

A few notes on catching (a view of) a satellite with a telescope  
- cookbook to get you started -  
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I am but a casual astronomy aficionado (an occasional satellite peeper) and I assume you are as well. Checking the night sky for satellite passings requires a few things I usually take for granted: clear skies and good weather, knowing exactly where you are on the planet, knowing which part of the sky you are looking at, knowing exactly what time it is, and not being too tired to bother about all of these things. If you like to watch satellites from within in a city then your life gets a bit more difficult as you need to find a dark corner without street lights. You start to see the city in a new way.

Some very bright satellites can be viewed without any optical gear. Most require at least a pair of binoculars. I have a good but utterly hobbyist telescope (LX200gps, 8in aperture). It is not small but easily fits with the tripod, my dog and some gear into a Volkswagen beetle. Setting up a telescope can be tricky. You need to calibrate the motors and adjust the focus. I found good advice online with usergroups (see below).

Automating the viewing requires a camera to capture the images and a computer to control everything. Surprisingly, you can get away with rather cheap cameras. I have two. A \$100 camera in a plastic housing and a \$300 camera that is enjoyably more sensitive to the light in the sky. You have to mount the camera(s) to the telescope through either the viewfinder to make use of the amplification of the telescope or on top of the telescope if you have a separate lens for the camera. I usually put the cheap camera on the viewfinder of the telescope and use the better camera in piggyback mount on the telescope with a variable zoom lens (30 to 70 mm). This is best for suboptimal but frequent viewing conditions as when the sky is cloudy and light pollution is present. Both cameras I have are based on the IEEE1394 IIDC/DCAM specifications. That means they deliver raw, uncompressed digital data that you can process any way you wish.

Most any old computer will do. A laptop is preferable if you work out in the field as it travels well. The usual caveats hold for setting up electronic gear outdoors. At night it is dark (no kidding). A head-mounted flashlight is really helpful; the fashion police will understand..

Before you start working outside you need to have access to the Internet to get the exact time, sync your computer, and to find your GPS location. Finally, you need to download the satellite trajectory data (TLE files) used to calculate the position of a particular satellite at a particular time (seen from a particular location on the earth – where you happen to be). Most of this is done by the startup routine included in the code.

The control and processing software is opensource and cross platform (it works on linux and windows). I have tested it on my systems, but don't guarantee it behaving the same way on yours. Opensource means you have some (well plenty of) responsibility. Also, it can be ported to Mac - by you - without too much effort if you know your way around the Apple system. The code includes a collection of telescope control algorithms, image capture and processing routines that make use of the astronomy package Xephem (by Elwood Downey) in its python cast (pyephem by Brandon Rhodes). Without the work of these wonderful people this little project would not have been possible.

Relevant resources I made some use of are listed below. Updates and images will be posted here ([www.realtechsupport.org/new\\_works/autolo.html](http://www.realtechsupport.org/new_works/autolo.html))

## Hardware

LX200 or similar with microprocessor, gps and serial-usb interface. A unibrain fire-i or imaging source DMK 21AU04.AS camera (both b/w as the single band ccd is more light sensitive). A laptop computer (old pentium 3) with linux (ubuntu 7.04) or windows (xp sp2). A 12V lawn mower battery to keep you going all night long, a battery charger, a 12V to 110V converter to power the laptop, a compass to orient yourself, at least one flashlight, several cables and connectors. A portable dolly luggage cart to comfortably roll the telescope and tripod along city sidewalks.

## Software

python with pyephem, pyserial, scipy, opencv and customized algorithms (satellite trajectory + data fetch from the web, position calculation, mathematical functions, telescope control, image capture and processing) – all customized code available from this website

## Online Resources

ubuntu	<a href="http://www.ubuntu.com/">http://www.ubuntu.com/</a>
python	<a href="http://www.python.org/">www.python.org/</a>
pyephem	<a href="http://rhodesmill.org/pyephem/">http://rhodesmill.org/pyephem/</a>
scipy	<a href="http://www.scipy.org">www.scipy.org</a>
matplotlib	<a href="http://matplotlib.sourceforge.net/">http://matplotlib.sourceforge.net/</a>
opencv:	<a href="http://www.intel.com/technology/computing/opencv/">http://www.intel.com/technology/computing/opencv/</a>
unconventional imaging	<a href="http://www.megastronomy.150m.com/New-QCUIAG/">http://www.megastronomy.150m.com/New-QCUIAG/</a>
LX200 command set	<a href="http://www.meade.com/support/CommandSet.html">http://www.meade.com/support/CommandSet.html</a>
NORAD elements (TLE files) (requires login)	<a href="http://celestrak.com/NORAD/elements/">http://celestrak.com/NORAD/elements/</a> <a href="http://www.space-track.org/perl/login.pl">http://www.space-track.org/perl/login.pl</a>
exact time	<a href="http://www.timeanddate.com/worldclock/">http://www.timeanddate.com/worldclock/</a> <a href="http://www.pool.ntp.org/">http://www.pool.ntp.org/</a>
satellite pass times, local coordinates, general purpose astronomy	<a href="http://www.calsky.com">www.calsky.com</a>
satellite trajectories (visual paths)	<a href="http://groundstation.sourceforge.net/gpredict/">http://groundstation.sourceforge.net/gpredict/</a> <a href="http://www.heavens-above.com">http://www.heavens-above.com</a>
high end satellite tracking	<a href="http://www.astrosponder.com/index.htm">http://www.astrosponder.com/index.htm</a>
LX200gps yahoo group	<a href="http://tech.groups.yahoo.com/group/lx200gps/">http://tech.groups.yahoo.com/group/lx200gps/</a>