

# DEVELOPMENT BEAGLE BONE WEBCAM SERVER FOR SECURITY AND SURVEILLANCE APPLICATIONS

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## ABSTRACT

Beagle bone webcam server is an IP webcam which is based on Linux, according to the ARM development board which inexpensive, it hosts a web server to display the webcam feeds by its own. The server can use either a wired router, or a wireless access point. The server uses the wired router or wireless access point to connect and control its functions through Wi-Fi enabled devices

The goals of the Beagle bone Webcam Server project are to design and implement an IP (Internet Protocol) webcam using open source software. The Webcam Server builds upon the rich tools and libraries that are being provided by the Linux community in order to implement the following features namely:

- 1) To view a live webcam stream by a web browser.
- 2) To save the stream to the server to view later or enable the client to download to later and
- 3) To control two-axis rotation of the webcam by the browser interface.

The Webcam Server focuses on using mature and stable base software components in order to provide a robust client facing user experience.

## 1 INTRODUCTION

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- 2) Saving the stream to the server to view later or to enable to download to a client and
- 3) Controlling two-axis rotation of the webcam by the browser interface.

This Server focuses on using mature and stable base software components in order to provide a robust client facing user experience. The web interface is written with JavaScript and PHP, with certain functional sections implemented with AJAX calls to server scripts that manipulate configuration files, or run programs on the server.

## 2 IMPLEMENTATION

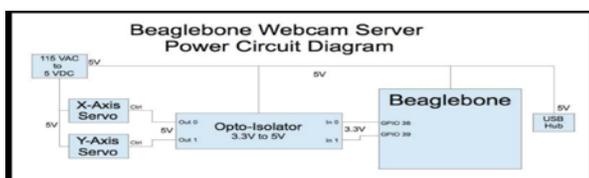
The Beagle bone Webcam Server required both hardware and software development and component selection.

### 2.1 LOGITECH C110 USB WEBCAM

The Logitech webcam features are VGA video capture, it has a USB interface facility, and a compact, and small form factor<sup>1</sup>. The only main reason in selecting a webcam to the project is its compatibility feature that is compatibility of webcam with the UVC (USB Video Class) Linux driver<sup>2</sup>. Open source community writes most of the Linux drivers because of lack of vender support, so it is essential<sup>3</sup> to select a support device with a mature driver. The other benefit of this webcam is its small size and weight, which allows it to mount it to the pan/tilt bracket, and thus moved by the servomotors.

### 2.2 ALFA AWUS036NHA USB WIRELESS ADAPTOR

The Alfa wireless adaptor is mainly based on the chipset called Atheros AR9271 chipset<sup>4</sup>. This chipset supports Monitor Mode / Access Point mode in the ath9k\_htc driver<sup>5</sup>. The Atheros chipset family is one among the most supported in the Linux kernel, and the Alfa wireless adaptor has power output which is one of the largest power outputs, which is mainly in need to provide access point with more strength.



## 2.3 BELKIN F4U040V 4-PORT USB 2.0 POWERED HUB

The power output of a the USB port on the Beagle- bone is only 500mA<sup>6</sup>, and the power requirements of the webcam and Wi-Fi adapter are greater than that, so a powered hub is needed. A solution with the minimum amount of available ports is needed in order to be able to fit inside a small enclosure.

## 2.4 SPARKFUN PAN/TILT BRACKET AND SMALL SERVO

In order to implement the pan and tilt functionality of the system, a two-axis system needs to be selected. The bracket and servo combination which is provided by Spark Fun is the most ideal solution to this problem not only mechanically, but also electrically. The same voltage rail as the main Beagle bone powers the servos, so no conversion is needed in order to provide the correct voltage and necessary current to drive the servomotors. The dual servo setup for the bracket also provides sufficient torque to move the webcam without any issue<sup>7</sup>.

## 2.5 SPARK FUN OPTO-ISOLATOR BREAKOUT

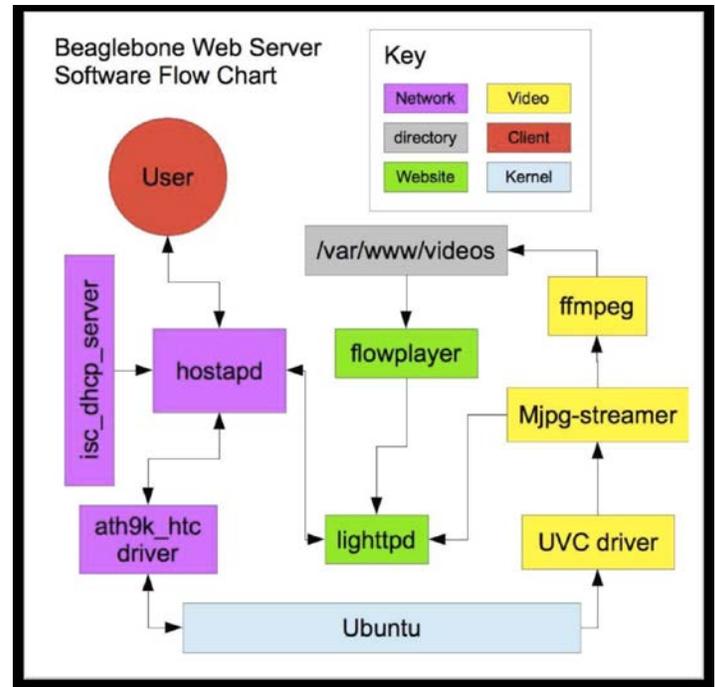
In order to ensure that the GPIO output of the Beagle bone can trigger the servo, an optical isolator circuit is used to convert the 3.3V output of the GPIO to 5V to drive the servomotors<sup>8</sup>.

## 3 SOFTWARE

All of the software libraries which are being used in the project are open source and installed from the distribution repository, when available, in order to simplify development, reliability, and reproducibility. When a user got connected to the system via WiFi, hostpad negotiates the connection by authenticating via WPA. Isc\_dhcp\_server assigns an IP address to the client. When the user navigates to the website, lighttpd serves up the correct page. If playing a saved video, Flowplayer searches for the video in the /var/www/videos directory. During live streaming, the lighttpd queries the web server running inside of Mjpg-streamer and displays the stream images. In order to save videos, ffmpeg takes the live stream from Mjpg-streamer and saves its output in /var/www/videos for Flowplayer to play, or for the user to download<sup>9</sup>.

### 3.1 LINUX UVC DRIVER

The Linux UVC driver is included in the Linux kernel and is loaded automatically upon booting the system with a webcam attached.



### 3.2 HOSTAPD

Hostapd<sup>10</sup> is a program, which is used in addition with the ath9k\_htc driver. Hostapd sets up the AP/Monitor mode functionalities. Hostapd allows different authentication modes such as WEP/WPA/WPA2 as well as any SSID configuration. Simply, it allows clients to connect to the server via Wi-Fi.

### 3.3 ISC-DHCP-SERVER

Internet Systems Consortium's DHCP software<sup>11</sup> is the pre-installed DHCP solution chosen by Ubuntu. This software will allows its clients who got connected to server using hostapd to assign an IPaddress dynamically. Without this software, clients need to assign their client an IP address manually, which would increase complexity of use, and therefore decrease the possible user base of the system.

### 3.4 LIGHTTPD

Lighttpd<sup>12</sup> is, as its name attests to, a full-featured lightweight web server, it allows the server to provide the present content to connected clients, which will not only provides the web page content, but also processes the PHP scripts that are needed for the project functionality.

### 3.5 MJPG-STREAMER

Mjpg-streamer<sup>13</sup> is a software solution that takes raw frame data from the webcam and outputs a stream in the MJPG format, a series of JPEG images. The software package has a great feature, it contains its own small web server that outputs the stream, as well as a great documentation on how to format and use the stream for different applications. For this project, any HTTP request that Lighttpd receives for the webcam stream is forwarded to the Mjpg streamer server to process. This allows for a very lightweight capture process which does not use a large amount of CPU cycles converting

the raw webcam stream to other more traditional video formats.

### 3.6 FFMPEG

Ffmpeg<sup>14</sup> is used in this project to convert the live mjpg stream to the FLV format when saving videos. The conversion process runs through a PHP script that executes ffmpeg in order to save a video to the server. The conversion process is CPU intensive process extremely, and thus it takes a bit longer to convert a video than it takes to stream the video actually. This bottleneck was the main reason that ffmpeg was not used to convert the webcam data directly for live streaming.

### 3.7 FLOWPLAYER

Flowplayer<sup>15</sup> is used to playback saved videos on the server. It is an open source player. It allows for pausing and reloading of the video, as well changing playback cursor position.

## 4 BEAGLEBONE WEBCAM SERVER COMPARISON WITH CCTV

The wireless IP camera market is evolved from wired camera market, that means wired closed circuit television (CCTV) surveillance camera market, with bulk of the major networking companies putting out products that focus on using the IP protocol as a medium to transfer video, as opposed wired CCTV technologies<sup>16</sup>. The Beagle bone has similar features so many IP camera offerings, including pan/tilt, configuration via web interface, and viewing the stream over the Internet, and saving of content<sup>17</sup>, but unique to the Beagle bone Webcam Server is the ability to act as a standalone access point, and selectively save videos to the system. The cost of prototype system can also be comparable to purchasing a complete system, which means provided along with a streamlined production process, the costs could be reduced, which is below the price of all other competitors who exists in the market.

## 5 APPLICATIONS

The system developed by this process would be used as an alternative to traditional CCTV cameras in the field of surveillance and security. Given the size and cost, the Beagle bone will help most of open source developers and other hobbyists in India to realize their creative design ideas without any restrictions by many other problems like huge expense on hardware development tools, performance capabilities of lackluster, high electricity consumption or stifled design environments. With the help of this development board open source developers and other hobbyists will have the expandability of desktop machines without the problems of expense, bulk or noise. Beagle board is fan-less embedded system development board. It is powerful and low cost, its size is very small, compared it is smaller than index card size. Many workshops can be conducted on the same topic to spread the knowledge among the student body and also to enable various student projects without the need of heavy infrastructure to come to fruition.

## 6 FUTURE WORK

Since the Beagle board and Beagle bone are supported by a vast open-source community, there is a large scope for many potential future projects

1. Linux PC
2. Digital signage via Network-connected devices
3. 3D user interface development (for Ex. Clutter, etc.)
4. Game console
5. LCD-to-picture-frame conversion kit
6. Adobe Flash client "alarm clock" (for Ex. Chumby)
7. Kitchen computer
8. Web services development
9. video phone in google talk
10. Notebook TV-out via USB
11. Projector media reader and also presenter
12. Emulator in Gaming platform
13. Thin client terminal
14. Web browsers used for the TV
15. Multimedia codec and framework development
16. Home networked media (DLNA/XMPP) server/client
17. Security camera analyzer, streamer, recorder, and monitor
18. USB traffic monitor (looks like a HUB)
19. USB class conversion (software support must be added where drivers aren't available on the PC)
20. Network sniffer
21. Set-top box
22. telemetric and automation of vehicles
23. Software defined radio
24. Mobile digital television
25. Robotics
26. Home automation

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