dialect will allow easy handling of that.

The function to initiate the dialect is called oshow (The word show is already used in Rebol to refresh GUI displays).

I've highlighted the code that is sent to the ODROID-Show module via the oshow dialect with bold letters. As is well known, bash scripting isn't the easiest to read, especially when interspersed with control codes. In addition, the Rebol example above is about 35% smaller, allows any order of color cycling, allows any number of words of any length at any number of coordinates, and will run on any platform that has a Rebol 3 interpreter (pretty much everything except for Windows RT and IOS which will come soon). I leave it to the reader to decide which is easier to modify.

**Using the oshow dialect, compare the program written in Rebol to the example provided in bash scripting in Tutorial #1: Text Output from the ODROID-Show user guide:**

```
do %oshow.r3
  call {port_open}
  serialport: %/dev/ttyUSB0
  display-text: ["ODROID" 25x100 "SHOW" 55x150]
  oshow serialport [reset rotate 0]

  forever [
      foreach color [red green yellow blue magenta cyan white] [
          foreach [word position] display-text [
              oshow serialport compose [cursor to (position) font (color) 5]
              foreach letter word [
                  oshow serialport compose [(to-string letter)]
                  wait .02
              ]
          ]
      ]
  ]
```

## Here is the full dialect definition.

**font** optionally followed by:

black
red
green
yellow
blue
magenta
cyan
white

optionally followed by:
default (sets default color as foreground color)

optionally followed by:
1 (sets text size to: 6x8 pixels * the number specified here)

Examples:
oshow [font cyan]
oshow [font white default]
oshow [font 2] (sets text size to 12x16 pixels)
oshow [font 1 cyan “Hello “ 2 red “ODROID!”]

**background** followed by one of the colors listed under foreground coloring.

optionally followed by:
default (sets default color as background color)

Examples:
oshow [background black]
oshow [background yellow default]

**cursor** followed by:
down
up
position? (reports current cursor position)
save (saves the current cursor position)
restore (restores the cursor to the position previously saved)
to (followed by:)
3x5 (moves the cursor to column 3, row 5)
home (moves cursor to column 1, row 1)
bottom (moves cursor to row 1 of the same column)
**reset** (resets the LCD screen)
**clear** (clears the screen)
**off** (turns LCD screen off)
**on** (turns LCD screen on)
**key** (simulated keyboard press) followed by:
2 (optional: the number of keypresses - default is 1)
up
down
left
right
**rotate** (rotates the display in 90 degree increments) followed by:
left (counterclockwise 90 degrees)
right (clockwise 90 degrees)
**draw** (not yet functional) followed by:
10x20 (optional: the upper left corner of the image - default is 0x0)
50x50 (optional: the size of the image - default is 320x240)
<image data>

# *RECOMPILING MALI DRIVERS*

## *UPDATING TO THE LATEST RELEASE (R4P0-00RELI)*

**by Mauro Ribeiro**

Prepare your ODROID to run the latest R4P0 Mali drivers by typing the following into a Terminal window:

```
sudo apt-get install xserver-
xorg-video-armsoc xserver-xorg-
dev libudev-dev
```

As of May 5, 2014, Hardkernel is no longer supporting the Mali r3p2 drivers, and haved moved on to using the R4P0 version exclusively. There are two major changes:

**1. Instead of using the Mali DDX, the Armsoc driver is installed.**
**2. UMP no longer exists, and Mali is now using dma-buf.**

We have provided an updated Armsoc DDX in order to adapt your existing Ubuntu or Debian operating system to the new Mali drivers. The source code for the r4p0 branch of the repository is located at `http://bit.ly/1oySeYE`. Download the source to a temporary folder, then type `make install` at the command prompt after navigating to the temporary folder.

Blobs for EGL/GLESv1/GLESV2 are available for free download at `http://bit.ly/1hiwJw9`, which includes an optional example xorg.conf file.

Note that if your defconfig still has UMP, it will probably fail to build, so make sure to remove it first.

If you have questions regarding the new Mali drivers, feel free to ask them in the ODROID community forums at `http://forum.odroid.com/`.

# GOT WIIMOTE? MAKE YOURSELF AN AWESOME GYROSCOPIC MOUSE

by Rob Roy

Do you have a Wii remote that hasn't seen much use lately? It's actually a very elegant piece of input hardware, with an ergonomic design, infrared scanner and gyroscope sensors. Ubuntu has several packages available from its repositories that automatically read the sensors in the Wii and translate them into mouse and button movements. To install the driver software, type:

```
$ sudo apt-get install libcwi-
id1 lswm wmgui wminput
```

After installation has completed, connect to the Wii remote by pressing 1 and 2 simultaneously, which activates the Bluetooth Connect mode. Once the Wiimote's lights start flashing, type:

```
$ hcitool scan
```

or

```
$ lswm
```

Either command will display the MAC address for all nearby Wiimote controllers that are currently in Bluetooth Connect mode. Load the Wiimote driver by typing the following, using the MAC address from the previous step. In this example, the MAC address is `01:FA:2C:9D:BB:05`:

```
$ sudo wminput \
01:FA:2C:9D:BB:05
```

The wiimote will then be treated by Ubuntu as a gyroscopic air mouse, suitable for use in situations where a normal mouse won't work, such as while delivering a group presentation or sitting on a couch.

And here is the code for the oshow dialect, to be saved as "oshow.r3", or it can be downloaded from the URL link in the header below.

```
REBOL [
    Title: {ODROID Show Dialect}
    Date: 20-May-2014
    Author: {Bohdan Lechnowsky}
    URL: http://respectech.com/odroid/odroid-show.r3
    Purpose: {
        Provides a dialect to allow easy usage of the ODROID Show hard-
ware component
    }
]

oshow: func [
    {Allow easy utilization of the ODROID-Show display module}
    serport {Name of the serial port to send to (i.e. "serial://
ttyUSB0/57600" or "%/dev/ttyUSB0")}
    specs [block!] "Dialect block of layout"
    /local outstring
][
    outstring: copy {}

    out: func [str /local pstr buffs][
        ;Break string into lines and output lines one at a time
        foreach lstr pstr: parse/all str "^/" [

            ;The ODROID-Show hardware is limited to 256 characters per
line, but this
            ; can be overcome by breaking the line into 256-character
chunks and
            ; outputting them one after the other.
            buffs: copy []

            ;Replace tabs with four spaces before breaking apart into
chunks.
            while [not tail? detab/size lstr 4][
                append buffs copy/part lstr 256
                lstr: skip lstr 256
            ]
            foreach buff buffs [
                write serport join buff "^J^M"

                ;In my tests, I find that wait values less than 80ms
often lead
                ; to output corruption. Longer waits may be required
with some
                ; output.
                wait .08
            ]
            append outstring lstr
            ]
        ]

        font-rules: [
            color-rules (out join "^[[3" col)
            | 'default (out "^[[39m")
             | set font-sz integer! (out rejoin ["^[["
font-sz "s"])
            | set textout string! (out textout)
        ]
        back-rules: [
            color-rules (out join "^[[4" col)
            | 'default (out "^[[49m")
        ]
        color-rules: [
            'black (col: "0m")
            | 'red (col: "1m")
            | 'green (col: "2m")
            | 'yellow (col: "3m")
            | 'blue (col: "4m")
            | 'magenta (col: "5m")
            | 'cyan (col: "6m")
            | 'white (col: "7m")
        ]
        cursor-rules: [
            'down (out "^[D")
            | 'up (out "^[M")
            | 'position? (out "^[[6n")
            | 'save (out "^[[s")
            | 'restore (out "^[[u")
            | 'to any [
                set cpos pair! (out rejoin ["^[[" cpos/x
";" cpos/y "H"])
                | 'home (out "^[[H")
                | 'bottom (out "^[E")
            ]
        ]

        ;'presses uses a fun trick.  If keypresses have
been defined by the input from the user,
        ; then use that number.  If not, use the default
(1 in this case).  This is shorter than
         ; the old-school method that would look like
this:
        ;
        ;    unless value? 'keypresses [keypresses: 1]
        ;    keypresses
        ;
        ;    (52 bytes, not including the line break)
        ;   ("unless" is a synonym in Rebol of "if not",
which is not any shorter than "unless")
        ;
        ; Another possible method could be like this:
        ;
         ;     all [not value? 'keypresses keypresses:
1]
        ;    keypresses
        ;
        ;    (53 bytes, not including the line break)
        ;
         ;     (The "do pick" method below is only 41
bytes)

        presses: [do pick [keypresses 1] value? 'key-
presses]

        key-rules: [
            'up (out rejoin ["^[[" do presses "A"])
               | 'down (out rejoin ["^[[" do presses
"B"])
               | 'left (out rejoin ["^[[" do presses
"C"])
              | 'right (out rejoin ["^[[" do presses
"D"])
            | set keypresses integer!
        ]
        rotate-rules: [
            'left (loop 3 [out "^[[r"])
            | 'right (out "^[[r")
        ]
        show-rules: [any [
            'font any font-rules
            | 'backdrop any back-rules
            | 'cursor any cursor-rules
            | 'reset (out "^[c")
            | 'clear (out "^[[2J")
            | 'off (out "^[[0q")
            | 'on (out "^[[1q")
            | 'key any key-rules
            | 'rotate any rotate-rules
            | 'draw
            | set textout string! (out textout)
        ]]
        parse specs show-rules
        outstring
    ]
```

This simple Rebol program makes the ODROID-SHOW's commands more accessible by abstracting the native command syntax.

Please refer to the Rebol website for more information at `http://www.rebol.com`, or download the source code at `http://www.rebolsource.net`.

# PACKAGE YOUR COMPILED SOFTWARE FOR INSTALLATION

## COMPILING DOOM PART 2

by Tobias Schaaf

To install DOOM, type INSTALL and press ENTER
DOOM
Created by id Software
©1993 id Software, Inc. All Rights Reserved.

DOOM originally came on floppy disks that held only 1.44MB of game data and were very fragile.

In the previous article, I outlined the process for compiling and porting software and games to the ODROID, using DOOM as an example. This month, I present a technique for packaging the compiled binaries for sharing and distribution.

### Checkinstall

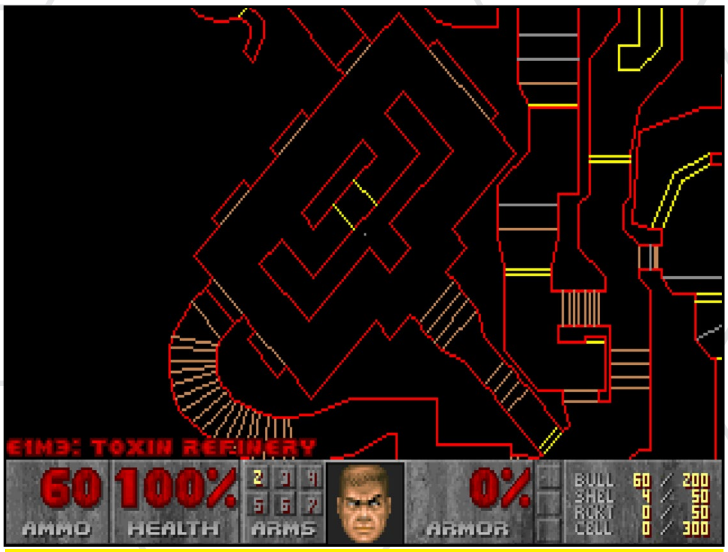
Checkinstall is very useful as a simple way to create installation (.deb) files. It allows you to pack everything your program need into a single file and add required libraries as a dependency, so that you can install it on systems that do not yet have the required libraries installed.

If you run checkinstall on the sdldoom project, it will look like this:

```
root@odroid-wheezy:/home/odroid/sources/sdldoom-1.10$
checkinstall

checkinstall 1.6.2, Copyright 2009 Felipe Eduardo
Sanchez Diaz Duran
   This software is released under the GNU GPL.

The package documentation directory ./doc-pak does
not exist.
Should I create a default set of package docs?  [y]:

Preparing package documentation...OK

Please write a description for the package.
End your description with an empty line or EOF.
>> SDL Doom

*****************************************
**** Debian package creation selected ***
*****************************************

This package will be built according to these values:

0 -  Maintainer: [ root@odroid-wheezy ]
1 -  Summary: [ SDL Doom ]
2 -  Name:    [ sdldoom ]
3 -  Version: [ 1.10 ]
4 -  Release: [ 1 ]
5 -  License: [ GPL ]
6 -  Group:   [ checkinstall ]
7 -  Architecture: [ armhf ]
8 -  Source location: [ sdldoom-1.10 ]
9 -  Alternate source location: [  ]
10 - Requires: [  ]
11 - Provides: [ sdldoom ]
12 - Conflicts: [  ]
13 - Replaces: [  ]

Enter a number to change any of them or press ENTER
to continue:
```

Checkinstall takes the name of the folder you are currently in as the package name (sdldoom) and automatically takes the -1.10 that was added to the folder name as the version number. If your folder names does not match, you can alter these names here as well as setting the right version here. Make sure to change #2 Name as well as #11 Provides.

Here you can configure your installation and add required packages such as libsdl1.2debian, which is the libsdl library needed for this build under #10 Requires. After pressing Enter, it should generate a nice little .deb file.



**DOOM is where the fastest player with the biggest gun wins! Unless, of course, you've modified the source code to make yourself 100% invincible, or be able to shoot through walls.**

```
Enter a number to change any of them or press ENTER
to continue:

Installing with make install...

=========================     Installation     results
===========================
make[1]:  Entering  directory  `/home/odroid/sources/
sdldoom-1.10'
/bin/sh ./mkinstalldirs /usr/local/bin
/usr/bin/install -c  doom /usr/local/bin/doom
make[1]: Nothing to be done for `install-data-am'.
make[1]: Leaving directory `/home/odroid/sources/sdl-
doom-1.10'

========================    Installation    successful
==========================

Copying documentation directory...
./
./README.asm
./Changelog
./TODO
./FILES
./README.book
./README.SDL
./README.b
./README.gl

Copying files to the temporary directory...OK
Stripping ELF binaries and libraries...OK
Compressing man pages...OK
Building file list...OK
Building Debian package...OK
Installing Debian package...OK
Erasing temporary files...OK
Writing backup package...OK
OK

Deleting temp dir...OK
*****************************************************
*****************
Done.  The new package has been installed and saved
to
/home/odroid/sources/sdldoom-1.10/sdldoom_1.10-1_arm-
hf.deb
You can remove it from your system anytime using:
    dpkg -r sdldoom
*****************************************************
*****************
```

Although interactive mode is an easy method to create a deb file, another way is to give the parameters right when you start checkinstall, which allows for some extra options as well:

```
$ checkinstall --backup=no --install=no
--requires="libsdl1.2debian" --pkgname="sdldoom-
odroid" --pkgversion=1.10
```

If you start checkinstall without the "--backup=no" option, a tar file is going to be created with all the files that were copied during the install process. If you start checkinstall without the "--install=no" option, your software will be installed right after the package is done building. After all this is completed, you will find a nice little .deb file in your folder.

```
$ ls -l *.deb
-rw-r--r-- 1 root root 174490 Apr  5 15:16 sdldoom_1.10-1_
armhf.deb
```

The .deb file can then be copied and installed to any other ODROID, and if you have set the dependency requirements right, it should start right away. Getting the requirements correct will take some time and experience, depending on the project. The libsdl1.2-dev package actually only includes the header files for SDL (files ending on .h and located somewhere within /usr/include/ ), but the actually SDL library is called libsdl1.2debian.

If you check on the libsdl1.2-dev package, you will see Depends: libsdl1.2debian (= 1.2.15-5)in the dependencies list.

```
apt-cache show libsdl1.2-dev
Package: libsdl1.2-dev
Source: libsdl1.2
Version: 1.2.15-5
Installed-Size: 2358
Maintainer: Debian SDL packages maintainers <pkg-sdl-
maintainers@lists.alioth.debian.org>
Architecture: armhf
Replaces: libsdl-dev
Provides: libsdl-dev
Depends: libsdl1.2debian (= 1.2.15-5), libasound2-dev,
libcaca-dev, libdirectfb-dev (>= 0.9.22), libglu1-me-
sa-dev | libglu-dev, libpulse-dev, libx11-dev, libts-
dev, libxext-dev
Conflicts: libsdl-dev
Description-en: Simple DirectMedia Layer development
files
SDL is a library that allows programs portable low
level access to a video
framebuffer, audio output, mouse, and keyboard.

This package contains the files needed to compile and
link programs which
use SDL.
Homepage: http://www.libsdl.org/
Description-md5: 9a82f59c5790721baad7ffc5f181d3d6
Tag: devel::library, role::devel-lib, uitoolkit::sdl
Section: libdevel
Priority: optional
Filename:      pool/main/libs/libsdl1.2/libsdl1.2-
dev_1.2.15-5_armhf.deb
Size: 861890
MD5sum: 4295708cab85d1eb546b449350dd2da6
SHA1: 76fa9923c9765d7b92e373df6fe12949f2092db5
SHA256: 71def7638b06e6711f6fa8d96724aa7eb238a7b10f9f-
b14192b5a5c1018d1322
```

Libsdl1.2debian is the actual library that contains the binary files needed to run libsdl. As previously mentioned, the -dev file only includes the headers, and is useless if you only want to RUN the program. However, if you are unsure what libraries to add in checkinstall, you can add the -dev libs as well. This method is not as clean, but it will work well, since the program will always have the actual library as a dependency.

## Some special notes about checkinstall

Since checkinstall copies the files to the location, you will most likely have to run it as root, since the normal user will not be allowed to copy files in certain folders and the build will fail.

Sometimes, checkinstall fails even though it has root privileges, and there sometimes seems to be a problem with the creation of folders when using checkinstall. If a program that you installed requires creating a folder, checkinstall may fail because it cannot create the folder to copy the files. To solve this, run `make install` first and then run `checkinstall` again.

Checkinstall is very helpful, as it will strip all binary files of unnecessary content such as comments and debug symbols that are no longer needed after the program is build completely, which can reduce the size of files greatly.

**Size of the doom binary before stripping:**

```
$ ls -lh doom
-rwxr-xr-x 1 root root 423K Apr  5 11:33 doom
```

**Size of the doom library in the .deb file:**

```
$ ls -lh doom
-rwxr-xr-x 1 root root 368K Apr  5 15:16 doom
```

The file size for DOOM might not make a very huge impact, but it can for other programs. For example, the kernel files provided by Hardkernel have a total of 354MB uncompressed.

```
$ du -h --max-depth=1
45M     ./usr
307M    ./lib
2.5M    ./boot
354M    .
```

And the same kernel files after stripping:

```
$ du -h --max-depth=1
45M     ./usr
18M     ./lib
2.5M    ./boot
65M     .
```

As we can see, the /usr and /boot directory have not changed at at all, since they have only header files or files that can not be excluded, but if you strip away the unnecessary comments symbols on the actual libraries in the /lib folder, the size is reduced from 307 to 18 MB, and still the libraries have the same functionality as they did with 307 MB of size. As a result, the install size of the kernel will be reduced from 354 MB to 65 MB using checkinstall. Depending on the software packages you create, checkinstall can help you keep your software nice and clean (and slim).

Some of the fiercest monsters in DOOM came straight from my worst nightmares. Meet Spider Demon, a 4-legged robot brain with a chaingun.

Checkinstall won't always work. Some projects do not provide a `make install` function, and checkinstall won't work for those applications. But don't worry, as you get more experienced in compilation, you'll probably figure out how to build your own install routines.

## Building a larger project

For DOOM, compiling and packaging is very simple, and we only had to download one file instead of ten, hundreds, or thousands of files, and there was only one view dependency.

As an example of a larger project, I included compilation instructions for OpenXCom. When you browse the OpenXcom homepage, click on the following link in the wiki sidebar: `http://bit.ly/1rWH0ml`.

## Compiling OpenXCom

OpenXcom requires the following libraries to compile:

**SDL (libsdl1.2)**
**SDL_mixer (libsdl-mixer1.2)**
**SDL_image (libsdl-image1.2)**
**SDL_gfx (libsdl-gfx1.2), version 2.0.22 or later**
**yaml-cpp, (libyaml-cpp), version 0.5 or later**

This is great, because everything we need is right in front of us, mostly because of OpenXcom's excellent documentation. It's now a simple matter to install what we need.

```
apt-get  install  libsdl1.2-dev  libsdl-mixer1.2-dev
libsdl-image1.2-dev libsdl-gfx1.2-dev
```

I skipped the yaml-cpp because if you compile it on Ubuntu, installing libyaml-cpp-dev will give you a version 0.5 or higher, but on Debian Wheezy, you only get libyaml-cpp version 0.3 which doesn't work.

To overcome this, I compiled libyaml-cpp myself which can be installed by typing the following in Terminal:

```
$  wget  http://oph.mdrjr.net/meveric/repository/liby-
aml-cpp0.5_0.5.1-1_armhf.deb
$ dpkg -i libyaml-cpp0.5_0.5.1-1_armhf.deb
```

Now that we have all the requirements, we can start to download the sources. On the top of the OpenXCom Wiki page, there is a link to a repository, which leads to a project page containing lots of folder and files. It will be very time-consuming to download them all with wget, but luckily there is a faster alternative.

From the git repository, we can download all of the files from the entire repository with just one command. First, get the URL of the project site:

```
$ git clone https://github.com/SupSuper/OpenXcom.git
Cloning into 'OpenXcom'...
remote: Reusing existing pack: 40755, done.
remote: Counting objects: 124, done.
remote: Compressing objects: 100% (118/118), done.
remote: Total 40879 (delta 67), reused 0 (delta 0)
Receiving objects: 100% (40879/40879), 14.05 MiB | 849
KiB/s, done.
Resolving deltas: 100% (33534/33534), done.
```

Well, that was nice, since we just downloaded about 700 files in a few seconds! For other projects that use subversion instead of git, the command line is very similar: `svn checkout <url>`. Shown below is a list of the new files:

```
$ ls -l
total 152
-rwxr-xr-x  1 root root    82 Apr  5 17:12 autogen.sh
drwxr-xr-x  3 root root  4096 Apr  5 17:12 bin
-rw-r--r--  1 root root 32796 Apr  5 17:12 CHANGELOG.
txt
drwxr-xr-x  3 root root  4096 Apr  5 17:12 cmake
-rw-r--r--  1 root root  5681 Apr  5 17:12 CMakeLists.
txt
-rw-r--r--  1 root root  3385 Apr  5 17:12 configure.
ac
-rw-r--r--  1 root root 35819 Apr  5 17:12 COPYING
drwxr-xr-x  2 root root  4096 Apr  5 17:12 docs
drwxr-xr-x  6 root root  4096 Apr  5 17:12 install
drwxr-xr-x  2 root root  4096 Apr  5 17:12 m4
-rw-r--r--  1 root root 21142 Apr  5 17:12 Makefile.am
drwxr-xr-x  2 root root  4096 Apr  5 17:12 obj
-rw-r--r--  1 root root  4446 Apr  5 17:12 README.txt
drwxr-xr-x  5 root root  4096 Apr  5 17:12 res
drwxr-xr-x 12 root root  4096 Apr  5 17:12 src
```

This time, there is no configure and no Makefile either, just a Makefil.am. So what can we do now?

There are two things in this folder that will help: an executable file called: autogen.sh and a file called CMakeList.txt.

## Autogen

Some projects have a file with the name autogen, automake or autoconf instead of a configure file in their source directory.

```
$ ./autogen.sh
aclocal: installing `m4/pkg.m4' from `/usr/share/aclo-
cal/pkg.m4'
autoreconf: Entering directory `.'
autoreconf: configure.ac: not using Gettext
autoreconf: running: aclocal --force -I m4
autoreconf: configure.ac: tracing
autoreconf: configure.ac: not using Libtool
autoreconf: running: /usr/bin/autoconf --force
autoreconf: configure.ac: not using Autoheader
autoreconf:  running:  automake  --add-missing  --force-
missing
configure.ac:106: installing `./config.guess'
configure.ac:106: installing `./config.sub'
configure.ac:17: installing `./install-sh'
configure.ac:17: installing `./missing'
Makefile.am: installing `./depcomp'
autoreconf: Leaving directory `.'
```

The output is very short, and it's not apparent what has been done. Let's check if it did something.

```
$ ls -l
total 1204
-rw-r--r--  1 root root  36830 Apr  5 17:23 aclocal.
m4
-rwxr-xr-x  1 root root     82 Apr  5 17:12 autogen.
sh
drwxr-xr-x  2 root root   4096 Apr  5 17:23 autom4te.
cache
drwxr-xr-x  3 root root   4096 Apr  5 17:12 bin
-rw-r--r--  1 root root  32796 Apr  5 17:12 CHANGELOG.
txt
drwxr-xr-x  3 root root   4096 Apr  5 17:12 cmake
-rw-r--r--  1 root root   5681 Apr  5 17:12 CMakeLists.
txt
lrwxrwxrwx  1 root root     37 Apr  5 17:23 config.guess
-> /usr/share/automake-1.11/config.guess
lrwxrwxrwx  1 root root     35 Apr  5 17:23 config.sub
-> /usr/share/automake-1.11/config.sub
-rwxr-xr-x  1 root root 211749 Apr  5 17:23 configure
-rw-r--r--  1 root root   3385 Apr  5 17:12 configure.
ac
-rw-r--r--  1 root root  35819 Apr  5 17:12 COPYING
lrwxrwxrwx  1 root root     32 Apr  5 17:23 depcomp ->
/usr/share/automake-1.11/depcomp
drwxr-xr-x  2 root root   4096 Apr  5 17:23 docs
drwxr-xr-x  6 root root   4096 Apr  5 17:12 install
lrwxrwxrwx  1 root root     35 Apr  5 17:23 install-sh
-> /usr/share/automake-1.11/install-sh
drwxr-xr-x  2 root root   4096 Apr  5 17:23 m4
-rw-r--r--  1 root root  21142 Apr  5 17:12 Makefile.
am
-rw-r--r--  1 root root 822542 Apr  5 17:23 Makefile.
in
lrwxrwxrwx  1 root root     32 Apr  5 17:23 missing ->
/usr/share/automake-1.11/missing
drwxr-xr-x  2 root root   4096 Apr  5 17:12 obj
-rw-r--r--  1 root root   4446 Apr  5 17:12 README.
txt
drwxr-xr-x  5 root root   4096 Apr  5 17:12 res
drwxr-xr-x 12 root root   4096 Apr  5 17:19 src
```

After this step, there is now a configure file, which gives the same starting point for compilation as the first example.

## CMakeLists.txt

Cmake is also a very nice tool, and if a project has a CMakeLists.txt in its directory, it supports cmake. We could just go ahead and type cmake, but i would highly advise NOT to do so!

Although cmake will work, and would generate the code that we need, it's somewhat messy. Also, you can't figure out what is source code and what comes from cmake, so there is a better way to do it.

Instead, create a new folder change in that folder and start cmake from there.

```
$ mkdir build
$ cd build
$ cmake ..
```

Cmake is started with a path to the CMakeLists.txt file. In the DOOM example, it was "cmake .". Since we were in the same directory we used the "." to tell cmake to use the current directory. Now that we are in a subfolder called build, we just tell cmake that the CMakeLists.txt is one folder up by typing "cmake ..". With everything setup correctly, it should look similar to this:

```
$ cmake ..
-- The C compiler identification is GNU 4.7.2
-- The CXX compiler identification is GNU 4.7.2
-- Check for working C compiler: /usr/bin/gcc-4.7
-- Check for working C compiler: /usr/bin/gcc-4.7 --
works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Check for working CXX compiler: /usr/bin/g++-4.7
-- Check for working CXX compiler: /usr/bin/g++-4.7
-- works
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
-- Looking for include file pthread.h
-- Looking for include file pthread.h - found
-- Looking for pthread_create
-- Looking for pthread_create - not found
-- Looking for pthread_create in pthreads
-- Looking for pthread_create in pthreads - not found
-- Looking for pthread_create in pthread
-- Looking for pthread_create in pthread - found
-- Found Threads: TRUE
-- Found PkgConfig: /usr/bin/pkg-config (found version
"0.26")
-- Looking for XOpenDisplay in /usr/lib/arm-linux-
gnueabihf/libX11.so;/usr/lib/arm-linux-gnueabihf/
libXext.so
-- Looking for XOpenDisplay in /usr/lib/arm-linux-
gnueabihf/libX11.so;/usr/lib/arm-linux-gnueabihf/
libXext.so - found
-- Looking for gethostbyname
-- Looking for gethostbyname - found
-- Looking for connect
-- Looking for connect - found
-- Looking for remove
-- Looking for remove - found
-- Looking for shmat
-- Looking for shmat - found
-- Looking for IceConnectionNumber in ICE
-- Looking for IceConnectionNumber in ICE - found
-- Found X11: /usr/lib/arm-linux-gnueabihf/libX11.so
-- Found OpenGL: /usr/local/lib/libGL.so
found SDL 1.2.15 (/usr/lib/arm-linux-gnueabihf:/usr/
include/SDL)
found SDL_mixer 1.2.12 (/usr/lib/arm-linux-gnueabi-
hf:/usr/include/SDL)
found SDL_gfx 2.0.23 (/usr/lib/arm-linux-gnueabihf:/
usr/include/SDL)
found SDL_image 1.2.12 (/usr/lib/arm-linux-gnueabi-
hf:/usr/include/SDL)
found     yaml-cpp(/usr/local/lib:/usr/local/include/
yaml-cpp;/usr/local/include/yaml-cpp/..)
-- Found Git: /usr/bin/git (found version "1.7.10.4")
git found: /usr/bin/git
version:0.9.g8bcafea
No doxygen command found.  Disable API documentation
generation
-- Configuring done
-- Generating done
-- Build files have been written to: /home/odroid/
sources/OpenXcom/build

$ ls -l
total 68
drwxr-xr-x 2 root root  4096 Apr  5 17:37 bin
-rw-r--r-- 1 root root 29527 Apr  5 17:37 CMakeCache.
txt
drwxr-xr-x 4 root root  4096 Apr  5 17:37 CMakeFiles
-rw-r--r-- 1 root root  1906 Apr  5 17:37 cmake_in-
stall.cmake
-rw-r--r-- 1 root root  3526 Apr  5 17:37 CPackConfig.
cmake
-rw-r--r-- 1 root root  3942 Apr  5 17:37 CPackSource-
Config.cmake
drwxr-xr-x 3 root root  4096 Apr  5 17:37 docs
-rw-r--r-- 1 root root  6481 Apr  5 17:37 Makefile
drwxr-xr-x 3 root root  4096 Apr  5 17:37 src
```

Since we got a Makefile here, so we run `make` and watch the pretty colors go by!

```
$ make
Scanning dependencies of target openxcom
[  0%] Building CXX object src/CMakeFiles/openxcom.
dir/main.cpp.o
[  0%] Building CXX object src/CMakeFiles/openxcom.
dir/lodepng.cpp.o
[  1%] Building CXX object src/CMakeFiles/openxcom.
dir/Basescape/BaseView.cpp.o
[  1%] Building CXX object src/CMakeFiles/openxcom.
dir/Basescape/CraftSoldiersState.cpp.o
[...]
[ 99%] Building CXX object src/CMakeFiles/openxcom.
dir/Ufopaedia/ArticleStateTextImage.cpp.o
[ 99%] Building CXX object src/CMakeFiles/openxcom.
dir/Ufopaedia/ArticleStateArmor.cpp.o
[100%] Building CXX object src/CMakeFiles/openxcom.
dir/Ufopaedia/ArticleStateVehicle.cpp.o
Linking CXX executable ../bin/openxcom
[100%] Built target openxcom
```

Everything looks good, and we have an OpenxCom build in the bin folder. Now, run checkinstall again. We already know what libraries to add to the required list since we got that list from the OpenXCom site.

```
$    checkinstall    --backup=no    --install=no
--requires="libdl1.2debian,  libsdl-image1.2,  lib-
sdl-mixer1.2,   libsdl-gfx1.2-4,   libyaml-cpp0.5"
--pkgname="openxcom" --pkgversion="0.9.g8bcafea"
```

This is one of the moments when checkinstall will fail because of its issue with creating directories, so run `make install` first and then re-run checkinstall.

```
$     checkinstall     --backup=no     --install=no
--requires="libdl1.2debian,   libsdl-image1.2,   lib-
sdl-mixer1.2,     libsdl-gfx1.2-4,     libyaml-cpp0.5"
--pkgname="openxcom" --pkgversion="0.9.g8bcafea"

checkinstall 1.6.2, Copyright 2009 Felipe Eduardo San-
chez Diaz Duran
         This software is released under the GNU GPL.


The package documentation directory ./doc-pak does not
exist.
Should I create a default set of package docs?  [y]:
y

Please write a description for the package.
End your description with an empty line or EOF.
>> OpenXCom
>>
*****************************************
**** Debian package creation selected ***
*****************************************

This package will be built according to these values:

0 -  Maintainer: [ root@odroid-wheezy ]
1 -  Summary: [ OpenXCom ]
2 -  Name:    [ openxcom ]
3 -  Version: [ 0.9.g8bcafea ]
4 -  Release: [ 1 ]
5 -  License: [ GPL ]
6 -  Group:   [ checkinstall ]
7 -  Architecture: [ armhf ]
8 -  Source location: [ build ]
9 -  Alternate source location: [  ]
10 - Requires: [ libdl1.2debian, libsdl-image1.2, lib-
sdl-mixer1.2, libsdl-gfx1.2-4, libyaml-cpp0.5 ]
11 - Provides: [ openxcom ]
12 - Conflicts: [  ]
13 - Replaces: [  ]

Enter a number to change any of them or press ENTER to
continue:

Installing with make install...

=========================    Installation    results
===========================
[100%] Built target openxcom
Install the project...
-- Install configuration: ""
-- Installing: /usr/local/bin/openxcom
--  Removed  runtime  path  from  "/usr/local/bin/openx-
com"
-- Installing: /usr/local/share/openxcom/data
--    Installing:    /usr/local/share/openxcom/data/Re-
sources
--    Installing:    /usr/local/share/openxcom/data/Re-
sources/UI
-- Installing: /usr/local/share/openxcom/data/Resourc-
es/UI/reserve.png
--    Installing:    /usr/local/share/openxcom/data/Re-
sources/Weapons
-- Installing: /usr/local/share/openxcom/data/Resourc-
es/Weapons/Terror.png
-- Installing: /usr/local/share/openxcom/data/Resourc-
es/Pathfinding
-- Installing: /usr/local/share/openxcom/data/Resourc-
es/Pathfinding/Pathfinding.png
-- Installing: /usr/local/share/openxcom/data/Resourc-
es/BulletSprites
-- Installing: /usr/local/share/openxcom/data/Resourc-
es/BulletSprites/BulletSprites.png
--    Installing:    /usr/local/share/openxcom/data/Re-
sources/BulletSprites/TFTD-LAND.png
--    Installing:    /usr/local/share/openxcom/data/Re-
sources/BulletSprites/TFTD-UNDERWATER.png
-- Installing: /usr/local/share/openxcom/data/Shaders
--   Installing:   /usr/local/share/openxcom/data/Shad-
ers/Phosphor-simple.OpenGL.shader
--   Installing:   /usr/local/share/openxcom/data/Shad-
ers/Openxcom.OpenGL.shader
CMake Error at src/cmake_install.cmake:54 (FILE):
file INSTALL cannot find
"/home/odroid/sources/test/OpenXcom/bin/data/Shaders/
heavybloom.OpenGL.shader".
Call Stack (most recent call first):
cmake_install.cmake:38 (INCLUDE)

make: *** [install] Error 1

****   Installation  failed.   Aborting  package  cre-
ation.

Cleaning up...OK

Bye.
```

```
$ make install
[100%] Built target openxcom
Install the project...
-- Install configuration: ""
-- Installing: /usr/local/bin/openxcom
--  Removed  runtime  path  from  "/usr/local/bin/openx-
com"
-- Installing: /usr/local/share/openxcom/data
--    Installing:    /usr/local/share/openxcom/data/Re-
sources
…
-- Installing: /usr/local/share/openxcom/data/Ruleset
--   Installing:   /usr/local/share/openxcom/data/Rule-
set/Xcom1Ruleset.rul
```

```
$     checkinstall     --backup=no     --install=no
--requires="libdl1.2debian,   libsdl-image1.2,   lib-
sdl-mixer1.2,     libsdl-gfx1.2-4,     libyaml-cpp0.5"
--pkgname="openxcom" --pkgversion="0.9.g8bcafea"

checkinstall 1.6.2, Copyright 2009 Felipe Eduardo San-
chez Diaz Duran
         This software is released under the GNU GPL.

*****************************************
**** Debian package creation selected ***
*****************************************

This package will be built according to these values:

0 -  Maintainer: [ root@odroid-wheezy ]
1 -  Summary: [ OpenXCom ]
2 -  Name:    [ openxcom ]
3 -  Version: [ 0.9.g8bcafea ]
4 -  Release: [ 1 ]
5 -  License: [ GPL ]
6 -  Group:   [ checkinstall ]
7 -  Architecture: [ armhf ]
8 -  Source location: [ build ]
9 -  Alternate source location: [  ]
10 - Requires: [ libdl1.2debian, libsdl-image1.2, lib-
sdl-mixer1.2, libsdl-gfx1.2-4, libyaml-cpp0.5 ]
11 - Provides: [ openxcom ]
12 - Conflicts: [  ]
13 - Replaces: [  ]

Enter a number to change any of them or press ENTER
to continue:
```

```
Installing with make install...

========================= Installation results
===========================
[100%] Built target openxcom
Install the project...
-- Install configuration: ""
-- Up-to-date: /usr/local/bin/openxcom
-- Installing: /usr/local/share/openxcom/data
-- Installing: /usr/local/share/openxcom/data/Resourc-
es
...
-- Installing: /usr/local/share/openxcom/data/Ruleset
-- Up-to-date: /usr/local/share/openxcom/data/Ruleset/
Xcom1Ruleset.rul

======================== Installation successful
==========================

Copying documentation directory...
./
./docs/
./docs/Makefile
./docs/CMakeFiles/
./docs/CMakeFiles/CMakeDirectoryInformation.cmake
./docs/CMakeFiles/progress.marks
./docs/cmake_install.cmake

Some of the files created by the installation are inside
the home directory: /home

You probably don't want them to be included in the
package.
Do you want me to list them?  [n]: n
Should I exclude them from the package? (Saying yes is
a good idea)  [n]: y

Copying files to the temporary directory...OK
Stripping ELF binaries and libraries...OK
Compressing man pages...OK
Building file list...OK
Building Debian package...OK
NOTE: The package will not be installed
Erasing temporary files...OK
Deleting temp dir...OK

******************************************************
*****************
Done.  The new package has been saved to

/home/odroid/sources/test/OpenXcom/build/
openxcom_0.9.g8bcafea-1_armhf.deb
You can install it in your system anytime using:

    dpkg -i openxcom_0.9.g8bcafea-1_armhf.deb
******************************************************
*****************
```

One this step completes, the OpenXcom .deb installation package is ready for use! This should be enough information to get started with compiling your first projects.

## Notes on cmake

There is something that I rather like about cmake. After cmake is done creating the build-tree for a project, you will find a folder with the name of the binary file of the project. For example, on the OpenXcom project, the folder can be found at src/CMakeFiles/openxcom.dir/. In this folder, you will always find a file called link.txt which will show you how the final binary is built as well as which libraries are linked into it.

The Cyber Demon has a frightening description in the original DOOM manual: "a missile-launching skyscraper with goat legs. 'Nuff said".

```
$ cat src/CMakeFiles/openxcom.dir/link.txt
[…]
-o ../bin/openxcom -rdynamic -lSDL_image -lSDL_mixer
-lSDL_gfx -Wl,-Bstatic -lSDLmain -Wl,-Bdynamic -lSDL
-lpthread /usr/local/lib/libyaml-cpp.so /usr/local/
lib/libGL.so -Wl,-rpath,/usr/local/lib:
```

If you check the last line, you will find the libraries that are linked to the binary file, for example, -lSDL_image -lSDL_mixer -lSDL_gfx -lSDL. As mentioned in the previous article, the files starting with "-l" are libraries. These are exactly the libraries that we used in our checkinstall command, and that were listed on the OpenXCom site. So, in case you don't know which libraries you needed, you can also find them here.

## Checking dependencies

With the `ldd` command, you can easily check on the dependencies of a particular binary file that has already been compiled.

```
$ ldd /usr/local/bin/doom
libm.so.6    =>    /lib/arm-linux-gnueabihf/libm.so.6
(0xb6e80000)
libSDL-1.2.so.0 => /usr/lib/arm-linux-gnueabihf/libS-
DL-1.2.so.0 (0xb6e03000)
libc.so.6    =>    /lib/arm-linux-gnueabihf/libc.so.6
(0xb6d1e000)
/lib/ld-linux-armhf.so.3 (0xb6f08000)
[...]
```

Now, go play DOOM!

To install DOOM, type INSTALL and press ENTER
DOOM
Created by id Software
©1993 id Software, Inc. All Rights Reserved.

# DESCRIBING THE MATHEMATICAL FUNCTION ATAN2

## A USEFUL TOOL FOR PROGRAMMING APPLICATIONS THAT REQUIRE REAL-TIME TRIGONOMETRY

by Jussi Opas

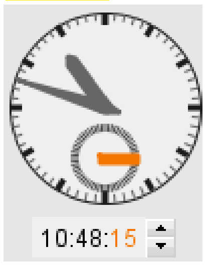
Many of us have been applying the casual trigonometric functions such as sin, cos or tan and their reverse functions asin, acos, and atan to make geometric computations. That is what also school mathematics has taught us to do. While doing so, one meets such problems as, the value interval of sin is [-π/2, π/2], and there is a chance to divide with zero, when tan(y/x) is used. To solve these problems, programs must branch with "if" sentences, and the division by zero problem must be handled, too. There is an excellent method for solving all the mentioned problems within computer programs by applying the atan2(y, x) method.

The atan2 function was originally introduced in FORTRAN programming language to ease up trigonometric computations [WIK14]. It is available also elsewhere, like C, Java, and (surprise, surprise) in .NET and Excel, too. The advantage of atan2 is that it gives continuous values in the interval of (-π, π]. When expressed with atan function, the definition is as follows:

```
atan2(y,x)=atan(yx),ifx>0atan(yx)+π,ify≥0,x<0atan
(yx)-π,ify<0,x=0π2,ify>0,x=0-π2,ify<0,x=0undefined
,ify=0,x=0
```

When one looks at the formula, the conclusion is that it is quite a complex function, with many branches to implement the functionality of atan2 with atan instead. The same applies also if one tries to use asin or acos. An issue with the above definition is that there is no defined value when both x and y are zero. Another note is that the order of parameters is y, x instead of x, y. But, it is in reverse order in Excel.

clock



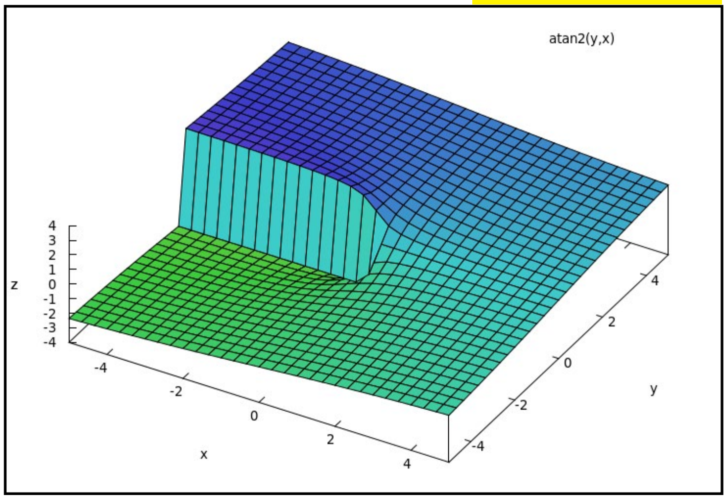
In a mouse-interactive clock, we can compute, from the mouse location, the angle of selected pointer to determine how the selected time can be adjusted. For instance, one can calculate the angle from north to mouse click as follows:

```
 double angleAsRadians = Math.atan2(point.y - centerY,
point.x - centerX);
 // atan2 returns values in the range of [-PI, PI]
 // so, we can get values into the ranges [0, 2PI] by
adding one PI
 angleAsRadians += PI;
```

It is just so awesome that no "if" statements are needed. Though, this is not expensive like a shooting game, where the angle and distance to target must be calculated continuously. Trigonometry is also heavily used in ray tracing applications, such as radio coverage and 3D modelling, where atan2 can be successfully applied. So, atan2 is a beast in its expressiveness, therefore we can safely call it the best trigonometrical function in a programmer's toolkit.

The behavior of atan2 can be shown most easily with some mathematics software such as Octave or Maxima. Both of them are available in Ubuntu Software Center. Android has its own versions available in PlayStore.

Atan2 is beautiful!

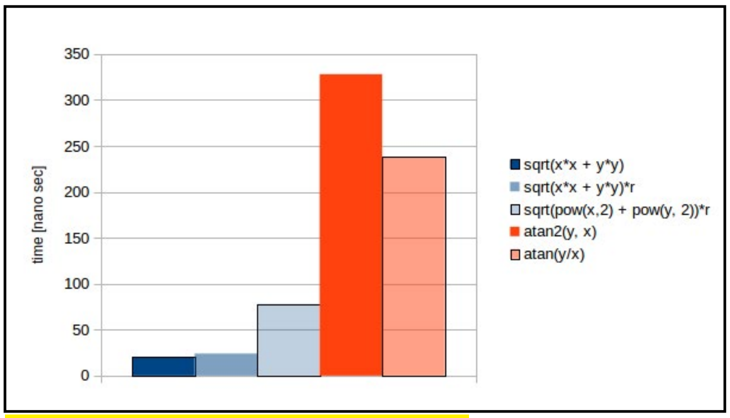


In the plot window, one can rotate to an appropriate view angle with the mouse and watch the 3 dimensional view from an appropriate angle.

Software development is driven by use cases and by user stories to be fulfilled. Projects are often very busy with implementing all necessary functionality, and performance testing is done only in the end of the project. At that time it may be even too late to react on poor performance, since it may be difficult to improve in late project phase. Therefore it would be nice to already know what the performance implication will be at the program writing time.

If an application uses intensive math like distance and angular computations, it would be good to know what it costs to call these methods. In Java, for instance, calls like Math.sqrt, Math.atan, or Math.atan2 are then important to understand.

We made a test by calling different distance and angle computations methods 10 million times with Java. The test framework adds on method call overhead to each functionusing an ODROID XU at 1.6 GHz frequency running Ubuntu with Java. The relative behavior of the tested math methods are similar in other platforms. The results are shown in the enclosed graph.



**Computing distance and angle**

Computation of distance is fast, that is calling of sqrt(x*x + y*y)*r takes only 24 nano seconds on average. Multiplication with resolution r is almost free, since calling of plain sqrt(x*x, y*y) is only 4 nanoseconds faster. Then, one sees clearly that calling of pow(x,2) is essentially more expensive than x*x. The next observation is that angle computation methods are slow, especially Java's trigonometric functions, which is a tradeoff for their accurateness. In this case, the precious atan2 seems to be slower that atan.

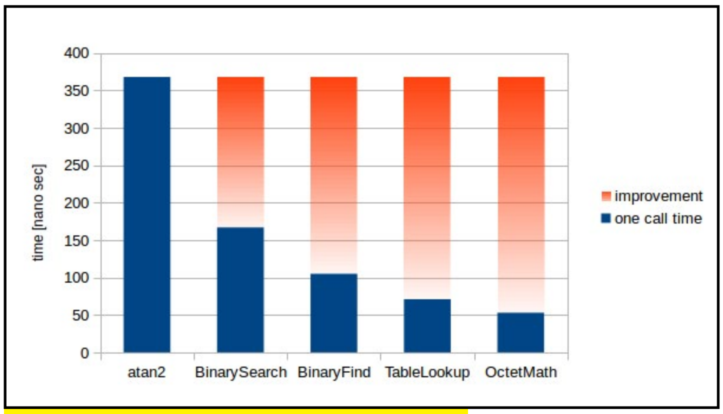
If we want to use the atan2 method, we must find some means to compute it more quickly. We could ourselves implement a faster, but less accurate, method to compute atan2. We could use parabolic approximation, Taylor series or Chebyshev series or similar, [COR09], or a software implementation of the famous CORDIC method. On the other hand, we could implement some table lookup method. In the first place, utilization of prior computed values might be the easiest to implement by creating the following look up methods for fast access of atan2 values:

**- binary search based on Java's Arrays.binarySearch method**
**- binary find is a self implemented method to find aimed value from array**
**- table lookup with a large n*n table, and, an**
**- octet math is another table lookup method where each symmetric octet of a unit circle is represented as an array, [RIV06].**

The next figure shows the call time of atan2 against the used look up methods. In the representative run, it took 368 nanoseconds to compute. Lookup methods are compared against that value. The call of one access method is shown with blue bar and the achieved improvement has been shown with orange gradient bar.

It is a surprise that a self written binary find is faster than the binary search that is based on Java's standard method. One should be suspicious of that, and the result would need to be verified prior to using a newly written method in production code.

The two array based look up methods, table lookup and octet math are the fastest. By using octet math, an atan2 value can be completed in about 50 nanoseconds. That is the method that we have been using in our sample application, too.



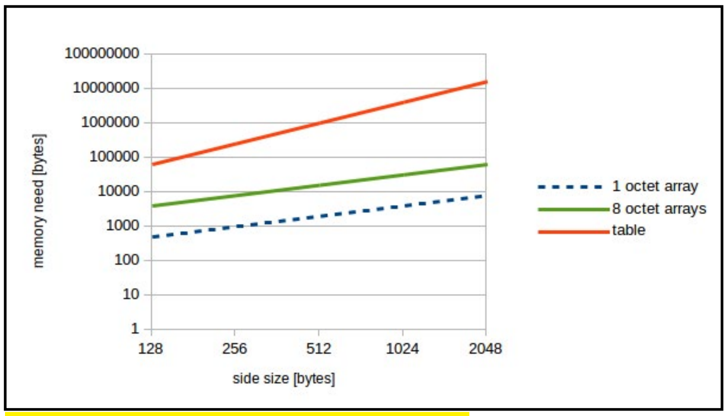
**Atan2 Lookup Methods**

Here is the source code for those who are interested in the actual Java implementation:

```
/**
 * Octet based atan2 lookup method.
 * Created by xyz on 12/13/13.
 */
public class OctetMath {
    private static final double ROUND = 0.5;
    private static final double PI = Math.PI;
    // To be accurate enough, at least 2000 values are
needed, we use exponent of two in here.
    // The memory consumption is 2048 * 8 * 4 = 65536
bytes ~ 65.5 kBytes.
    // Using of bigger size will increase accuracy.
    private static final int SIZE = 2048;
    // last index per side
    private static final float LAST = SIZE - 1;
    private static final float NEGATIVE_LAST = -LAST;
    // Octets are illustrated below.
    //           ^ y
    //         8 | 1st octet
    //       7   |   2nd octet
    //     ----------------> x
    //      6    |    3
    //        5 | 4
    //           |
   // Array representations of strictly computed atan2
values.
    // Using double would not make the result more ac-
curate.
        private  static  final  float[]  OCTET1  =  new
float[SIZE];
        private  static  final  float[]  OCTET2  =  new
float[SIZE];
        private  static  final  float[]  OCTET3  =  new
float[SIZE];
        private  static  final  float[]  OCTET4  =  new
float[SIZE];
        private  static  final  float[]  OCTET5  =  new
float[SIZE];
        private  static  final  float[]  OCTET6  =  new
float[SIZE];
        private  static  final  float[]  OCTET7  =  new
float[SIZE];
        private  static  final  float[]  OCTET8  =  new
float[SIZE];

    static {
        initializeOctets(SIZE);
    }

    /**
     * Get atan2 as table lookup.
      * The complexity of the method is 14, but we do
not want this method to be split.
     * @param y
     * @param x
      * @return angle as radians, the value is in the
interval [-PI, PI]
     */
    @SuppressWarnings("all")
     public static float atan2(final float y, final float
x) {
        if (0 <= x) {
            if (0 <= y) {
                if (x < y) {
                    return OCTET1[(int) (LAST * x / y
+ ROUND)];
                } else {
                    return OCTET2[(int) (LAST * y / x
+ ROUND)];
                }
            } else {
                if (-y < x) {
                   return OCTET3[(int) (NEGATIVE_LAST
* y / x + ROUND)];
                } else {
                   return OCTET4[(int) (NEGATIVE_LAST
* x / y + ROUND)];
                }
            }
        } else {
            if (y < 0) {
                // both x and y are negative
                if (x > y) {
                    return OCTET5[(int) (LAST * x / y
+ ROUND)];
                } else {
                    return OCTET6[(int) (LAST * y / x
+ ROUND)];
                }
            } else {
                if (y < -x) {
                   return OCTET7[(int) (NEGATIVE_LAST
* y / x + ROUND)];
                } else {
                   return OCTET8[(int) (NEGATIVE_LAST
* x / y + ROUND)];
                }
```

```
                }
            }
        }

     private static void initializeOctets(final double
size) {
        final double y = size;
        for (double i = 0; i < size; i++) {
            final double x = i;
            final double theta = Math.atan2(y, x);
            final int index = (int) i;
            OCTET1[index] = (float) theta;
             OCTET2[index] = (float) (PI / 2.0 - the-
ta);
             OCTET3[index] = (float) (-PI / 2.0 + the-
ta);
            OCTET4[index] = (float) -theta;
            OCTET5[index] = (float) (-PI + theta);
             OCTET6[index] = (float) (-PI / 2.0 - the-
ta);
             OCTET7[index] = (float) (PI / 2.0 + the-
ta);
            OCTET8[index] = (float) (PI - theta);
        }
    }

    private OctetMath() {
        //
    }
}
```

One should always verify self-made implementations, since the accuracy of the method is of concern. The correctness and reached accuracy can be tested against the built-in Math.atan2 Java method. The accuracy can be improved by using larger arrays to represent prior computed atan2 values. The disadvantage of bigger arrays is, of course, that more statically allocated memory is needed. The memory consumption of three different memory layouts is shown comparatively in logarithmic scale in the next figure.



**Array and Memory Size**

The table memory layout is consuming the most memory. The worst thing is that its behavior is exponential. As the 8 octets of a unit circle are symmetric, the same method could be implemented by storing only the data of one of the octets, in which case only 1/8 of the memory amount is needed. Then the call time would be bigger, since more control flow branches must be traversed during one call.

## Summary

With an ODROID, one can make mathematical studies with dedicated tools, by implementing his own application and studying its behavior. We warmly recommend application of atan2 in computer programs, especially intensive programs that use a lot of angle and distance computations such games and ray tracing. Java's accurate trigonometric methods are slow. Therefore some faster methods should be available. We implemented an octet based table lookup method in order to access atan2 values faster. Our self-made implementation OctetMath.atan2 is about 7x faster than the standard Math.atan2. It allocates 66 kB of static memory, which is affordable in terms of resources.

## References

*[WIK14] atan2. 8 pages, 2014.* `http://en.wikipedia.org/wiki/Atan2`

*[COR09] Coranac / Vijn Jasper. Another fast fixed-point sine approximation. 16.7.2009.* `www.coranac.com/2009/07/sines`

*[RIV06] Riven X. 13.8x faster atan2. 2006.* `http://www.java-gaming.org/topics/13-8x-faster-atan2-updated/14647/view.html`

# *FRAMEBUFFER* *TERMINAL CONSOLE FOR THOSE GUI-LESS MOMENTS*

by Rob Roy

When running an Ubuntu distribution running Kernel 3.8.13 or above on an ODROID-X/X2/U2/U3, there is a resident framebuffer terminal console that can be activated by pressing Control-Alt-F[1-6]. To return to the X11 graphical interface, press Control-Alt-F7. This gives you access to the command line even if the X11 interface has stopped working.

# *INSTALLING MATHEMATICAL TOOLS FROM THE UBUNTU SOFTWARE CENTER*

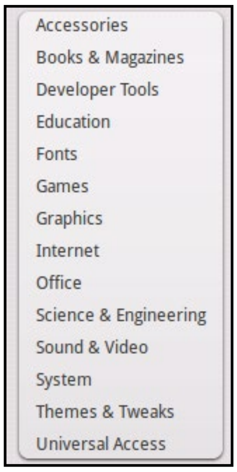
## CREATE BEAUTIFUL 3D GRAPHS FOR YOUR OFFICE AND IMPRESS YOUR COLLEAGUES

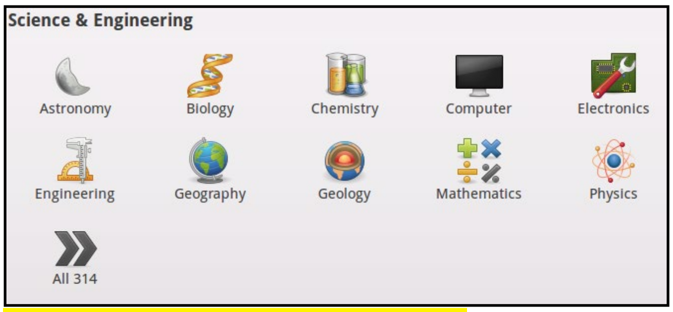
by Jussi Opas

The Ubuntu Software center contains many free and low-priced applications, including scientific and mathematical programs. Not all of them are available for ARM processor based computers, but many of them run natively on the ODROID, and the Software Center ensures that one can load a correctly compiled version. This article describes how to load a mathematics application from the Ubuntu store.

In the upper right corner of the Ubuntu Software Center, there is a search box which can be used if we know approximately what we are looking for. In the left there is a category list, as shown in the first screenshot.

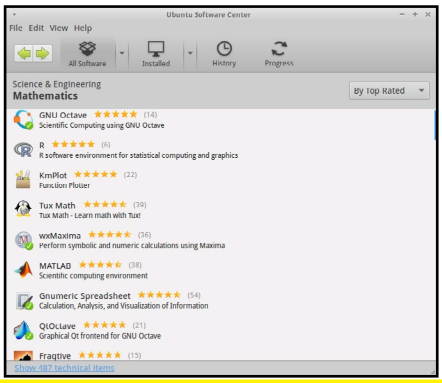
To find a mathematics tool, push the 'Science & Engineering' button. Then the store gives a list of alternatives represented as icons.





**Science and Engineering**

Select the Mathematics icon, and the next window will show a collection of tools that are useful for doing mathematics. It is easy to install a selected tool, and uninstallation is also possible from this interface.



GNU Octave ★★★★★ (14)
Scientific Computing using GNU Octave

R ★★★★★ (6)
R software environment for statistical computing and graphics

KmPlot ★★★★★ (22)
Function Plotter

Tux Math ★★★★★ (39)
Tux Math - Learn math with Tux!

wxMaxima ★★★★★ (36)
Perform symbolic and numeric calculations using Maxima

MATLAB ★★★★★ (38)
Scientific computing environment

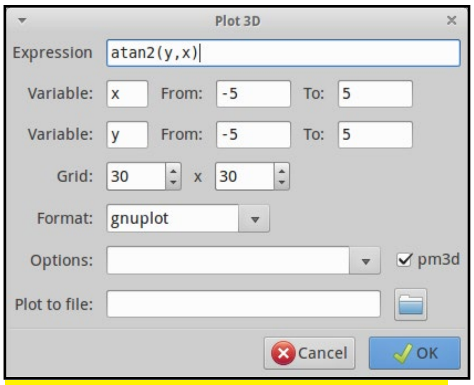
Gnumeric Spreadsheet ★★★★★ (54)
Calculation, Analysis, and Visualization of Information

QtOctave ★★★★★ (21)
Graphical Qt frontend for GNU Octave

Fraqtive ★★★★★ (15)

Show 487 technical items

**Mathematics Ubuntu Shop**



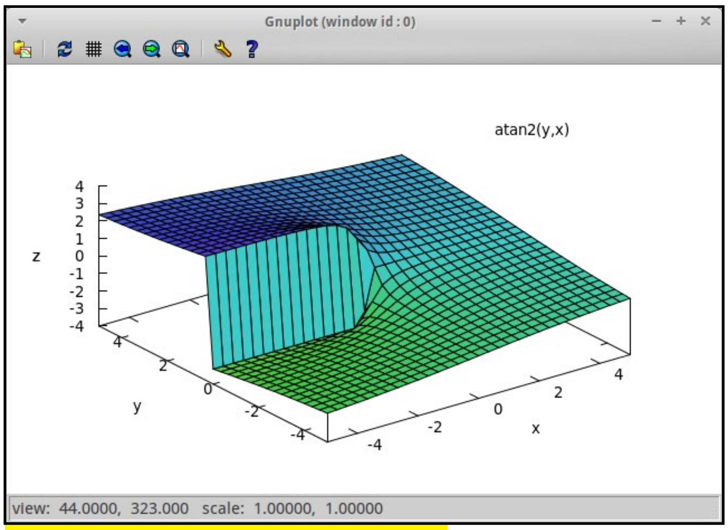
Expression: atan2(y,x)
Variable: x From: -5 To: 5
Variable: y From: -5 To: 5
Grid: 30 x 30
Format: gnuplot
Options: ✓ pm3d
Plot to file:

**Plot 3D**

To start, I recommend loading wxMaxima and/or QtOctave. To demonstrate that the programs are working, let's paint atan2 with Maxima and Octave.

After installation, wxMaxima appears in the Education menu. Select 'Plot 3D...' from wxMaxima's Plot menu to see the plotting dialog.

Next, write your favorite mathematical formula into the Expression field and fill in the value intervals for x and y.

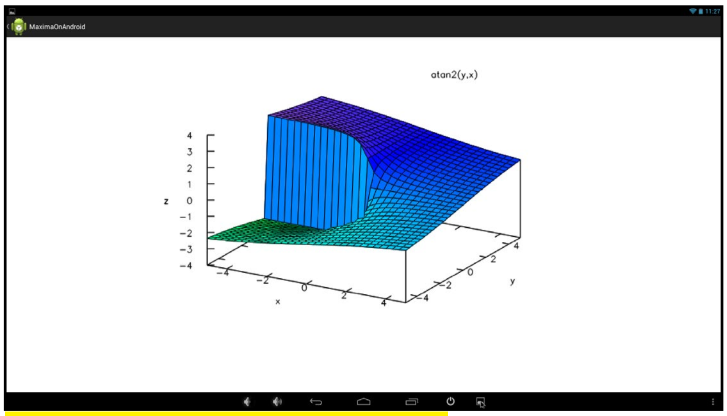


atan2 Maxima

In the plot window, one can rotate to an appropriate viewing angle and see the 3D illustration from any side. This same can be written also into a wxMaxima applications command line as follows: plot3d(atan2(y,x), [x,-5,5], [y,-5,5], [plot_format,gnuplot], [gnuplot_pm3d,true]).

Also in QtOctave, one can define a formula, and then rotate the resulting image with a mouse.

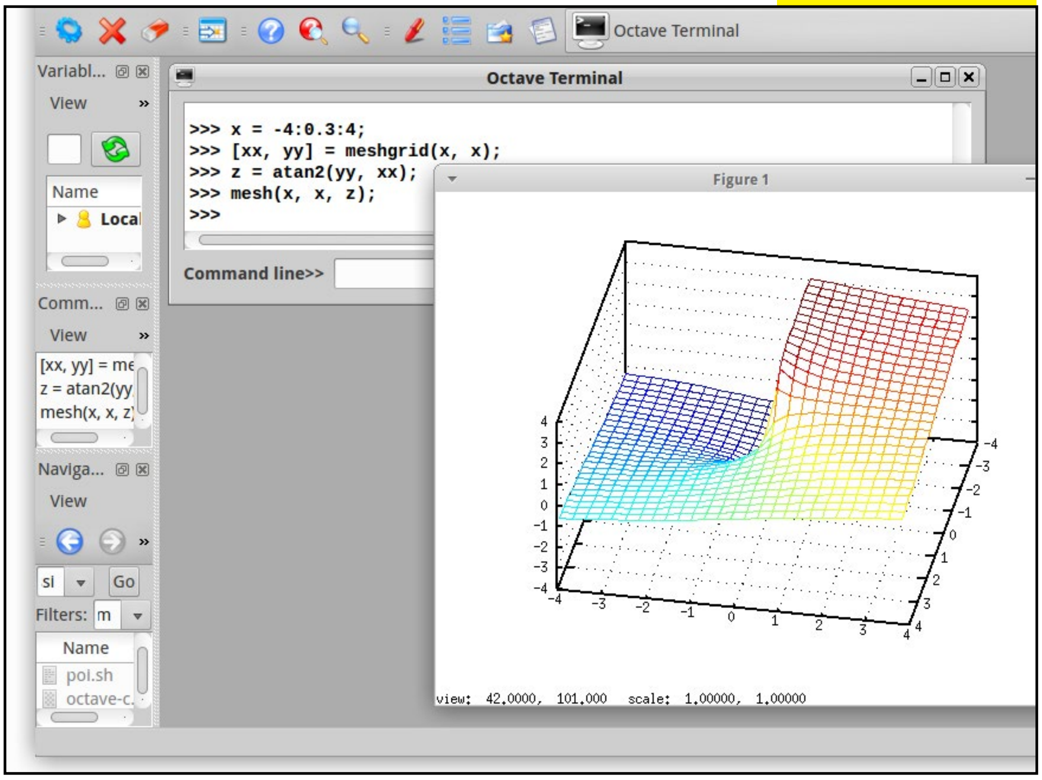
Mathematical tools are available also on Android in the Play Store. The Maxima Android version is shown in the next figure. However, in Android, one can not rotate the picture, unlike the Linux version of the Maxima application.



Atan2 ODROID

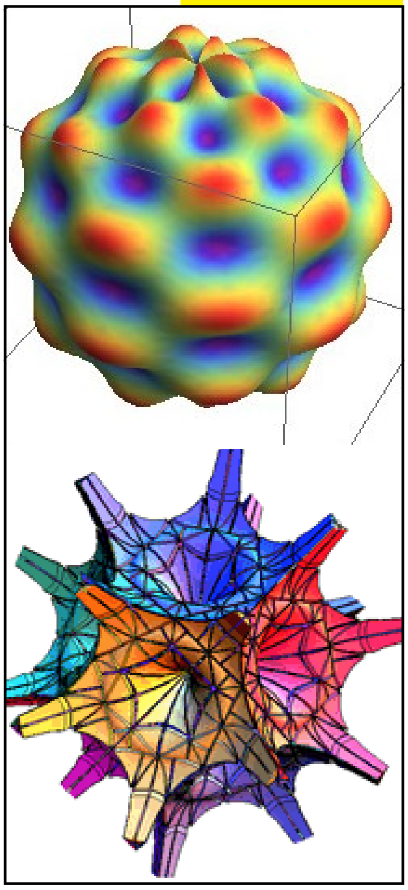
Because Ubuntu is popular for running scientific applications, there are many interesting plotting programs available to verify your experiment results, visualize mathematical formulas, and create intricate 3D graphs. There is also a dedicated engineering and scientific group on the official Ubuntu Engineering site at `http://bit.ly/1vV1VHx`, where you can find CAD programs, electronics applications, data visualization packages, and much more to help you have fun with your mathematical projects on the ODROID!

QTOctave Atan2



```
>>> x = -4:0.3:4;
>>> [xx, yy] = meshgrid(x, x);
>>> z = atan2(yy, xx);
>>> mesh(x, x, z);
>>>
```

Mathematica



# ANDROID IMAGE FILES

## A PEEK INTO THE COMPRESSED FILES THAT MAKE ANDROID PORTABLE AND LIGHTWEIGHT

by Nanik Tolaram

The Android source code is incredibly massive (more than 4GB), but how does this large code base gets installed onto phones, tablets and our ODROID boards? The simple answer is that the source gets compiled into compact binary files and is then compressed to a particular format. In the last 2 issues, we have been looking into Android source and how to compile it for ODROID-U3. In this month's article, we are going to explore the different image files that are generated by the Android build system. Please note that all software tools used in this article can be downloaded from `http://bit.ly/1hy3vdc`.

Android devices run on very limited resources and disk space, which makes it crucial that the operating system, along with the supporting files, be as small as possible. The final image files generated by the build system are:

```
boot.img
cache.img
recovery.img
system.img
userdata.img
```

There are a few scenarios in which knowing more about the image files may benefit:

**Removing or adding files to the image file**
**Experimenting with different configurations quickly**
**Upgrading Android versions without compiling the full source code**

## boot.img

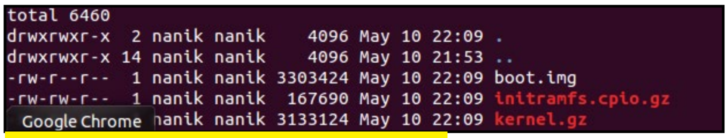
This image file contains the initialization (init) file that is used to boot up Android. The file init.rc contains information for hosting the different services and configurations that are needed to start Android. There are 2 files inside the /sbin directory, and one in particular is very important, called adbd, which is the adb daemon that is run as part of the Android startup process. Adbd allows you to connect to your device using the adb command.

The following steps shows you how to extract the boot.img:

**1. Run the unmkbooting utility by typing**

```
$ unmkbooting boot.img.

Kernel size 3133124
Kernel address 0x10008000
Ramdisk size 167690
Ramdisk address 0x11000000
Secondary size 0
Secondary address 0x10f00000
Kernel tags address 0x10000100
Flash page size 2048
Board name is ""
Command line ""
Extracting kernel.gz ...
Extracting initramfs.cpio.gz ...
All done.

---------------
To recompile this image, use:
 mkbooting --kernel kernel.gz --ramdisk initramfs.cpio.gz -o new_boot.img
---------------
```

A set of directories files are then placed into the current directory.



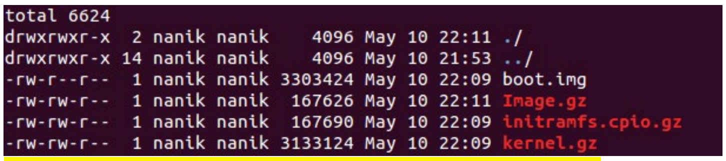
```
total 6460
drwxrwxr-x  2 nanik nanik    4096 May 10 22:09 .
drwxrwxr-x 14 nanik nanik    4096 May 10 21:53 ..
-rw-r--r--  1 nanik nanik 3303424 May 10 22:09 boot.img
-rw-rw-r--  1 nanik nanik  167690 May 10 22:09 initramfs.cpio.gz
 Google Chrome  nanik nanik 3133124 May 10 22:09 kernel.gz
```

File list after extracting boot.img

### 2. Run the extract_uImage.sh script by typing

```
$ extract_uImage.sh initramfs.cpio.gz.

Checking for uImage magic word...
1+0 records in
0+1 records out
4 bytes (4 B) copied, 3.9012e-05 s, 103 kB/s
uImage recognized.
Extracting data...
2619+1 records in
327+1 records out
167626 bytes (168 kB) copied, 0.00185786 s, 90.2 MB/s
Checking for ARM mach-type...
3+0 records in
0+1 records out
3 bytes (3 B) copied, 3.5863e-05 s, 83.7 kB/s
Checking for zImage...
1+0 records in
0+1 records out
4 bytes (4 B) copied, 2.6783e-05 s, 149 kB/s
>>> initramfs.cpio.gz extracted to Image
```

Which the results in the files show here:



```
total 6624
drwxrwxr-x  2 nanik nanik    4096 May 10 22:11 ./
drwxrwxr-x 14 nanik nanik    4096 May 10 21:53 ../
-rw-r--r--  1 nanik nanik 3303424 May 10 22:09 boot.img
-rw-rw-r--  1 nanik nanik  167626 May 10 22:11 Image.gz
-rw-rw-r--  1 nanik nanik  167690 May 10 22:09 initramfs.cpio.gz
-rw-rw-r--  1 nanik nanik 3133124 May 10 22:09 kernel.gz
```

File list after extracting initramfs.cpio.gz

### 3. The extracted file is now a gzip file, so we need to rename it.

```
$ mv Image Image.gz
```

### 4. Extract the newly renamed file using gunzip.

```
$ gunzip Image.gz
```

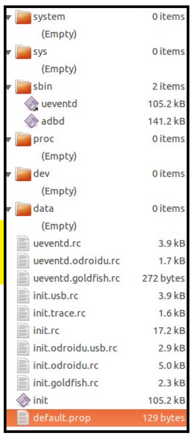
Check the file type using the file tool by typing

```
$ file Image

Image: ASCII cpio archive (SVR4 with no CRC).
```

### 5. Use the cpio tool to extract the content

```
$ cpio -i < ./Image

563 blocks.
```

You will now see the full contents of the boot.img as shown below. Previous files such as boot.img have been removed from the screenshot for easier viewing.



```
▾ system                   0 items
     (Empty)
▾ sys                      0 items
     (Empty)
▾ sbin                     2 items
     ueventd             105.2 kB
     adbd                141.2 kB
▾ proc                     0 items
     (Empty)
▾ dev                      0 items
     (Empty)
▾ data                     0 items
     (Empty)
  ueventd.rc               3.9 kB
  ueventd.odroidu.rc       1.7 kB
  ueventd.goldfish.rc    272 bytes
  init.usb.rc              3.9 kB
  init.trace.rc            1.6 kB
  init.rc                 17.2 kB
  init.odroidu.usb.rc      2.9 kB
  init.odroidu.rc          5.0 kB
  init.goldfish.rc         2.3 kB
  init                   105.2 kB
  default.prop           129 bytes
```

Complete file list of boot.img

## cache.img

This image file does not contain anything major. As the name implies, it is used as cache storage. On an Android device, this particular image file will reside in its own partition, or sometimes its own directory called /cache. The cache is used by Android OTA (Over The Air) application to store updated image files, or to upgrade your Android system.

The following steps shows you how to extract the cache.img:

### 1. Use the simg2img tool to extract the image file by typing

```
$ simg2img  cache.img  cache.raw

computed crc32 of 0xc76ce614, expected 0x00000000
```

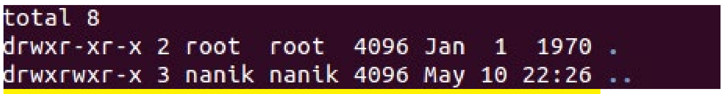
### 2. Using command file cache.raw you will see the type of the extracted file.

```
$ file cache.raw
cache.raw:  Linux  rev  1.0  ext4  filesystem  data,
UUID=57f8f4bc-abf4-655f-bf67-946fc0f9f25b   (extents)
(large files)
```

### 3. Create a directory to mount the extracted file to the directory.

```
$ mkdir cc
$ sudo mount -t ext4 -o loop cache.raw cc/
```

### 4. You will see there is nothing inside the cc/ directory.



```
total 8
drwxr-xr-x 2 root  root  4096 Jan  1  1970 .
drwxrwxr-x 3 nanik nanik 4096 May 10 22:26 ..
```

Complete file list of cache.img

## recovery.img

The recovery image contains Linux kernel and busybox tool, and resides in its own partition. In normal Android devices, there is a particular physical key sequence that you normally have to press in order to instruct the device to boot to the recovery partition. There is another way to boot to recovery using the following command inside Android:

```
adb reboot recovery
```

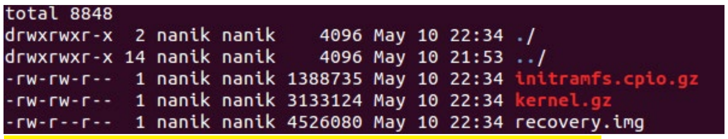
Follow these steps to extract the recovery.img:

### 1. Run the unmkbooting utility

```
$ unmkbooting recovery.img

Kernel size 3133124
Kernel address 0x10008000
Ramdisk size 1388735
Ramdisk address 0x11000000
Secondary size 0
Secondary address 0x10f00000
Kernel tags address 0x10000100
Flash page size 2048
Board name is “”
Command line “”
Extracting kernel.gz ...
Extracting initramfs.cpio.gz ...
All done.
---------------
```

To recompile this image, use:

```
 mkbooting --kernel kernel.gz --ramdisk initramfs.
cpio.gz -o new_boot.img
---------------
```



```
total 8848
drwxrwxr-x  2 nanik nanik    4096 May 10 22:34 ./
drwxrwxr-x 14 nanik nanik    4096 May 10 21:53 ../
-rw-rw-r--  1 nanik nanik 1388735 May 10 22:34 initramfs.cpio.gz
-rw-rw-r--  1 nanik nanik 3133124 May 10 22:34 kernel.gz
-rw-r--r--  1 nanik nanik 4526080 May 10 22:34 recovery.img
```

Extracted file list for recovery.img

By using the file command to the check the type of the initramfs.cpio.gz file, you will see the following:

```
$ file
./initramfs.cpio.gz: u-boot legacy uImage, ramdisk, Li-
nux/ARM, RAMDisk Image (Not compressed), 1388671 bytes,
Wed Apr  2 10:35:12 2014, Load Address: 0x40800000,
Entry Point: 0x40800000, Header CRC: 0x70CA98DA, Data
CRC: 0xC14A4AFD
```

### 2. Run the extract_uImage.sh script

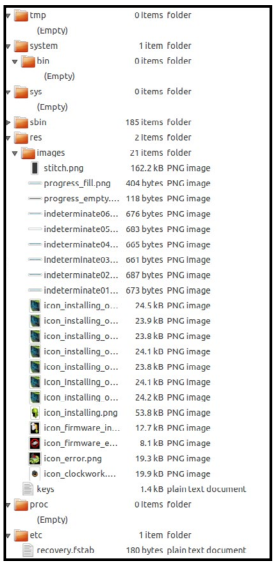
```
$ extract_uImage.sh initramfs.cpio.gz

Checking for uImage magic word...
1+0 records in
0+1 records out
4 bytes (4 B) copied, 2.322e-05 s, 172 kB/s
uImage recognized.
Extracting data...
21697+1 records in
2712+1 records out
1388671 bytes (1.4 MB) copied, 0.0140089 s, 99.1 MB/s
Checking for ARM mach-type...
3+0 records in
0+1 records out
3 bytes (3 B) copied, 3.6532e-05 s, 82.1 kB/s
Checking for zImage...
1+0 records in
0+1 records out
4 bytes (4 B) copied, 3.2578e-05 s, 123 kB/s
>>> initramfs.cpio.gz extracted to Image
```

### 3. The extracted file is now a gzip file, so we need to rename it:

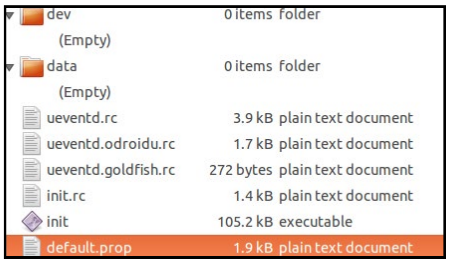
```
$ mv Image Image.gz
```

### 4. Extract the newly renamed file using gunzip:

```
$ gunzip Image.gz
```



```
tmp                        0 items  folder
   (Empty)
system                     1 item   folder
  bin                      0 items  folder
     (Empty)
sys                        0 items  folder
   (Empty)
sbin                     185 items  folder
res                        2 items  folder
  images                  21 items  folder
    stitch.png          162.2 kB  PNG image
    progress_fill.png   404 bytes PNG image
    progress_empty....  118 bytes PNG image
    indeterminate06...  676 bytes PNG image
    indeterminate05...  683 bytes PNG image
    indeterminate04...  665 bytes PNG image
    indeterminate03...  661 bytes PNG image
    indeterminate02...  687 bytes PNG image
    indeterminate01...  673 bytes PNG image
    icon_installing_o...  24.5 kB PNG image
    icon_installing_o...  23.9 kB PNG image
    icon_installing_o...  23.8 kB PNG image
    icon_installing_o...  24.1 kB PNG image
    icon_installing_o...  23.8 kB PNG image
    icon_installing_o...  24.1 kB PNG image
    icon_installing_o...  24.2 kB PNG image
    icon_installing.png   53.8 kB PNG image
    icon_firmware_in...   12.7 kB PNG image
    icon_firmware_e...     8.1 kB PNG image
    icon_error.png        19.3 kB PNG image
    icon_clockwork....    19.9 kB PNG image
  keys                     1.4 kB plain text document
proc                       0 items  folder
   (Empty)
etc                        1 item   folder
  recovery.fstab        180 bytes plain text document
```

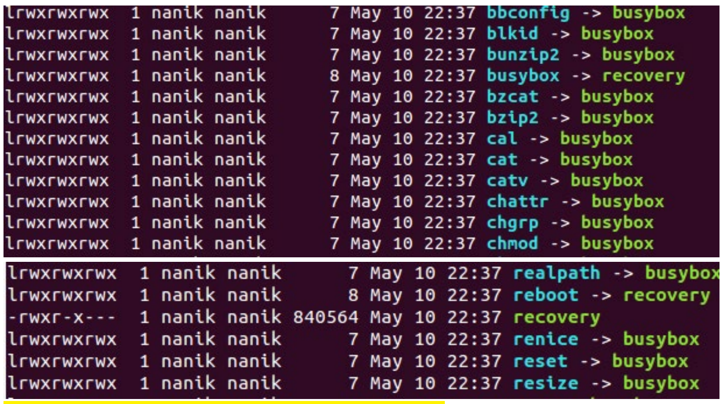


```
dev                   0 items  folder
   (Empty)
data                  0 items  folder
   (Empty)
ueventd.rc            3.9 kB  plain text document
ueventd.odroidu.rc    1.7 kB  plain text document
ueventd.goldfish.rc   272 bytes plain text document
init.rc               1.4 kB  plain text document
init                  105.2 kB executable
default.prop          1.9 kB  plain text document
```

Complete file list for recovery.img

### 5. Use the cpio tool to extract the content

```
$ cpio -i < ./Image
3820 blocks
```



```
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 bbconfig -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 blkid -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 bunzip2 -> busybox
lrwxrwxrwx  1 nanik nanik      8 May 10 22:37 busybox -> recovery
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 bzcat -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 bzip2 -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 cal -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 cat -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 catv -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 chattr -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 chgrp -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 chmod -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 realpath -> busybox
lrwxrwxrwx  1 nanik nanik      8 May 10 22:37 reboot -> recovery
-rwxr-x---  1 nanik nanik 840564 May 10 22:37 recovery
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 renice -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 reset -> busybox
lrwxrwxrwx  1 nanik nanik      7 May 10 22:37 resize -> busybox
```

Busybox symlinks

The /sbin directory contains lots of tools, most of which are a symlink to recovery (via busybox symlink) as shown in the screenshot.

## system.img

The most important image file is system.img, which contains the heart and soul of Android, and is the largest in terms of file size.

### 1. Use the simg2img tool to extract the image file

```
$ simg2img system.img  system.raw
computed crc32 of 0x9a5d4d54, expected 0x00000000
```

**2. Using the file tool you will see the type of the extracted file.**

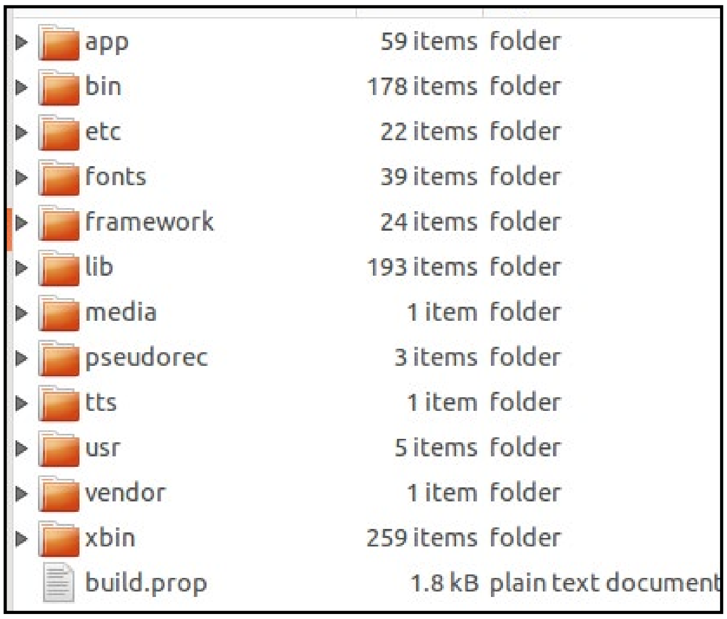
```
$ file system.raw
./system.raw:  Linux  rev  1.0  ext4  filesystem  data,
UUID=57f8f4bc-abf4-655f-bf67-946fc0f9f25b   (extents)
(large files)
```

**3. Create a directory to mount the extracted file and mount the file to the directory**

```
$ mkdir sys
$ sudo mount -t ext4 ./system.raw  ./sys
```

**4. You will see a lot of folders inside the sys/ directory.**

If you look each of the folders, you will the application, configuration and executables files that are used to run Android.



```
app         59 items folder
bin        178 items folder
etc         22 items folder
fonts       39 items folder
framework   24 items folder
lib        193 items folder
media        1 item  folder
pseudorec    3 items folder
tts          1 item  folder
usr          5 items folder
vendor       1 item  folder
xbin       259 items folder
build.prop      1.8 kB plain text document
```

Complete file list for system.img

## userdata.img

This particular image file resides in its own partition, and will be used as the /data partition. The image file does not contain many files, and sometimes, in different devices, it is just an empty image file. Since this is used for data, it does not matter what it contains, since Android does not use it, and is intended only for storage purposes.

The following steps shows you how to extract the userdata.img:

**1. Use the simg2img tool to extract the image file**

```
$ simg2img userdata.img userdata.raw
computed crc32 of 0x20aec0ac, expected 0x00000000
```

**2. Using the file tool, you can see the type of the extracted file.**

```
$ file ./userdata.raw
./userdata.raw: Linux rev 1.0 ext4 filesystem data,
UUID=57f8f4bc-abf4-655f-bf67-946fc0f9f25b   (extents)
(large files)
```

**3. Create a directory to mount the extracted file and mount the file to the directory**

```
$ mkdir data
$ sudo mount -t ext4 ./userdata.raw ./data
```

**4. You will see that there are only 2 folders inside the /data directory**

(these 2 folders are not used in Android)

## Packing

In the previous section, we unpacked the image file, so after making changes to the image files, you will want to pack them up again and use them to copy it into your sdcard or eMMC storage.

## boot.img and recovery.img part 2

After making the changes inside the directory, you need to pack it up and convert it to a .gz file, using the following command.

```
   $ find .  | cpio -o -H newc | gzip > ../newramdisk.
cpio.gz
```

You have to run the above command inside of the extracted directory after you unpack it, using the cpio command as shown in the previous step.

A ../newramdisk.cpio.gz file will be created, and this file will be packed together using another command:

```
$ mkbooting --kernel kernel.gz --ramdisk newramdisk.
cpio.gz -o new_boot.img
```

The kernel.gz comes from the original boot.img, while the newramdisk.cpio.gz contains our changes. On completiong of the mkbooting command, you will have a new boot image called new_boot.img.

## system.img part 2

After you make changes to the files inside the extracted system.img directory, you can pack it using the following command:

```
sudo make_ext4fs -s -l 512M -a system ./system_new.
img  ./system
```

The last parameter ./system is the directory that contains the extracted image files.

# RESIZING ANDROID PARTITIONS

## MAKE FULL USE OF YOUR LARGE SD CARD OR EMMC

by Venkat Bommakanti

Large capacity installation media such eMMC or SD cards have a lot of unallocated space available after initial installation of a Hardkernel or community image. The partitions are kept small during the image creation process so that the resulting file is more portable, and can still be installed on smaller storage devices of 4GB or 8GB size. With a 16GB, 32GB or 64GB device, the partitions can be expanded in order to take advantage of the unused space, making it available for system use.

This article presents the steps necessary to properly resize your Android image's FAT32 partition, usually referred to as /mnt/sdcard. If the partitions are not resized properly, the resolution will be locked to 720p because the boot.scr file will not be found by the bootloader. The procedure essentially re-assigns most of the unallocated space to the Android partition while still allowing 1080p resolution - it's as simple as that!

## Requirements

**1. An ODROID U3 or XU board, with an appropriate power adapter**
**2. Any MicroSD or an eMMC card of 8+ GB capacity, along with an SD Card reader/writer, containing a freshly copied, unbooted Android image. To download the latest supported Android version relevant to your platform, check the following link, using http://bit.ly/1k8OIbP.**

**3. A (native) Linux host with GParted (to graphically manage disk partitions) installed. If you have access to only an MS Windows system, you may use one of two options:**

A GParted Live CD for x86 systems (`http://bit.ly/1hGJVvw`), or

An Ubuntu 14.04+ Desktop virtual machine instance hosted on the X86 system with Gparted installed. See `http://bit.ly/1r2OP48` and `http://bit.ly/1nlDA5d`) for details.

GParted for Linux is preferred over tools such as EaseUS Partition Master for Windows, since Gparted detects Android ext3/ext4 partitions properly without problems, but newer versions of EaseUS may not read ext3/ext4 partitions at all. So, it is advisable for MS Windows users to run GParted via USB stick or Virtual Machine, as mentioned above.

## Overview

The first two steps involve moving two partitions to the end of the storage device (while still retaining their respective sizes), and

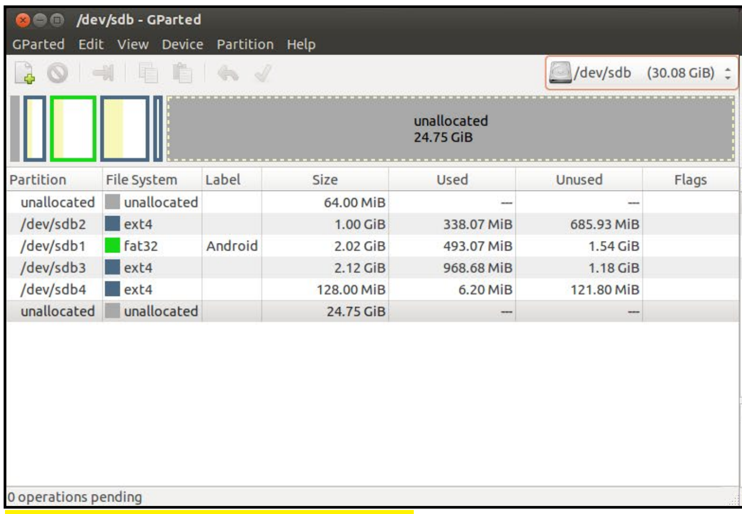
The third step is to combine most of the unallocated space to the already existing Android partition.

The first screenshot in this article shows the results of following the main steps on a 32GB card. There are quite a few sub-steps, so make sure to carefully follow the figures below. Cards of a capacity greater than 64GB have not yet been tested, but should work properly if the extra room is created as a second FAT32 partition.

The reason for separate instructions when using a 64GB card, is that FAT32 partitions are limited to 32GB in Android, although more recent Android images allow for larger partition sizes. Even though most of the steps are shared between the procedure for 32GB (or less) and 64GB cards, we did this unified chart that can help you for either case.

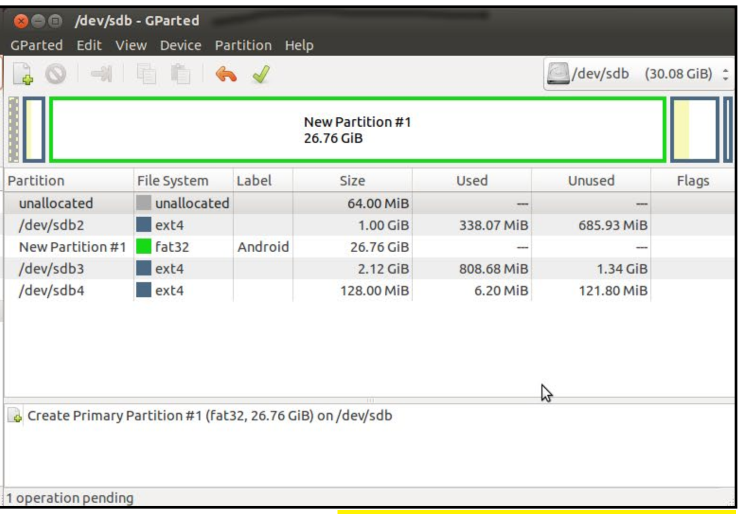
In addition to the chart, there is also a pictorial guide for resizing the partitions in Gparted on pages 28 and 29.

If you have completed the steps correctly, the boot.scr file should be recognized properly and allow 1080p resolution. It's advisable to perform this operation on a new copy of Android to avoid any potential data loss. Always make a backup first!



| Partition | File System | Label | Size | Used | Unused | Flags |
|---|---|---|---|---|---|---|
| unallocated | unallocated | | 64.00 MiB | — | — | |
| /dev/sdb2 | ext4 | | 1.00 GiB | 338.07 MiB | 685.93 MiB | |
| /dev/sdb1 | fat32 | Android | 2.02 GiB | 493.07 MiB | 1.54 GiB | |
| /dev/sdb3 | ext4 | | 2.12 GiB | 968.68 MiB | 1.18 GiB | |
| /dev/sdb4 | ext4 | | 128.00 MiB | 6.20 MiB | 121.80 MiB | |
| unallocated | unallocated | | 24.75 GiB | — | — | |

0 operations pending



| Partition | File System | Label | Size | Used | Unused | Flags |
|---|---|---|---|---|---|---|
| unallocated | unallocated | | 64.00 MiB | — | — | |
| /dev/sdb2 | ext4 | | 1.00 GiB | 338.07 MiB | 685.93 MiB | |
| New Partition #1 | fat32 | Android | 26.76 GiB | — | — | |
| /dev/sdb3 | ext4 | | 2.12 GiB | 808.68 MiB | 1.34 GiB | |
| /dev/sdb4 | ext4 | | 128.00 MiB | 6.20 MiB | 121.80 MiB | |

Create Primary Partition #1 (fat32, 26.76 GiB) on /dev/sdb

1 operation pending

**Before resizing the Android partitions**

**After resizing the Android partitions**

## Resizing an eMMC or SDCard less than 64GB

For eMMC or SD cards less than 64GB, follow steps 1-6, then use steps 6a or 6b, then finish with steps 8-10.

## Resizing a 64GB eMMC or SDCard

The procedure for resizing a 64GB card is slightly different because FAT32 partitions are limited to 32GB in size.

**First, follow these steps to prepare your eMMC or SD card for its resizing.**

**After doing steps 1-5, move on to 6a or 6b depending on your eMMC or SD card's capacity.**

**1.** Insert the card or module into a Linux host using an appropriate USB adapter/reader.

**2.** Create a temporary directory on the host's local drive, to receive the files from the FAT32 partition of the card. Backup the files from the card's FAT32 partition to the newly created backup directory in the host.

**3.** Using GParted, perform the following operations on the FAT32 partition of the card:
- unmount the FAT32 partition,
- delete the FAT32 partition, and lastly,
- select [Apply] to make the change permanent.

**4.** While still in GParted, perform these operations:
- unmount the last partition of the card,
- move this last partition to the end of the card, and lastly,
- select [Apply] to make the change permanent.

**5.** Then perform these final move operations:
- unmount the 2nd-last partition

**6a.** (<64GB) Move this 2nd-last partition towards the end, just before the previously moved (last) partition. The last two partitions should touch each other, with no empty (unallocated) space in between them.
- select [Apply] to make the change permanent.

**7a.** (<64GB) When completed, the layout will look like so:
- a single untouched partition at the start of the card,
- a lot of blank space, and then,
- two partitions all the way at the end.

**6b.** (64GB) Move this 2nd-last partition roughly towards the midpoint of the unused space, such that:
there is ~28GB space free to the left of the partition, and
there is ~26GB space free to the right.
- select [Apply] to make the change permanent.

**7b.** (64GB) Edit the 2nd-last partition:
- resize it to use the ~26GB available space to its right, and lastly,
- select [Apply] to make the change permanent.

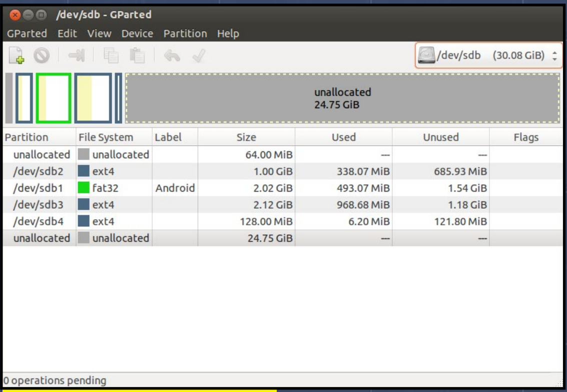
**8.** Format the unallocated (available) space as FAT32 and select [Apply].

**9.** Copy the backup files from the local temporary backup directory (created in the second step) to the new FAT32 partition.

**10.** Reinsert the card into the Odroid device, boot and enjoy Android on your ODROID!

# QUICK PICTORIAL GUIDE FOR RESIZING AN ANDROID SD OR EMMC

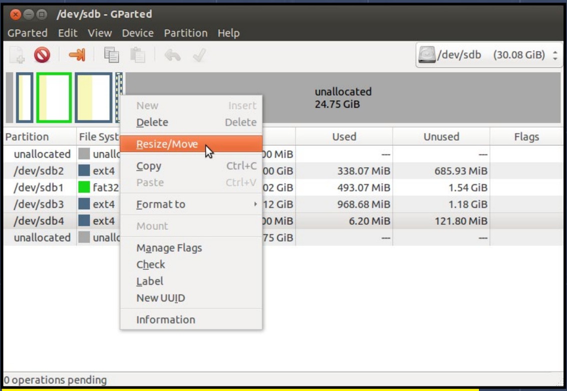
by Venkat Bommakanti



| Partition | File System | Label | Size | Used | Unused | Flags |
|---|---|---|---|---|---|---|
| unallocated | unallocated | | 64.00 MiB | — | — | |
| /dev/sdb2 | ext4 | | 1.00 GiB | 338.07 MiB | 685.93 MiB | |
| /dev/sdb1 | fat32 | Android | 2.02 GiB | 493.07 MiB | 1.54 GiB | |
| /dev/sdb3 | ext4 | | 2.12 GiB | 968.68 MiB | 1.18 GiB | |
| /dev/sdb4 | ext4 | | 128.00 MiB | 6.20 MiB | 121.80 MiB | |
| unallocated | unallocated | | 24.75 GiB | — | — | |

0 operations pending

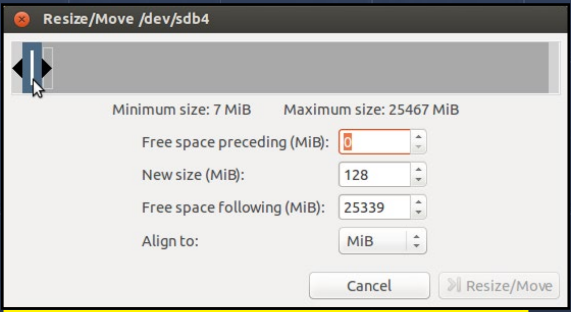
Initial partition layout



| Partition | File Syst | | Used | Unused | Flags |
|---|---|---|---|---|---|
| unallocated | unallo | 0 MiB | — | — | |
| /dev/sdb2 | ext4 | 00 GiB | 338.07 MiB | 685.93 MiB | |
| /dev/sdb1 | fat32 | 02 GiB | 493.07 MiB | 1.54 GiB | |
| /dev/sdb3 | ext4 | 12 GiB | 968.68 MiB | 1.18 GiB | |
| /dev/sdb4 | ext4 | 00 MiB | 6.20 MiB | 121.80 MiB | |
| unallocated | unallo | 75 GiB | — | — | |

0 operations pending

Move the selected 128 MB partition



Minimum size: 7 MiB Maximum size: 25467 MiB

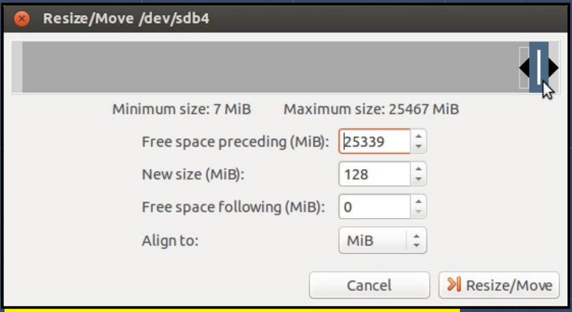
Free space preceding (MiB): 0

New size (MiB): 128

Free space following (MiB): 25339

Align to: MiB

Initial parameters of 128 MB partition to be moved



Minimum size: 7 MiB Maximum size: 25467 MiB

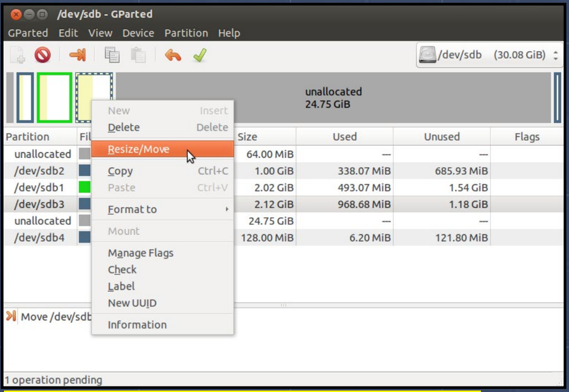
Free space preceding (MiB): 25339

New size (MiB): 128

Free space following (MiB): 0

Align to: MiB

New parameters to move 128 MB partition

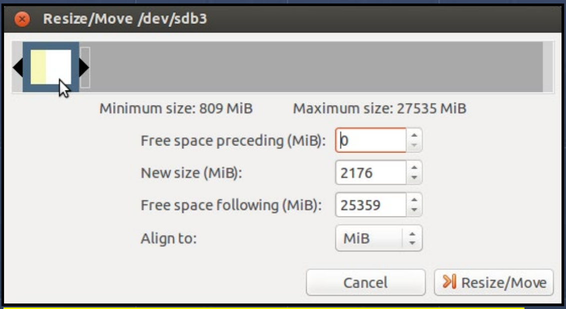


| Partition | Fil | Size | Used | Unused | Flags |
|---|---|---|---|---|---|
| unallocated | | 64.00 MiB | — | — | |
| /dev/sdb2 | | 1.00 GiB | 338.07 MiB | 685.93 MiB | |
| /dev/sdb1 | | 2.02 GiB | 493.07 MiB | 1.54 GiB | |
| /dev/sdb3 | | 2.12 GiB | 968.68 MiB | 1.18 GiB | |
| unallocated | | 24.75 GiB | — | — | |
| /dev/sdb4 | | 128.00 MiB | 6.20 MiB | 121.80 MiB | |

Move /dev/sdb

1 operation pending

Move the selected 2.12 GB partition



Minimum size: 809 MiB Maximum size: 27535 MiB

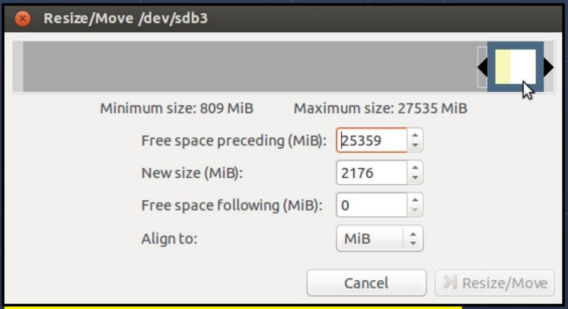
Free space preceding (MiB): 0

New size (MiB): 2176

Free space following (MiB): 25359

Align to: MiB

Initial parameters of 2.12 GB partition to be moved



Minimum size: 809 MiB Maximum size: 27535 MiB

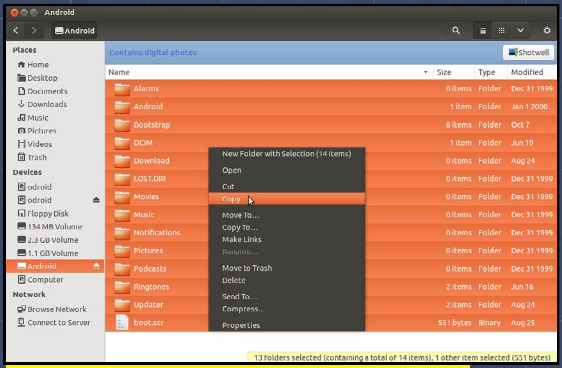
Free space preceding (MiB): 25359

New size (MiB): 2176

Free space following (MiB): 0

Align to: MiB

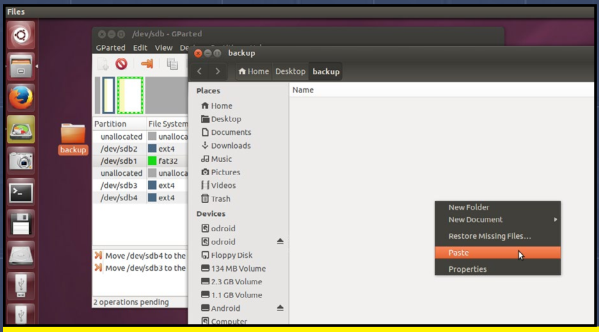
New parameters to move 2.12 GB partition



| Name | Size | Type | Modified |
|---|---|---|---|
| Alarms | 0 items | Folder | Dec 31 1999 |
| Android | 1 item | Folder | Jan 1 2000 |
| Bootstrap | 8 items | Folder | Oct 7 |
| DCIM | 1 item | Folder | Jun 19 |
| Download | 0 items | Folder | Aug 24 |
| LOST.DIR | 0 items | Folder | Dec 31 1999 |
| Movies | 0 items | Folder | Dec 31 1999 |
| Music | 0 items | Folder | Dec 31 1999 |
| Notifications | 0 items | Folder | Dec 31 1999 |
| Pictures | 0 items | Folder | Dec 31 1999 |
| Podcasts | 0 items | Folder | Dec 31 1999 |
| Ringtones | 2 items | Folder | Jun 16 |
| Updater | 2 items | Folder | Aug 24 |
| boot.scr | 551 bytes | Binary | Aug 25 |

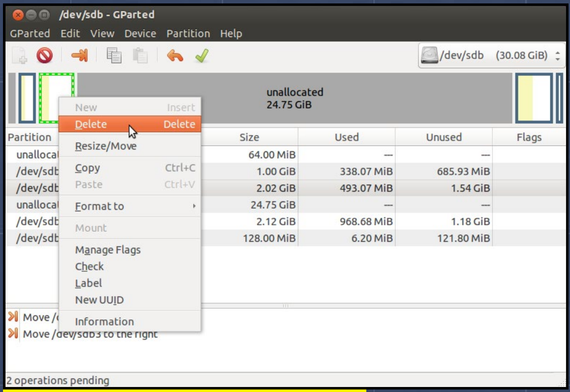
13 folders selected (containing a total of 14 items), 1 other item selected (551 bytes)

**Copy original Android partition for backup**



Move /dev/sdb4 to the
Move /dev/sdb3 to the
2 operations pending

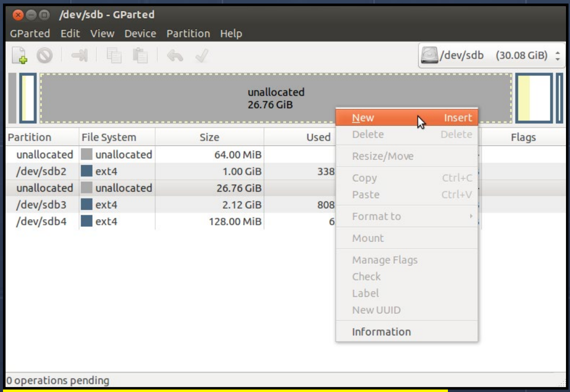
**Save the copy of original Android partition to backup folder**



| Partition | Size | Used | Unused | Flags |
|---|---|---|---|---|
| unallocated | 64.00 MiB | — | — | |
| /dev/sdb | 1.00 GiB | 338.07 MiB | 685.93 MiB | |
| /dev/sdb | 2.02 GiB | 493.07 MiB | 1.54 GiB | |
| unallocated | 24.75 GiB | — | — | |
| /dev/sdb | 2.12 GiB | 968.68 MiB | 1.18 GiB | |
| /dev/sdb | 128.00 MiB | 6.20 MiB | 121.80 MiB | |

Move /
Move /dev/sdb3 to the right
2 operations pending

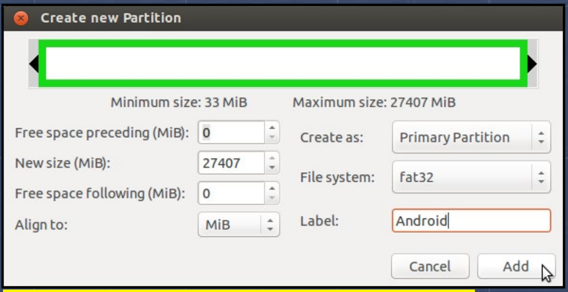
**Delete original Android partition**



| Partition | File System | Size | Used | Flags |
|---|---|---|---|---|
| unallocated | ▨ unallocated | 64.00 MiB | | |
| /dev/sdb2 | ■ ext4 | 1.00 GiB | 338 | |
| unallocated | ▨ unallocated | 26.76 GiB | | |
| /dev/sdb3 | ■ ext4 | 2.12 GiB | 808 | |
| /dev/sdb4 | ■ ext4 | 128.00 MiB | 6 | |

0 operations pending

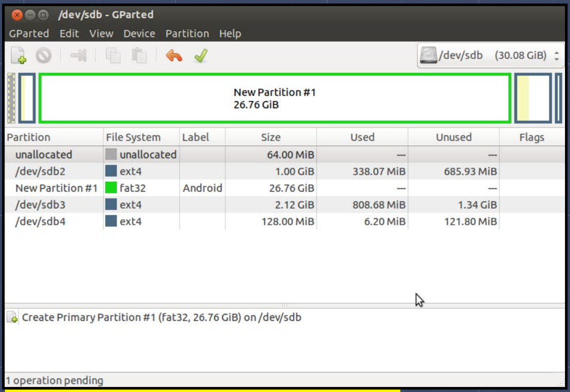
**Request to create new Android partition**



Minimum size: 33 MiB Maximum size: 27407 MiB

| | | | |
|---|---|---|---|
| Free space preceding (MiB): | 0 | Create as: | Primary Partition |
| New size (MiB): | 27407 | File system: | fat32 |
| Free space following (MiB): | 0 | | |
| Align to: | MiB | Label: | Android |

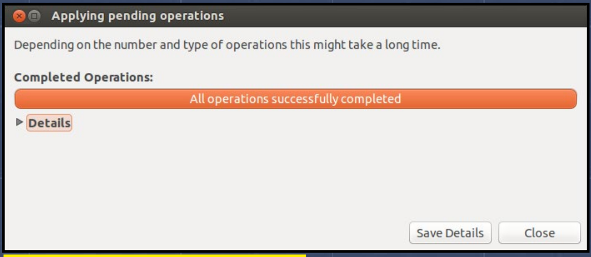
**Enter parameters for new Android partition**



| Partition | File System | Label | Size | Used | Unused | Flags |
|---|---|---|---|---|---|---|
| unallocated | ▨ unallocated | | 64.00 MiB | — | — | |
| /dev/sdb2 | ■ ext4 | | 1.00 GiB | 338.07 MiB | 685.93 MiB | |
| New Partition #1 | 🟩 fat32 | Android | 26.76 GiB | — | — | |
| /dev/sdb3 | ■ ext4 | | 2.12 GiB | 808.68 MiB | 1.34 GiB | |
| /dev/sdb4 | ■ ext4 | | 128.00 MiB | 6.20 MiB | 121.80 MiB | |

Create Primary Partition #1 (fat32, 26.76 GiB) on /dev/sdb
1 operation pending

**Apply new partition layout**

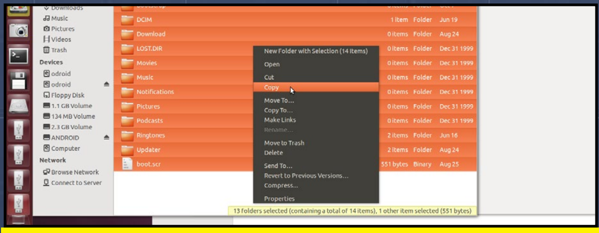


Depending on the number and type of operations this might take a long time.

Completed Operations:

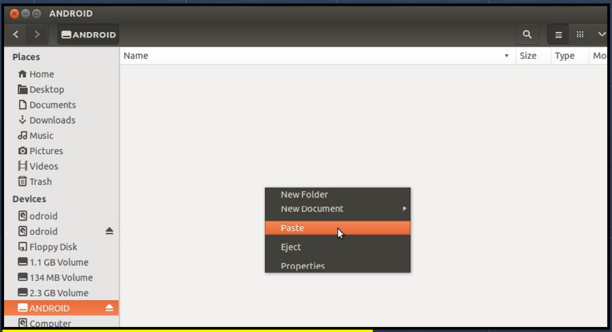
All operations successfully completed

**Partition layout completed**



13 folders selected (containing a total of 14 items), 1 other item selected (551 bytes)

**Copy contents of backup folder (original Android partition)**



**Restore backup Android files**

# HOW TO FEED YOUR CAT OVER THE INTERNET

## A GUIDE FOR ATTACHING STEP MOTORS TO THE ODROID-U3

by Marian Mihailescu

In the previous automation article, we showed how to attach sensors to the ODROID-XU: a temperature sensor and a motion detector to monitor a cat's movement habits. In this article we will go one step further, and learn how to control a step motor using the ODROID. And what better application for a motor than building an Internet-controlled automatic cat feeder!

We will start with the Cat Mate C50 feeder, shown in Figure 1.

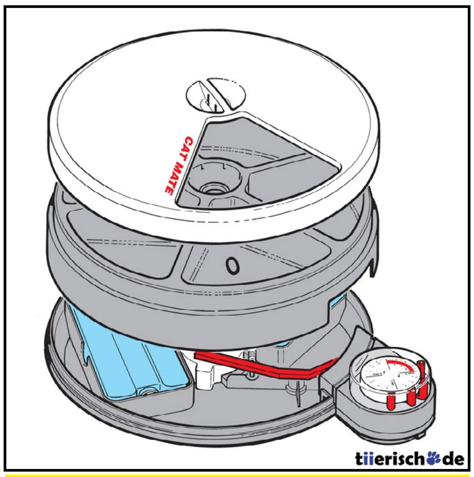


Figure 1. Cat Mate C50

This particular feeder has a battery-powered clock mechanism that activates every 24 hours, releasing the red lever to the next position, which results in the white hood moving to the next meal compartment. It is also very easy to hack - you can just remove the clock mechanism that rotates the lever, and replace it with a motor, as shown in Figure 2 and Figure 3.

For this project, I will be using the ODROID-U3, which has several advantages over the ODROID-XU for this project: it's more affordable, requires less power, does not have a fan, and has the optional IO-SHIELD accessory, which provides extra GPIO ports. The cat feeder will be controlled using a 5V stepper motor (model 28BYJ-48), which can be purchased from Ebay together with the driver board ULN2003 for less than $3 USD. The stepper motor is ideal in this case, since it can rotate a fixed number of steps, allowing us precise control of the cat feeder. In particular, the 28BYJ-48 motor has 32 steps per revolution, with a gear reduction of 1/64, which means that it does 2048 steps in one full revolution (360 degrees). Most motors usually need more current than development boards can support, and thus are usually connected to an external power

We interrupt this article to announce the return of the cat memes!

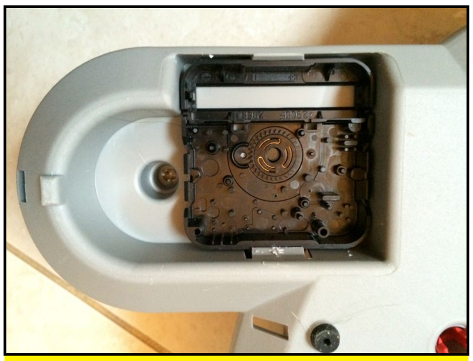


Figure 2a - Clock mechanism removed with lever gear visible

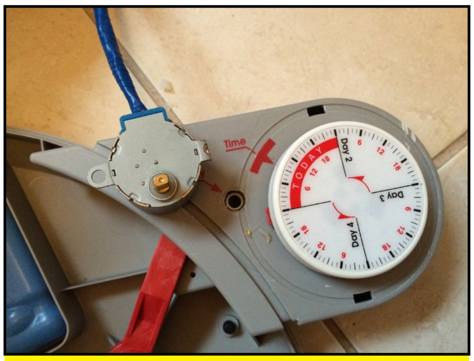


Figure 2b - Front access to the lever gear

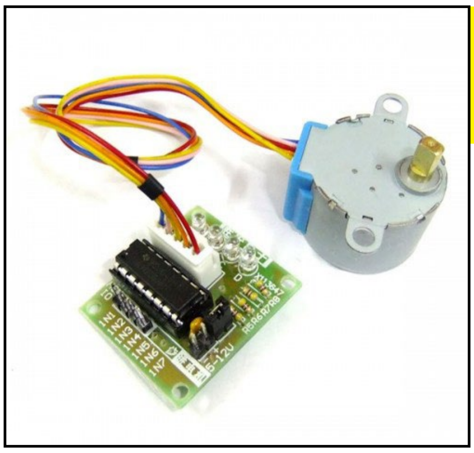


Figure 3a - 28BYJ-48 5V stepper motor with ULN2003 Driver Board

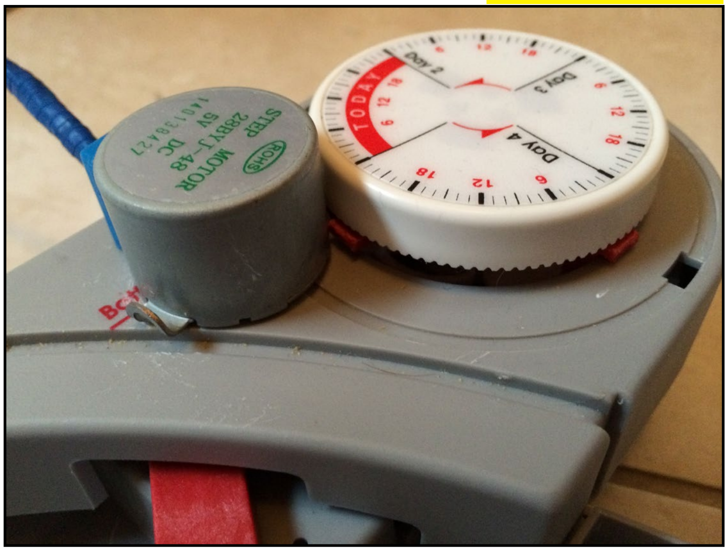


Figure 3b - Motor fits right in the lever gear

Even though a space hyperdrive would be far more useful, we dutifully succumb to the will of our feline masters by combining both robotics and Linux to automatically feed them, in case we suddenly "disappear".

supply or a battery pack; however this particular motor can get all the power it needs from the ODROID.

The role of the motor driver board is to allow the small current output from the ODROID to control a bigger current needed for the stepper motor. The driver board is controlled by four inputs that determine how the coil is magnetized in order to rotate the motor magnet core. There are also the 5V power and ground inputs, for a total of six connections to the ODROID.

Since the motor requires 5V logic, we need a level shifter to work with the 1.8V outputs of the ODROID. Similar to the previous automation article, where is explained in more detail, we will be using the four port Freetronics Logic Level Converter. Since the motor driver requires four GPIO pins for control and the ODROID U3 only has three GPIOs (GPIO199, GPIO200 and GPIO204), the ODROID IO-SHIELD is required. However, in the absence of the IO-SHIELD, it is possible to control the driver board with only three GPIO by using a shift register.

The shift register gets all required GPIO outputs in a serial way, and then outputs them to the stepper motor in parallel. You need to connect the SERIAL IN input to the GPIO that sends the motor control logic. CLOCK is used to make the shift register load the logical value from SERIAL IN on a low-high transition, while shifting the other stored values. LATCH enables the output of the shift register on a low-high transition. OUTPUT ENABLE is used to disable the outputs - since we want them enabled all the time, we can connect it to GND, and RESET is used to clear the shift register. We can connect OUTPUT ENABLE to 5V (VCC) and set up all the outputs each time, such that RESET is not required. This particular shift register model has eight outputs, so we will load eight values each time, even if we only need four.

The motor driver is connected to the motor in the feeder by a 2m cable, which allows the board to be placed safely away from the cat. To control the feeder, the bash script shown below is executed by clicking a button in a webpage. A webcam was also

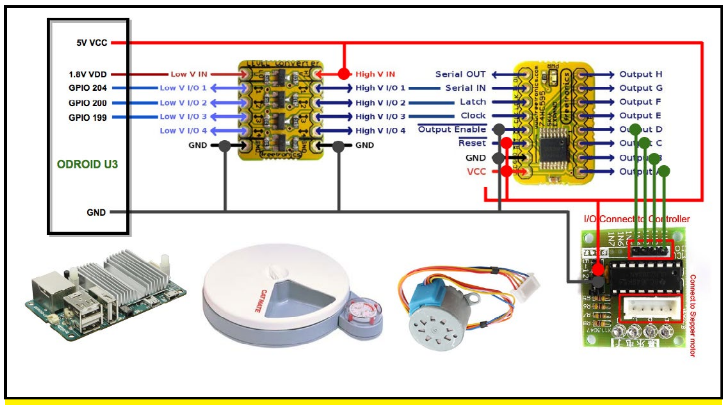


Figure 4 - ODROID Internet-controlled cat feeder schematics

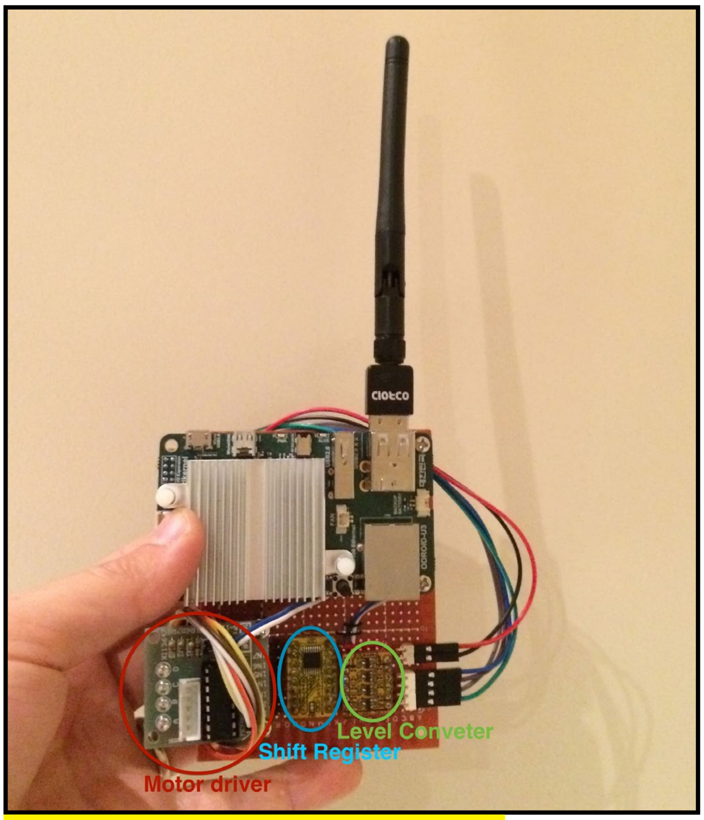


Figure 5a - Board with all components attached

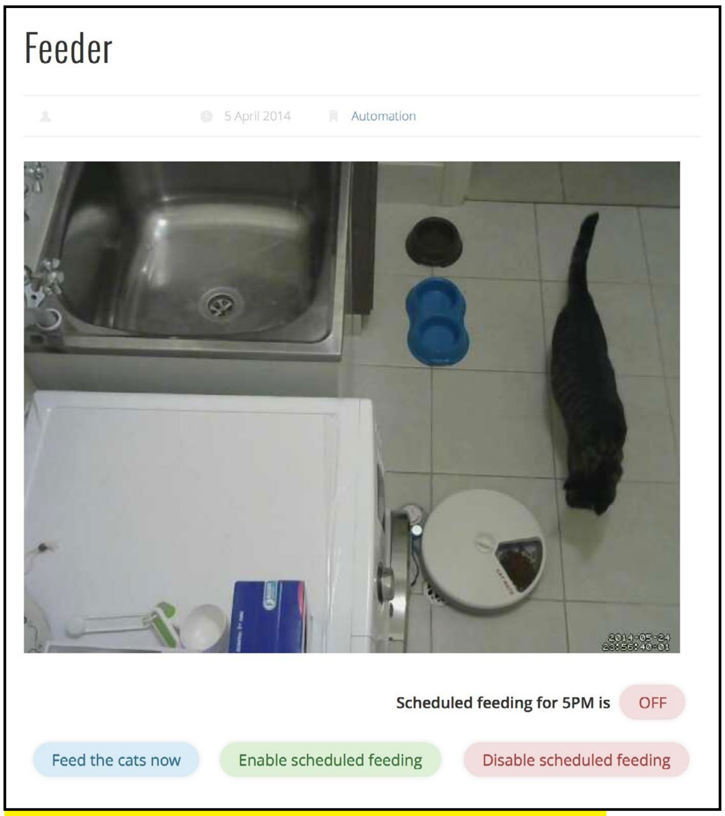


Figure 5b - Webpage to control the feeder over the internet

added to the ODROID to provide visual feedback. Using Motion webcam server, a live stream is embedded in the webpage with the cat feeder controls. With a slightly more complex version of the script and the Linux cron job scheduler, it is possible to activate the feeder not only on-demand, but also automatically, at pre-defined periods of time. Your cat has never been happier!

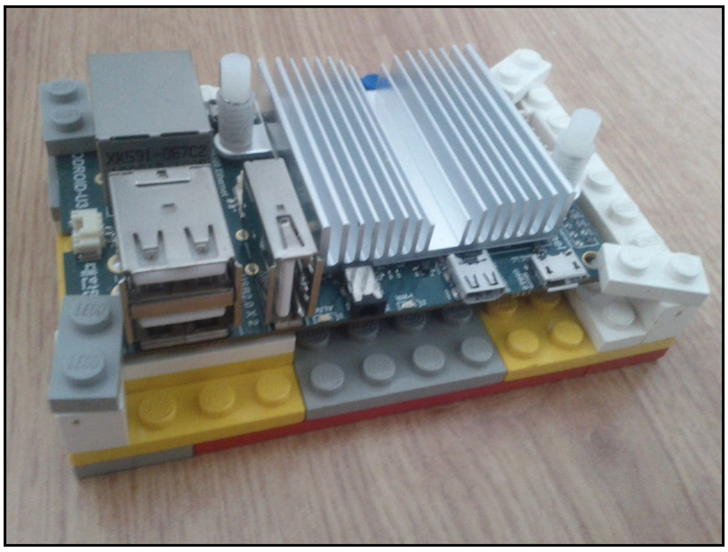
```
#!/bin/bash

### enable ODROID U3 GPIO

echo 199 > /sys/class/gpio/export
echo out > /sys/class/gpio/gpio199/direction
echo 0   > /sys/class/gpio/gpio199/value

echo 200 > /sys/class/gpio/export
echo out > /sys/class/gpio/gpio200/direction
echo 0   > /sys/class/gpio/gpio200/value

echo 204 > /sys/class/gpio/export
echo out > /sys/class/gpio/gpio204/direction
echo 0   > /sys/class/gpio/gpio204/value

### setup motor sequence

declare -a SEQ0=(0 0 0 0 1 0 0 0)
declare -a SEQ1=(0 0 0 0 0 1 0 0)
declare -a SEQ2=(0 0 0 0 0 0 1 0)
declare -a SEQ3=(0 0 0 0 0 0 0 1)

### define level shifter GPIO

IN=/sys/class/gpio/gpio204/value
LATCH=/sys/class/gpio/gpio200/value
CLK=/sys/class/gpio/gpio199/value

### control motor

STEP_COUNTER=0
```

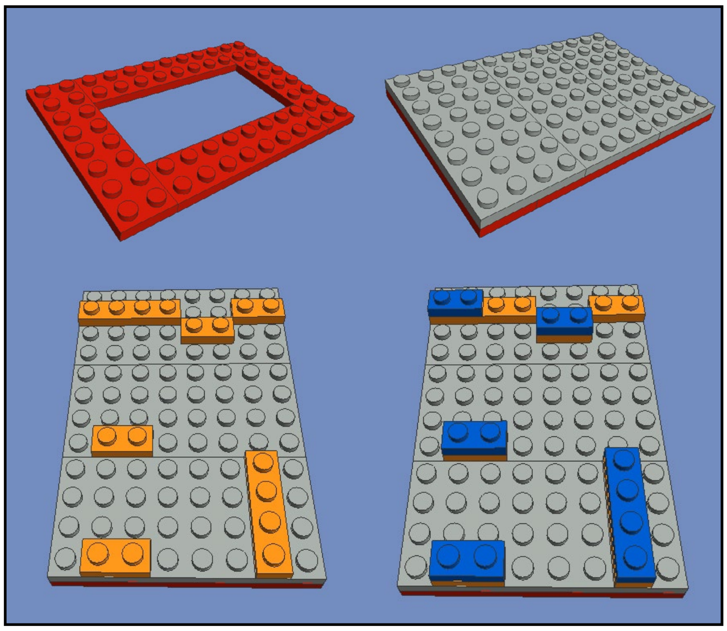
```
for STEP in {1..4096}
do
        echo 0 > $LATCH

        for PIN_COUNTER in {0..7}
        do
               PIN_VALUE="SEQ$STEP_COUNTER[$PIN_COUN-
TER]"
                echo ${!PIN_VALUE} > $IN
                echo 1 > $CLK
                echo 0 > $CLK
        done


        STEP_COUNTER=$[$STEP_COUNTER + 1]

        if [ "$STEP_COUNTER" = "4" ]
        then
                STEP_COUNTER=0
        fi

        echo 1 > $LATCH
        echo 0 > $LATCH

        sleep 0.000000001

done

### after feeder activated, reset motor inputs

for RESET in 0 0 0 0 0 0 0 0
do
        echo $RESET > $IN
        echo 1 > $CLK
        echo 0 > $CLK
done

echo 1 > $LATCH
echo 0 > $LATCH

echo "[$(date)] : Feeder activated successfully...
meow!"
```

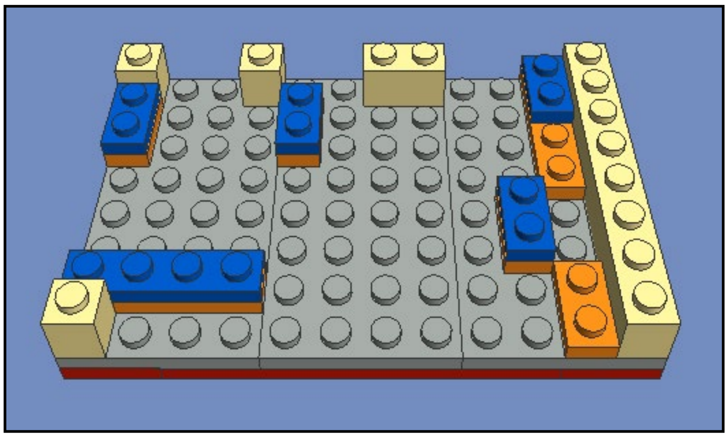
# MAKE A CUSTOM LEGO CASE FOR YOUR U3

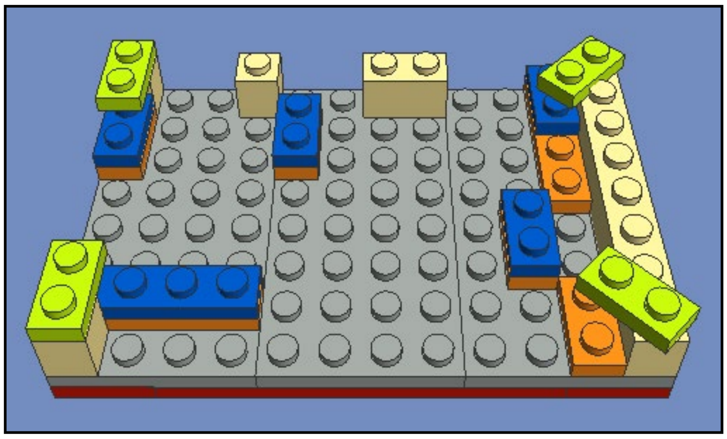
## DON'T HAVE YOUR OWN 3D PRINTER YET? ASSEMBLE THIS GREAT CASE FROM YOUR LEGO BUCKET!

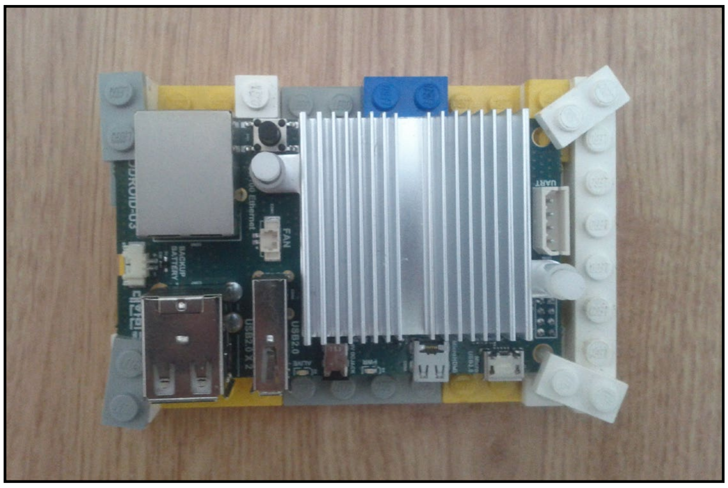
by @Zylophone

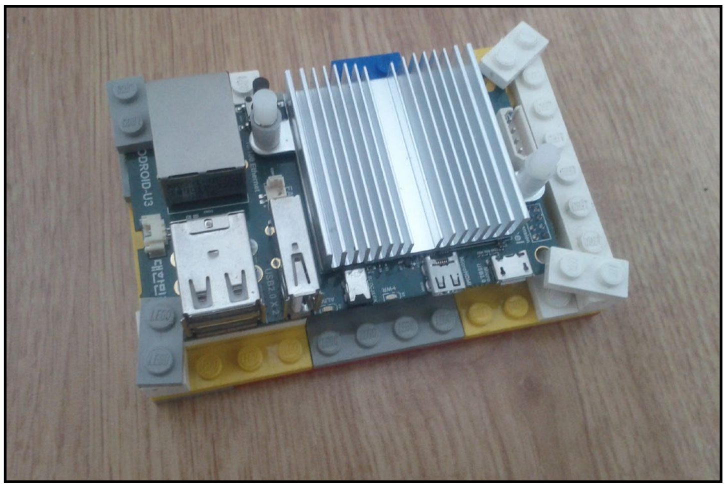












# HOW TO ENABLE MULTI-CHANNEL AUDIO OUTPUT WITH XBMC

## USING THE USB-S/PDIF PERIPHERAL TO DELIVER DIGITAL 5.1 SURROUND SOUND

by Justin Lee

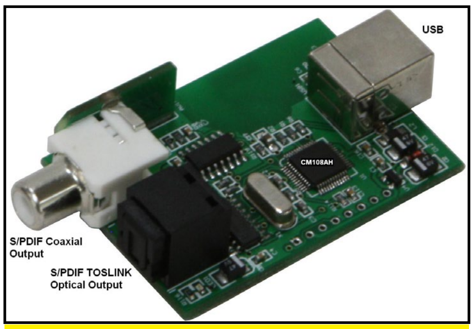
We have frequently received requests on the forums for instructions on how to enable 5-channel audio passthrough with ODROID computers. However, we couldn't find out how to implement the pass-through over the HDMI audio channel with the native hardware, even though we tried many different ways. So, we decided to develop pass-through functionality in another way, using a USB to S/PDIF interface.

What does this setup need? An ODROID powering it, of course!

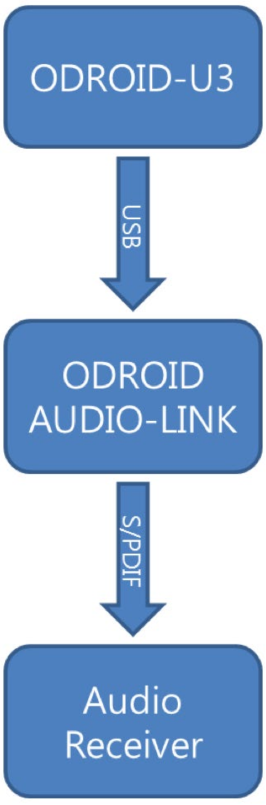
## Hardware setup

To allow HDMI passthrough, we created a USB-S/PDIF adapter board using the CM108AH chipset. We called it the USB-S/PDIF, which stands for AUDIO LINK. The price is only $16 and it comes with a USB cable and plastic shell.

The Cmedia CM108AH is a highly integrated single chip USB audio solution. All essential S/PDIF optical TOSLINK as well as Coaxial outputs, including PLL, regulator, and USB transceiver could be implemented on a small PCB.



ODROID Audio Link I

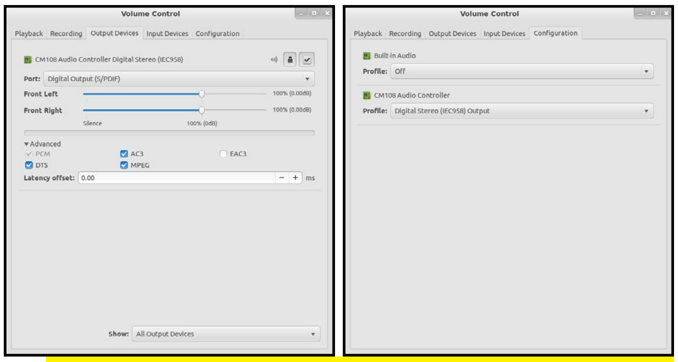


Audio Flow Diagram

## Software setup

The passthrough function in XBMC 12 Frodo doesn't work with the ODROID, but fortunately, XBMC 13 Gotham is capable of enabling HDMI passthrough output. For best results, use the latest Ubuntu or Debian OS image which has the XBMC 13 preinstalled.

We tested our hardware with these 2 prebuilt OS im-



CM108 Audio Controller Digital Stereo (IEC958)
Port: Digital Output (S/PDIF)
Front Left 100% (0.00dB)
Front Right 100% (0.00dB)
Silence 100% (0dB)
Advanced
✓ PCM ✓ AC3 ☐ EAC3
✓ DTS ✓ MPEG
Latency offset: 0.00 ms
Show: All Output Devices

Built-in Audio
Profile: Off
CM108 Audio Controller
Profile: Digital Stereo (IEC958) Output

PulseAudio Configuration Settings

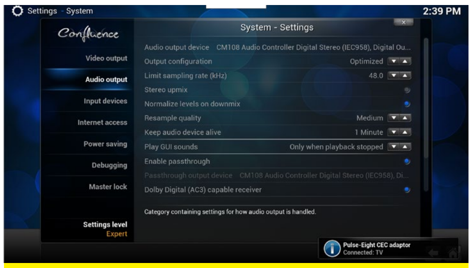
ODROID Audio Link 2

ages, either of which may be used to achieve the necessary software configuration for 5-channel surround:

```
   http://forum.odroid.com/view-
topic.php?f=29&t=4823
   http://forum.odroid.com/view-
topic.php?f=79&t=4626
```

To begin installation, plug in the USB-S/PDIF and boot your board. In order to activate Passthrough Codecs, first setup PulseAudio Volume Control according to the screenshots. Select Digital Output (S/PDIF), then select AC3 and DTS in the Advanced option menu.

Finally, start up XBMC, where you can easily setup the passthrough function. Select the CM108 device in the Audio output menu, then enable the options called Enable passthrough, Dolby Digital AC3 capable receiver, and DTS.



```
Settings - System                                                     2:39 PM
                         System - Settings
Confluence
                  Audio output device   CM108 Audio Controller Digital Stereo (IEC958), Digital Ou...
Video output      Output configuration                                   Optimized
Audio output      Limit sampling rate (kHz)                              48.0
Input devices     Stereo upmix
Internet access   Normalize levels on downmix
Power saving      Resample quality                                       Medium
Debugging         Keep audio device alive                                1 Minute
Master lock       Play GUI sounds                         Only when playback stopped
                  Enable passthrough
                  Passthrough output device   CM108 Audio Controller Digital Stereo (IEC958), Di...
                  Dolby Digital (AC3) capable receiver

                  Category containing settings for how audio output is handled.
Settings level
Expert                                        Pulse-Eight CEC adaptor
                                              Connected: TV
```

Setup on XBMC

The receiver which we used for this tutorial is a very cheap entry level, which works well for development and testing.

To verify that the hardware and software are configured properly, playing a video with AC3 sound should display that Dolby Digital encoding is being

Our audio system displaying both Dolby Digital and DTS sound. 5.1 surround is awesome!

used by the amplifier, and playing one with DTS sound should indicate DTS encoding.

There are also several third-party USB sound cards that use S/PDIF output which should work as 5.1 passthrough devices as long as the Linux driver supports it. Please note that PulseAudio does not currently allow TrueHD or DTS-MA passthrough, which is a PulseAudio limitation, unrelated to the USB-S/PDIF hardware or XBMC software configuration.

The USB-S/PDIF is now available from the Hardkernel store for $16 at `http://bit.ly/1kIt8aC`.

# TRAVEL BACK IN TIME WITH TELNET

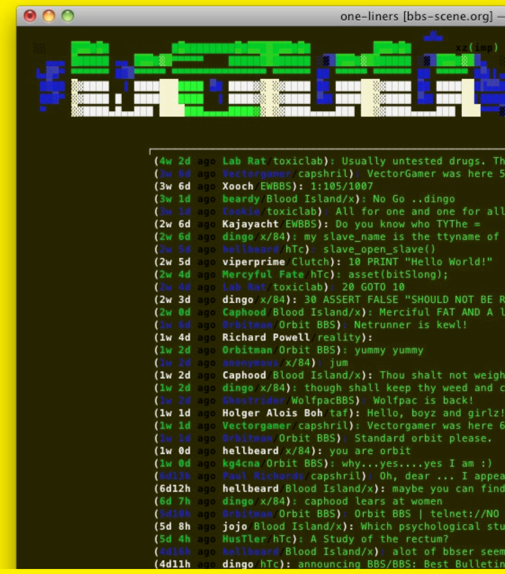
## DUST OFF THAT OLD 1200 BAUD MODEM

by Rob Roy

Before the World Wide Web and HTTP was invented, a protocol called Telnet was a popular way to communicate from one computer to another. By creating a primitive form of a web page that operated over Telnet, computer hackers built a large community of unique text-based server nodes running software called BBS (Bulletin Board System). This network included many special-interest communities that shared unique hobbies such as role playing, music and programming. To take a trip back in history to 1984, when the BBS network was in its golden age, type either of the following into a Terminal window:

```
telnet 1984.ws 23
telnet gcomm.com
```

Register and enjoy some of the most advanced ASCII graphics from the early days of network computing! More nostalgic BBS experiences such as multi-user dungeons (MUDs), chat programs and other epic systems can be found at `http://bit.ly/1qnkmSq`.



```
one-liners [bbs-scene.org]
                                                                  xz(imp)

(4w 2d ago Lab Rat/toxiclab): Usually untested drugs. Th
(3w 6d ago Vectorgamer/capshril): VectorGamer was here 5
(3w 6d ago Xooch/EWBBS): 1:105/1007
(3w 1d ago beardy/Blood Island/x): No Go ..dingo
(3w 1d ago Cookie/toxiclab): All for one and one for all
(2w 6d ago Kajayacht/EWBBS): Do you know who TYThe =
(2w 6d ago dingo/x/84): my slave_name is the ttyname of
(2w 5d ago hellbeard/hTc): slave_open_slave()
(2w 5d ago viperprime/Clutch): 10 PRINT "Hello World!"
(2w 4d ago Mercyful Fate/hTc): asset(bitSlong);
(2w 4d ago Lab Rat/toxiclab): 20 GOTO 10
(2w 3d ago dingo/x/84): 30 ASSERT FALSE "SHOULD NOT BE R
(2w 0d ago Caphood/Blood Island/x): Merciful FAT AND A l
(1w 6d ago Orbitman/Orbit BBS): Netrunner is kewl!
(1w 4d ago Richard Powell/reality):
(1w 2d ago Orbitman/Orbit BBS): yummy yummy
(1w 2d ago anonymous/x/84): jum
(1w 2d ago Caphood/Blood Island/x): Thou shalt not weigh
(1w 2d ago dingo/x/84): though shall keep thy weed and c
(1w 2d ago Ghostrider/WolfpacBBS): Wolfpac is back!
(1w 1d ago Holger Alois Boh/taf): Hello, boyz and girlz!
(1w 1d ago Vectorgamer/capshril): Vectorgamer was here 6
(1w 1d ago Orbitman/Orbit BBS): Standard orbit please.
(1w 0d ago hellbeard/x/84): you are orbit
(1w 0d ago kg4cna/Orbit BBS): why...yes....yes I am :)
(6d13h ago Paul Richards/capshril): Oh, dear ... I appea
(6d12h ago hellbeard/Blood Island/x): maybe you can find
(6d 7h ago dingo/x/84): caphood lears at women
(5d10h ago Orbitman/Orbit BBS): Orbit BBS | telnet://NO
(5d 8h ago jojo/Blood Island/x): Which psychological stu
(5d 4h ago HusTler/hTc): A Study of the rectum?
(4d16h ago hellbeard/Blood Island/x): alot of bbser seem
(4d11h ago dingo/hTc): announcing BBS/BBS: Best Bulletin
```

# OS SPOTLIGHT: DREAM MACHINE AND WHISPER

## UBUNTU 13.04 AND 13.10 WITH 8 DESKTOP ENVIRONMENTS, ALSO AVAILABLE IN TURBO

by Rob Roy, Editor-In-Chief

**Dream Machine and Whisper with Kernel 3.8 for the U2/U3/X/X2 may be downloaded from http://bit.ly/1rhHymu**

Dream Machine, a community prebuilt OS image, offers nearly every flavor of Ubuntu desktop available for versions 13.04 and 13.10, including Lubuntu, LXDE, Kubuntu (KDE), Blackbox, Openbox, Matchbox, Unity and Xubuntu (XFCE). The desktop environment can be selected by using the gear icon in the upper corner of the Dream Machine login screen. Whisper comes with a single performance-oriented speed-optimized environment called Lightweight X11 Desktop Environment (LXDE), which is graphically very fast and offers a similar interface to Windows.

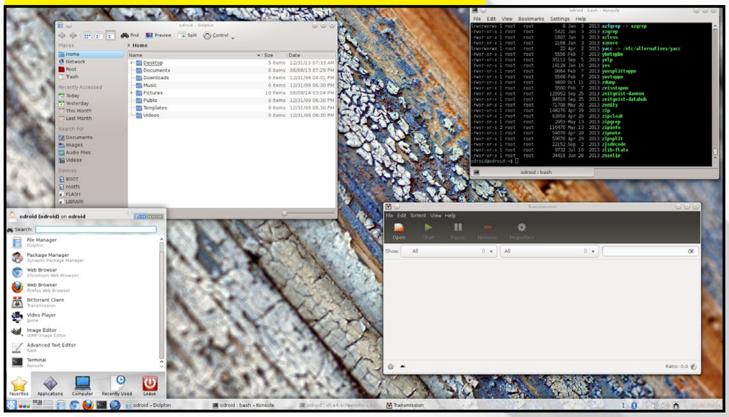
Because the software on Dream Machine includes everything on the Fully Loaded Ubuntu 12.11 image, please refer to the previous OS Spotlight column (May 2014) for details on the included packages. However, Dream Machine also comes with XBMC, which is not included with Fully Loaded, since XBMC only works with ODROID Kernel 3.8. There have been several improvements to 1080p playback in XBMC since Dream Machine 13.10 was finalized, and the latest version of XBMC will be included in the upcoming Dream Machine 14.04 release.

## KDE Plasma Workspace

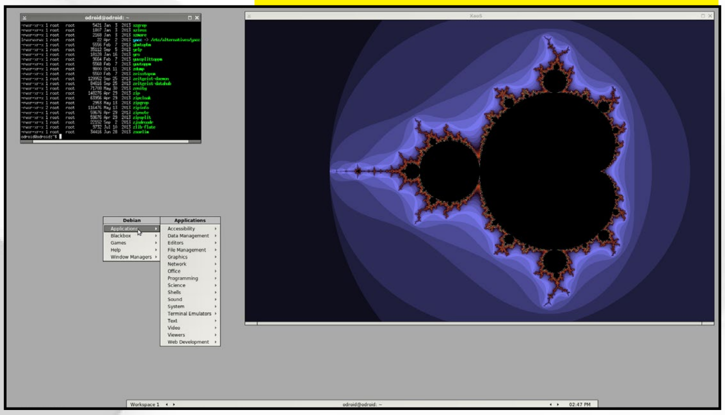
Although every desktop environment on Dream Machine contains basically the same software, there are many differences in the look of each desktop as well as additional UI features. The default environment in the 13.10 version is KDE Plasma Workspace, which features beautiful hardware-accelerated fade and transition effects in its windowing environment. KDE comes with a driver for OpenGLES called kwin_gles, so that the animations remain smooth and don't stress the CPU. Because other Ubuntu desktops are (generally) written for OpenGL, which is not supported by the Mali GPU, rendering in those environments is done at the software level, but KDE offers very fast UI responsiveness.

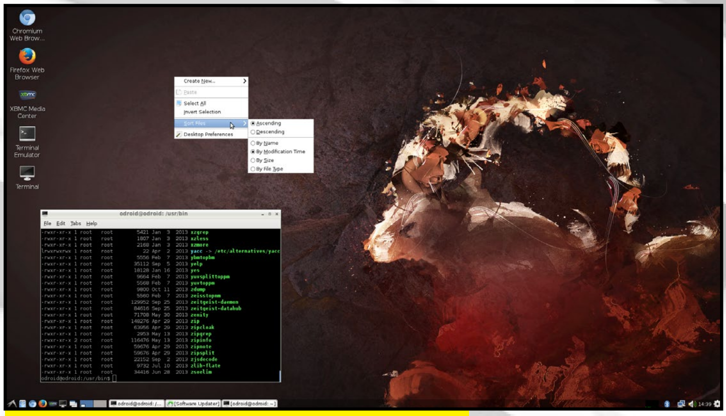
KDE Plasma Workspace will be familiar to users of Windows operating systems, since it has a well organized Start Menu and uses a similar desktop layout, with a notification area in the bottom right. It has its own robust screen saver program, and is the only environment to include dozens of notification sounds. It also has a Recent Documents and Applications area, as well as many useful widgets such as clocks and weather. It's my favorite desktop, and is a great choice for office work or web browsing. For more information on the KDE desktop, or to contribute to the ongoing open-source project, visit `http://www.kde.org/`.

**KDE Plasma Workspace features Open GLES2 GPU acceleration and has gorgeous effects!**



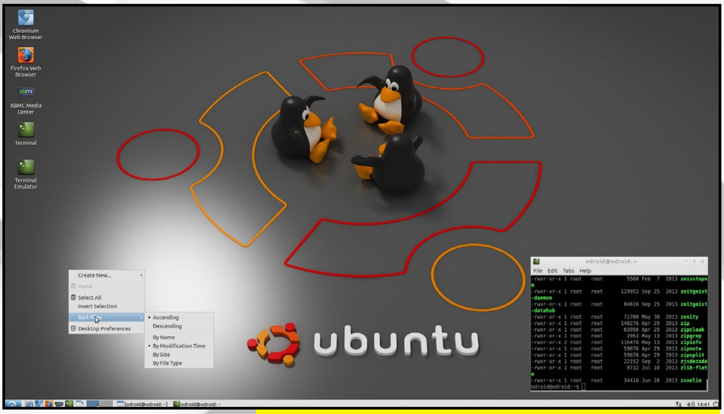
**Blackbox adheres to a minimalist aesthetic.**





```
odroid@odroid: /usr/bin
File  Edit  Tabs  Help
-rwxr-xr-x 1 root   root        5421 Jan  3  2013 xzgrep
-rwxr-xr-x 1 root   root        1807 Jan  3  2013 xzless
-rwxr-xr-x 1 root   root        2168 Jan  3  2013 xzmore
lrwxrwxrwx 1 root   root          22 Apr  2  2013 yacc -> /etc/alternatives/yacc
-rwxr-xr-x 1 root   root        5556 Feb  7  2013 ybmtopbm
-rwxr-xr-x 1 root   root       35112 Sep  5  2013 yelp
-rwxr-xr-x 1 root   root       18128 Jan 16  2013 yes
-rwxr-xr-x 1 root   root        9664 Feb  7  2013 yuvsplittoppm
-rwxr-xr-x 1 root   root        5568 Feb  7  2013 yuvtoppm
-rwxr-xr-x 1 root   root        9800 Oct 11  2013 zdump
-rwxr-xr-x 1 root   root        5560 Feb  7  2013 zeisstopnm
-rwxr-xr-x 1 root   root      129952 Sep 25  2013 zeitgeist-daemon
-rwxr-xr-x 1 root   root       84616 Sep 25  2013 zeitgeist-datahub
-rwxr-xr-x 1 root   root       71708 May 30  2013 zenity
-rwxr-xr-x 1 root   root      148276 Apr 29  2013 zip
-rwxr-xr-x 1 root   root       63956 Apr 29  2013 zipcloak
-rwxr-xr-x 1 root   root        2953 May 13  2013 zipgrep
-rwxr-xr-x 2 root   root      116476 May 13  2013 zipinfo
-rwxr-xr-x 1 root   root       59676 Apr 29  2013 zipnote
-rwxr-xr-x 1 root   root       59676 Apr 29  2013 zipsplit
-rwxr-xr-x 1 root   root       22152 Sep  2  2013 zjsdecode
-rwxr-xr-x 1 root   root        9732 Jul 10  2013 zlib-flate
-rwxr-xr-x 1 root   root       34416 Jun 28  2013 zsoelim
odroid@odroid:/usr/bin$
```

**LXDE (Lightweight X11 Desktop Environment) balances performance, speed and features.**



```
odroid@odroid: ~
File  Edit  Tabs  Help
-rwxr-xr-x 1 root   root        5560 Feb  7  2013 zeisstopn
m
-rwxr-xr-x 1 root   root      129952 Sep 25  2013 zeitgeist
-daemon
-rwxr-xr-x 1 root   root       84616 Sep 25  2013 zeitgeist
-datahub
-rwxr-xr-x 1 root   root       71708 May 30  2013 zenity
-rwxr-xr-x 1 root   root      148276 Apr 29  2013 zip
-rwxr-xr-x 1 root   root       63956 Apr 29  2013 zipcloak
-rwxr-xr-x 1 root   root        2953 May 13  2013 zipgrep
-rwxr-xr-x 2 root   root      116476 May 13  2013 zipinfo
-rwxr-xr-x 1 root   root       59676 Apr 29  2013 zipnote
-rwxr-xr-x 1 root   root       59676 Apr 29  2013 zipsplit
-rwxr-xr-x 1 root   root       22152 Sep  2  2013 zjsdecode
-rwxr-xr-x 1 root   root        9732 Jul 10  2013 zlib-flat
e
-rwxr-xr-x 1 root   root       34416 Jun 28  2013 zsoelim
odroid@odroid:~$
```

**Lubuntu is built on LXDE and offers a wide range of unique software applications.**

## Blackbox

The simplest desktop environment on Dream Machine is called Blackbox, which displays only a task bar and a compact Applications menu, accessed by right-clicking the Desktop. It's meant as a very lightweight way to monitor system processes, or just to reduce CPU cycles for power-hungry applications. A typical scenario for using Blackbox is an embedded Linux system that runs a single custom application, such as a robotics controller. The design is visually minimalist, it runs applications quickly, and also has a small memory footprint.

## LXDE

LXDE stands for Lightweight X11 Desktop Environment, and is best suited for those who wish to get the maximum performance from the ODROID while still retaining a robust interface. It looks and feels like Windows XP, and excludes graphic compositing and other visual effects in order to boost the environment's efficiency.

XBMC runs very well using LXDE, and is the best choice for those who wish to setup a Linux set-top box running XBMC, Transmission or Youtube. LXDE also offers a unique File Manager called PCManFM, which leverages the gio/gvfs libraries to connect to sftp, webdav, smb, and other Gnome Virtual File System-supported protocols.

## Lubuntu

Lubuntu, which is based on LXDE, offers some visual improvements to the basic LXDE interface with larger, squared-off icons and a streamlined taskbar. It also features many new software packages, including the Lubuntu Software Center.

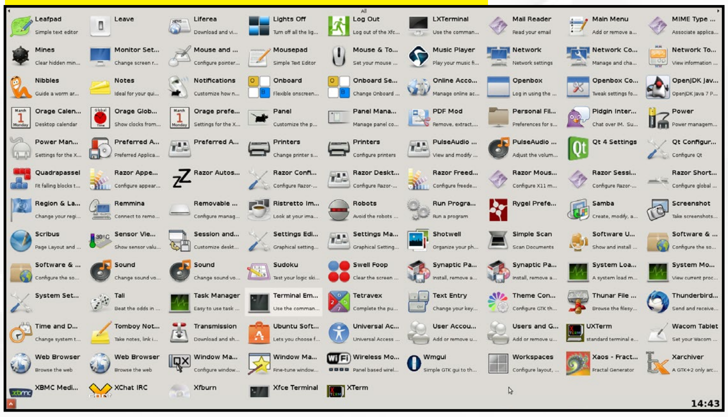
## Matchbox

Matchbox is different from other environments in its use of the entire desktop as an Applications menu. Click the arrows in the upper left and right to page through the categories, and scroll down the desktop to see more applications. Matchbox is perfect for accessing programs and icons quickly without needing to constantly open a menu, since every application shortcut is displayed on a single page. Although Matchbox was designed for PDAs and tablets, it looks great on a 1080p HDMI monitor. Matchbox shows only one window at a time rather than using a multi-window layout.

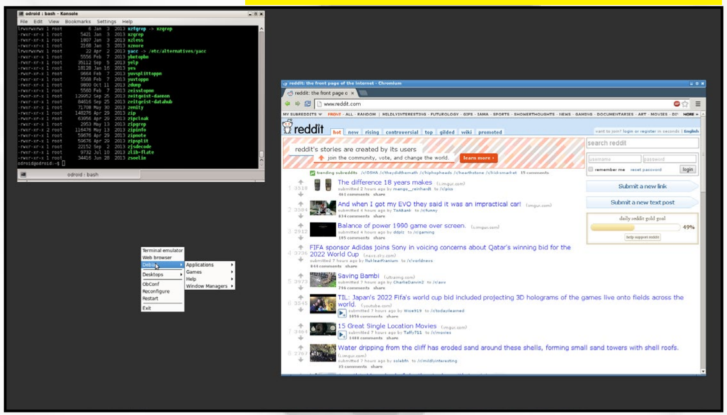
## Openbox

Openbox isn't actually a desktop environment, but a stand-alone Window Manager. It can be run by itself or within another desktop environment, and uses the minimum amount of resources necessary to launch programs and manage windows. The main focus of Openbox is speed, and is ideal for time-sensitive programs, high-traffic servers, and other applications where memory and processor use is important. Openbox is extremely sparse, has very few dependencies, and is delightfully compact.

**Matchbox is designed for PDAs, but also looks sharp on an HD 1080p monitor.**



**Openbox comes with only a terminal and web browser, and is perfect for embedded systems.**



```
odroid : bash - Konsole
File  Edit  View  Bookmarks  Settings  Help
lrwxrwxrwx 1 root          6 Jan  3  2013 xzfgrep -> xzgrep
-rwxr-xr-x 1 root       5421 Jan  3  2013 xzgrep
-rwxr-xr-x 1 root       1807 Jan  3  2013 xzless
-rwxr-xr-x 1 root       2168 Jan  3  2013 xzmore
lrwxrwxrwx 1 root         22 Apr  2  2013 yacc -> /etc/alternatives/yacc
-rwxr-xr-x 1 root       5556 Feb  7  2013 ybmtopbm
-rwxr-xr-x 1 root      35112 Sep  5  2013 yelp
-rwxr-xr-x 1 root      18128 Jan 16  2013 yes
-rwxr-xr-x 1 root       9664 Feb  7  2013 yuvsplittoppm
-rwxr-xr-x 1 root       5568 Feb  7  2013 yuvtoppm
-rwxr-xr-x 1 root       9800 Oct 11  2013 zdump
-rwxr-xr-x 1 root       5560 Feb  7  2013 zeisstopnm
-rwxr-xr-x 1 root     129952 Sep 25  2013 zeitgeist-daemon
-rwxr-xr-x 1 root      84616 Sep 25  2013 zeitgeist-datahub
-rwxr-xr-x 1 root      71708 May 30  2013 zenity
-rwxr-xr-x 1 root     148276 Apr 29  2013 zip
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-rwxr-xr-x 1 root       2953 May 13  2013 zipgrep
-rwxr-xr-x 2 root     116476 May 13  2013 zipinfo
-rwxr-xr-x 1 root      59676 Apr 29  2013 zipnote
-rwxr-xr-x 1 root      59676 Apr 29  2013 zipsplit
-rwxr-xr-x 1 root      22152 Sep  2  2013 zjsdecode
-rwxr-xr-x 1 root       9732 Jul 10  2013 zlib-flate
-rwxr-xr-x 1 root      34416 Jun 28  2013 zsoelim
odroid@odroid:~$
odroid : bash
```
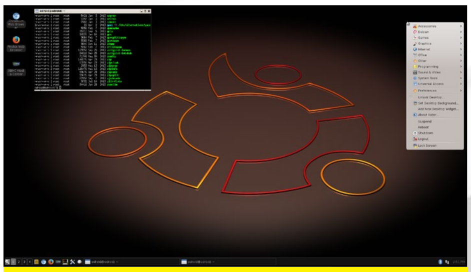
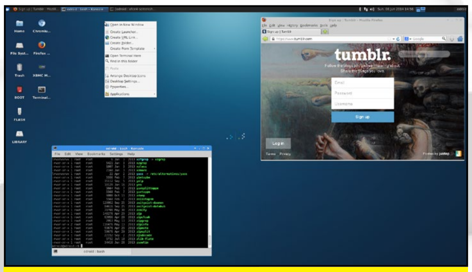
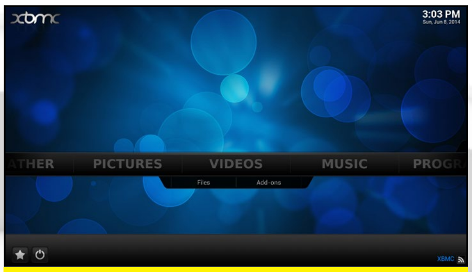


Razor is written entirely in the advanced QT programming language.


Xubuntu is a favorite of Ubuntu enthusiasts and offers many user-friendly features.



XBMC is the go-to program for all media playback, and can launch programs too.

## Razor

The Razor-qt desktop is written entirely in the QT programming language, and is one of the more recent desktop environments to be included in Ubuntu 13.10. While still a new project, Razor-qt already contains many key components, such as a panel, desktop, application launcher, settings center, and user session. Built for versatility and reuse, Razor-qt runs in conjunction with any number of window managers, although most Razor developers prefer to use Openbox. It's possible to use Razor with any modern window manager, from gw-wm2 to kwin, including running KDE without the Plasma Desktop.

## XFCE and Xubuntu

Xubuntu is based on the XFCE desktop environment, with the addition of many useful bundled packages which are meant to replace many Gnome-based software applications. It has a useful shortcut bar in the bottom area that appears on mouse hover, and an upper left start menu like Gnome. XFCE is a favorite of many Ubuntu users because of its nice balance between speed and functionality, as well as its convenient organization of applications into categories. The Search feature, represented by a magnifying glass in the shortcut bar, is similar to the Unity search bar, and can be used to find any program easily.

## XBMC

XBox Media Center (XBMC) can run as a standalone application, but can also be enjoyed as its own desktop environment by installing the "xbmc-standalone" package from Synaptic Package Manager. It is an all-in-one solution for audio and video playback, supporting Samba server connections, 5.1 DTS playback, third-party add-ons, and beautiful audio visualizations. It can also be used to launch Linux programs, so that software packages can be accessed within the need to go back to an Ubuntu desktop. For more information on using XBMC, please read the Quick-Start Guide at `http://bit.ly/1kTXKXI`.

## Whisper (LXDE)

Whisper is a single-user version of Dream Machine that offers one desktop environment (LXDE) and boots straight to the desktop very quickly by setting the auto-login variables in /etc/lightdm/lightdm.conf. It is designed for performance and speed, and contains the same major software packages as Dream Machine. Whisper is one of the most popular images available on the forums, and provides a familiar Windows XP-style interface which is ideal for programming, video playback, CPU-intensive applications, or just for lightweight use such as web browsing and document editing.

Although Dream Machine is not yet available for the XU series, Whisper has been successfully ported to the XU, and offers GXine instead of XBMC for video playback, since the XU version of XBMC does not run within X11. Open any media file from the File Explorer to automatically launch GXine, and double-click the playback window to enable full-screen viewing.

Now that that the Hardkernel 14.04 images have been released, an updated version of Dream Machine and Whisper will be released to the forums in the next few months. The recent improvements to XBMC that enable smooth 1080p playback will also be included in the X and U versions. Hardkernel is constantly improving its 3.8 kernel branch, and has recently replaced the kernel-update.sh script with the new odroid-utility package, which will also be added to the new releases.

Whisper, as fast as your ODROID can go!

# YOU'VE GOT MAIL... OR SHOULD!

## SUBSCRIBE TO THE HARDKERNEL EMAIL LIST TO KEEP UP WITH THE LATEST NEWS IN THE WORLD OF ODROID!

by Bruno Doiche

**Want to know when a new OS release is about to happen? How about the contents of every ODROID Magazine issue in one list? Email us today - we won't bother you with mundane news, just the cool stuff! odroid@hardkernel.com**

**The latest software release for ODROIDs**

**Ubunut 14.04 release for ODROID-U3/U2/X/X2 boards**
* Canonical Lubuntu 14.04 LTS base
* Mali GPU r4p0 drivers + armsoc driver + patched Xorg server
* Kernel 3.8.13.23 with improved 2D/3D hardware acceleration drivers
* All in one ODROID-Utility for HDMI configuration, Kernel-update, root partition expander and much more tools for maintenance
* XBMC 13.1 Gotham with Exynos-4412 MFC/FIMC hardware acceleration for 1080p videos
* Hardware accelerated Gstreamer plugins.
* Details : http://forum.odroid.com/viewtopic.php?f=29&t=5234

**Android KitKat 4.4.3 for ODROID-U3/U2/X/X2 boards**
* The latest Android OS KitKat 4.4.3 has been ported to ODROID.
* Source code and update images are available : http://com.odroid.com/sigong/nf_file_board/nfile_board.php

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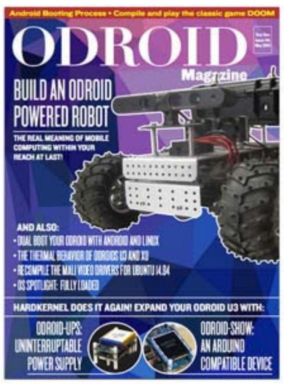
Android Booting Process • Compile and play the classic game DOOM
ODROID Magazine
BUILD AN ODROID POWERED ROBOT
THE REAL MEANING OF MOBILE COMPUTING WITHIN YOUR REACH AT LAST!
AND ALSO:
• DUAL BOOT YOUR ODROID WITH ANDROID AND LINUX
• THE THERMAL BEHAVIOR OF ODROIDS U3 AND XU
• RECOMPILE THE MALI VIDEO DRIVERS FOR UBUNTU 14.04
• OS SPOTLIGHT: FULLY LOADED
HARDKERNEL DOES IT AGAIN! EXPAND YOUR ODROID U3 WITH:
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ODROID-SHOW: AN ARDUINO COMPATIBLE DEVICE

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DO IT YOURSELF EDITION
Off-Roading with an ODROID Truck PC
GET STEP BY STEP TUTORIALS ON HOW TO CREATE:
A MINECRAFT SERVER
A HEAVY DUTY TABLET
CUSTOM ANDROID BUILD

# MEET AN ODROIDIAN

## RUPPI KIM, ONE OF THE FOUNDING MEMBERS OF HARDKERNEL

*edited by Rob Roy*

*Please tell us a little about yourself.*

I am the CTO of Hardkernel, as one of its founding members. I have been living in South Korea for 39 years and have worked in the hardware and software engineering industry for about 20 years. PCB artwork was my first job until I did my military service at 18 years old. After military discharge, I went into hardware and software development.

*What do you work on at Hardkernel?*

I am a hardware systems engineer. I have been designing circuits related to the ODROID computers, and artwork the PCB to the main boards. In my extra time, I port the latest Linux kernel, along with purchasing, manufacturing, and everything related to it. I also manage the odroid.com server and Hardkernel GitHub repository.

*How did you get started with computers?*

I started in middle school in 1998. I remember the first time that a computer showed up in class for a pilot course. It was first grade (I think I was 13), and the computer was a DAEWOO IQ1000 (MSX). Before I discovered computers, I only knew computers by the brand names in the arcade game room.

I first learned a programming language that allowed drawing of shapes with characters and arithmetic called MSX BASIC. Here is the spec sheet for the IQ1000 that I used in school: `http://bit.ly/1p1e1KM`.

After 3 years, I bought a $1500 NEWTEK 286 (AT) model as my first computer.

대우전자
국내최초 MSX방식
MSX
이제, 대우퍼스컴 아이큐 1000으로 세계 어느 MSX방식 컴퓨터의 소프트웨어도 쓰실 수 있습니다.
소프트웨어를 얼마든지 바꾸어 쓸 수 있는 대우퍼스컴 아이큐 1000탄생
국내에서 처음으로 선보이는 혁신적인 퍼스널 컴퓨터
소프트웨어는 훨씬 풍부해졌고 가격은 훨씬 낮아졌습니다.
대우 퍼스널 컴퓨터 특성
대우퍼스컴 아이큐 1000

Our art editor was enthralled with this picture of Bakyeon Falls in winter, along with the chance to publish a photo of an old MSX!! This article couldn't get any better...

... Unless, of course, we get to include pics of cute babies! Welcome Kyung A and Kyung Eun!

It had an INTEL 80286 (Code Name: P2) microprocessor at a clock speed of 16MHz. Turbo was at a clock speed of 21MHz. It used a Trident 1MB SVGA graphic card with a Goldstar (LG Electronics) 14" monitor, and had 1MB of memory. I mainly learned macro assembly language and typing exercises with this computer.

*What types of projects have you done with your ODROIDs?*

In the future, my ODROIDs will be used for educational purposes with my new twin daughters who were born in the autumn of last year. Caring for twin girls has become my new hobby! Their names are Kyung A and Kyung Eun. When not with my children, I am very involved in Linux development and the new upcoming Linux kernel: `http://bit.ly/SehCIb`.