College of Engineering

CS Capstone Technology Review

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Axolotl

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Abstract

This document investigates GPS Modules, backup cameras and Wireless video streaming solutions for use in the Axolotl project. A GPS module is necessary to deliver navigation and route guidance. Backup camera integration is a required feature and wireless streaming is desirable to reduce the amount of wiring in the project.

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1 Overview

The Axolotl is a car infotainment and navigation system paired with a black box. It will provide access to mapping, route guidance, music, and cameras mounted to the dashboard or the rear of the car. Users will interact with the system through a touch screen interface which will also be used as displays for the cameras. The black box system will keep a log of GPS and AHRS data as well as video from the cameras and some data captured from the car's internal computer. This technology review will examine GPS modules, backup cameras, and wireless video streaming solutions that can be used to complete this project.

2 GPS Modules

It will be necessary to select a GPS module to link to the Axolotl in order to provide navigation services. To choose a module it will be important to consider the update rate of a module. Update rate measure how frequently a module calculates and posts its position. Modules have update rates ranging from 1 Hz to 20 Hz and above. The number of channels a module uses to find a satellite to talk to is also important. Checking more channels allows a module to determine its position faster, especially when it first starts up. Twelve to fourteen channels is a common baseline for GPS Modules.

One possible GPS module is the Copernicus 2 from Trimble. This module has a on Hz update rate and uses twelve channels to communicate with satellites. It normally takes about 38 seconds to lock its position on startup. The Copernicus is accurate within 5 to 10 meters and is capable of enduring harsh temperature, humidity and vibration.

Another option is the Venus638 from SkyTraq. This module has an update rate up to 20Hz and utilizes 65 channels to communicate with GPS satellites. It has a slightly faster startup time at 29 seconds and is accurate within approximately 2.5 meters. Additionally the Venus unit has jamming detection and mitigation systems to help drown out noise and increase reliability.

The third GPS module is the NEO M8U from u-blox. The M8U also has a 20 Hz update rate and has a shorter startup time of 26 seconds with a 72 channel receiver. This unit also has an integrated accelerometer, gyroscope and odometer. Most attractively it has built in untethered dead reckoning functionality. Dead reckoning is when a system extrapolates its position based on other data after losing its GPS signal. It is very useful when traveling under thick cover or in remote areas.

The Copernicus is a very basic module, it is functional but it is generally sluggish compared to the other two. It has a slower startup speed and a lower update rate, making it less than ideal. The Venus is much sharper than the Copernicus and its anti jamming functions could be helpful in noisy areas. The M8U Module has the best performance overall and its integrated dead reckoning support is a major bonus because native support for it could greatly reduce development time and complexity.

We chose the M8U Module because its dead reckoning support will be very valuable to this project. Dead reckoning will allow the Axolotl to more smoothly move through areas without a GPS signal, such as tunnels. Because of the built in support for dead reckoning in the M8U module It will ease the complexity and time required to implement the feature.

3 Backup Cameras

This project also requires use of a backup camera mounted to the car. Backup cameras are generally a great feature for cars and the government will require new cars to have them beginning in 2018. The backup camera will be displayed on the screen when the car is in reverse. Video from the backup camera might also be included in the log.

Important things to consider in backup cameras include viewing angle and low light capability. Viewing angle describes how far to either side the camera will see. Low light functionality is important when parking at night. Some cameras have night vision or lights to illuminate the ground nearby. There are also several different mounting styles for backup cameras to be considered. Some cameras mount to the license plate, others have brackets, or mount flush with the car after a hole is drilled for them.

One backup camera option is BOYO's bracket mount camera. It features a simple bracket mount and has night vision for low light driving. This camera also has a built in guide line to help illustrate distances in the video to assist parking. The cameras output resolution is 640 x 480.

Another camera option is a license plate mounted camera from Metra. This camera Has a very wide viewing angle of 170 degrees, and also has night vision like the previous camera. Metra also provides parking assist guidelines on the display.

A third option is SVTCAM's backup camera. This camera boasts 720p resolution and 175 degree viewing angle. Like the others this camera offers night vision and parking assist guidelines.

It turns out that backup cameras have a fairly universal feature set, the primary difference being the mounting style. For testing purposes it seems ideal to use a mount that is easy to install and remove without being destructive. A flush mount camera for example would not be ideal as it requires a hole to be drilled or sawed for normal installation.

We recommend the Metra camera because the license plate mount seems like it would be the most versatile style to test with. Normal installation of bracket mount cameras requires them to be screwed in place. We could use tape or another adhesive instead, but it might not be as secure.

4 Wireless Video Streaming

To avoid running long wires through the car we need to set up a wireless connection to stream video from the backup camera to the main Axolotl unit. Wireless streaming makes installation and maintenance much easier, since it would be quite difficult to run a video wire the length of the car in a way that doesn't look terrible.

When looking at wireless streaming solutions it is important to consider price and the complexity of development and implementation. Due to the scope of the project and the number features we need to implement it would be undesirable for video streaming to require a large amount of development time.

One way to deliver wireless video is with a dedicated video transmitter and receiver. This is potentially the least costly solution in both money and development time. Transmitter receiver pairs can be found for as little as ten to twenty dollars, and in theory it should just work when you plug them in. When implemented in a car the transmitter may require some additional weatherproofing since will likely be somewhat exposed to the elements.

An alternative option is to connect the camera to a small computer like a Raspberry Pi, which could control the camera and send video over wifi to our Jetson. This is a little more expensive, Raspberry Pi computers as an example cost 25 to 35 dollars. This would also require some programming and the computer would definitely need to be protected when implemented, making it less time efficient as well. This option would allow more control over the camera then the previous solution.

A third option for wireless video would be to simply buy a wireless camera. This is the most expensive solution as wireless cameras start at around one hundred dollars. Additionally in most cases these products come with a monitor and offer little information as to how they talk. Because of this it is difficult to predict what might be necessary to integrate a camera into our system, or if it can be done.

These three solutions contrast quite starkly. One is cheap and easy, one is expensive and potentially very difficult and one is middle of the road on both counts. The Raspberry Pi, unlike the other two solutions, could allow us more fine control of the camera. Normally when a backup camera is installed it is wired to the backup lights so it only turns on when the car is in reverse. With a Raspberry Pi in place to control the camera we could add implement additional features such as allowing users to view the camera at will.

We believe a secondary controller for the computer is the best choice because of the flexibility it adds to the system. A secondary controller could allow us to give the end user greater ability to manipulate the camera. It would also make it easier to incorporate footage from the backup camera into the black box log.

References

[1] AUTO-VOX. Auto-vox m1w wireless backup camera kit,ip 68 waterproof led super night vision license plate reverse rear view back up car camera,4.3” tft lcd rearview monitor for vans,camping cars,trucks,rvs. https://www.amazon.com/AUTO-VOX-M1W-Wireless-Waterproof-Rearview/dp/B07425TPBT/ref=sr_1_3?s=car&ie=UTF8&qid=1511305628&sr=1-3&keywords=wireless+backup+camera. (Accessed on 11/21/2017).

[2] BestBuy. Boyo - night vision bracket type cmos camera - black. https://www.bestbuy.com/site/boyo-night-vision-bracket-type-cmos-camera-black/5807776.p?skuId=5807776. (Accessed on 11/21/2017).

[3] BestBuy. Metra - license plate back-up camera - black. https://www.bestbuy.com/site/metra-license-plate-back-up-camera-black/1570003.p?skuId=1570003. (Accessed on 11/21/2017).

[4] Camecho. Camecho new 2.4g wireless color video transmitter and receiver for the vehicle backup camera front car camera. https://www.amazon.com/Camecho-Wireless-Transmitter-Receiver-Vehicle/dp/B01DY0UAXE/ref=sr_1_4?ie=UTF8&qid=1511305199&sr=8-4&keywords=wireless+video+transmitter. (Accessed on 11/21/2017).

[5] SkyTraq Technology Inc. Venus638flpx gps receiver data sheet. https://cdn.sparkfun.com/datasheets/Sensors/GPS/Venus/638/doc/Venus638FLPx_DS_v07.pdf. (Accessed on 11/21/2017).

[6] luketc1. Raspberry pi backup camera - ece 470 clemson. https://www.youtube.com/watch?v=CUgvdArkWjM. (Accessed on 11/21/2017).

[7] Mortons on the Move. Diy inexpensive digital wireless rv backup camera- review ec170 and 903w transmitter. https://www.youtube.com/watch?v=6UIG-31UCFU. (Accessed on 11/21/2017).

[8] sparkfun. Gps buying guide. https://www.sparkfun.com/pages/GPS_Guide. (Accessed on 11/21/2017).

[9] SVTCAM. Svtcam hd backup camera high definition color ccd waterproof car rear view camera with 175 degrees wide viewing angle. https://www.amazon.com/dp/B0759GQPLZ/ref=sspa_dk_detail_2?psc=1&pd_rd_i=B0759GQPLZ&pd_rd_wg=GZ5SF&pd_rd_r=FWBE022TCNHVHD897WSF&pd_rd_w=CLOyT. (Accessed on 11/21/2017).

[10] Trimble. Copernicus 2 gps reciever reference manual. https://cdn.sparkfun.com/datasheets/Sensors/GPS/63530-10_Rev-B_Manual_Copernicus-II.pdf. (Accessed on 11/21/2017).

[11] U-Blox. Neo-m8u product summary. https://www.u-blox.com/sites/default/files/NEO-M8U_ProductSummary_%28UBX-15013483%29.pdf. (Accessed on 11/21/2017).

[12] Ben Wojdyla. How to put a backup camera on your older car. http://www.popularmechanics.com/cars/how-to/a7978/how-to-put-a-backup-camera-on-your-older-car/, June 2012. (Accessed on 11/21/2017).