

GPS Navigating Autonomous Vehicle

Senior Project Proposal

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Our world is becoming automated. Autonomous navigation is a necessity for any device that needs to operate without human interaction. GPS is a fantastic way to drive a vehicle, but alone is not accurate enough to be useful. An application of differential GPS will be needed to create a working feasible design. The GPS Gaucho will be a differential driven vehicle based on little user input with a wide array of capabilities.

The vehicle will be capable of identifying its current position and then, upon receiving a new location, calculate how to reach the new location and drive there. The differential GPS system consists of two GPS units which are capable of acting as either DPGS base stations or clients and a wireless RS-232 link between them. By programming the GPS receivers to correctly produce or interpret DGPS data, a location fix can be made with enough accuracy to enable the vehicle to stay in a relatively narrow drive path.

The Gaucho is a larger truck-type vehicle that has been used by projects in the past, and as such is already capable of being controlled over a serial port by a computer or other device. Because the Gaucho already has the low-level controls built into it, we will not have to implement that part of our project. Also, unlike most of the other vehicle platforms available to us, the Gaucho is large enough that it is capable of driving in rougher terrain, where many of the smaller vehicles would have trouble if they were to ever get into the grass.

The navigation control portion of the project will run on an embedded device known as an E-Box. The E-Box is essentially a small computer that runs Windows CE. One of the main advantages we gain by using Windows CE as the environment for our system is the ability to easily interface with multiple communication protocols, which will make it easier to build a method of communicating with the E-Box. Also, Windows CE has built in support for many layers of application priority, which will provide a way that we can specify what parts of the system are most important and need to run more than other parts.

There is currently a GPS antenna mounted on the roof of Jobst Hall. A GPS receiver has been attached to the antenna in order to create a base station. The second receiver will then be mounted on the Gaucho and act as the client. One of the issues with using DGPS is that the exact location of the base station must be known. In order to get a good idea of the location, we intend to log data over a period of a couple of weeks and then average the gathered data. While this will give us a solid reference point that is relatively close to the correct point, it won't give the exact location of the base station. However, this is unimportant to our project. In order for the Gaucho to be able to navigate the sidewalks outside on campus, it must know where the sidewalks are first. This will require us walking around with one of the GPS receivers while it is correcting itself from the base station and gathering data on where the sidewalk really is. In this case, the only criteria that really matters is that the base station's reference point remains

fixed, since the client's data will be relative to this point. As long as this is the case, our system will still work, even if the location fix of the base station is slightly off.

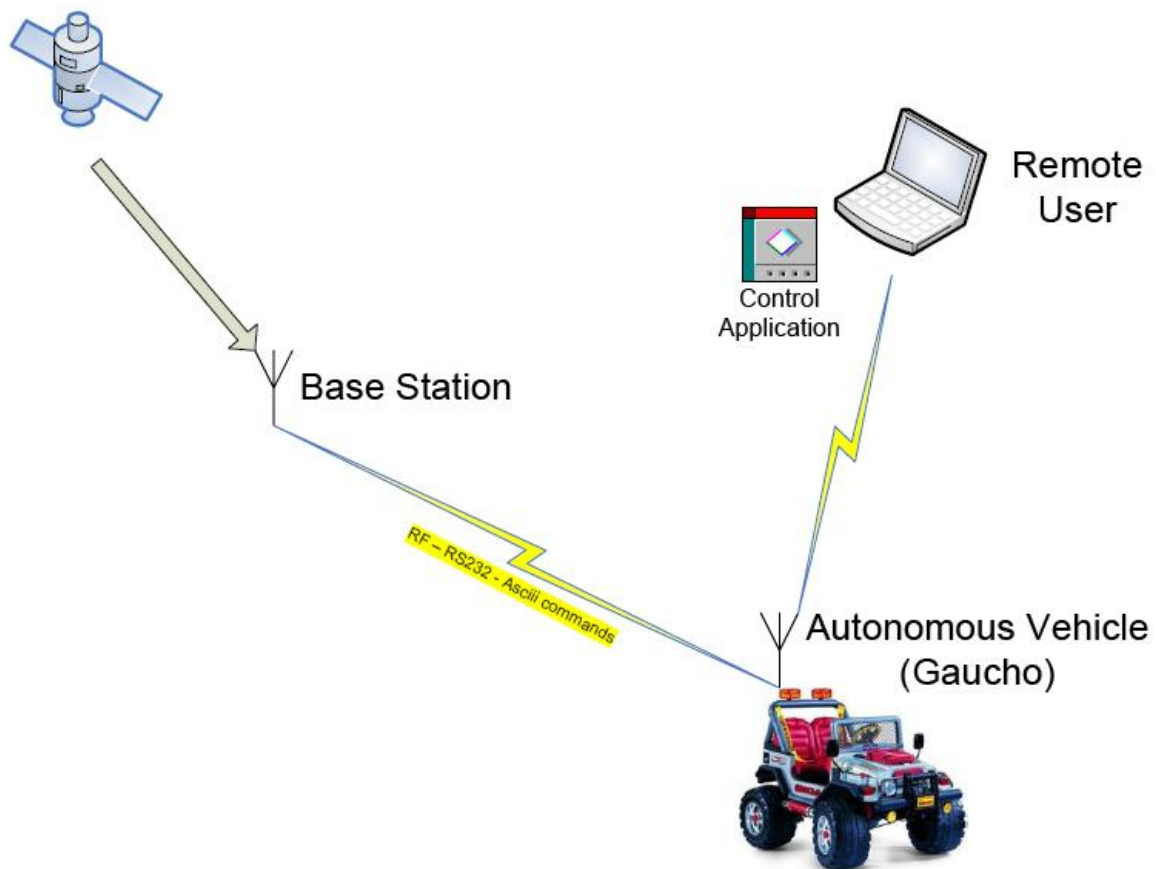


Figure 1: Parts of the system and the communication between them

The diagram for how the different parts of the system interact is in figure 1 (above). The main part of this system is the autonomous vehicle itself. The vehicle, which is the gaucho, will have one of the GPS receivers mounted on it in addition to the E-box. By using the wireless RS-232 link, the receiver on the Gaucho will receive correction data from the base station. Also, the E-Box will receive commands from a remote user over an 802.11 wireless network.

The majority of the work in the system will be done by the E-Box on the autonomous vehicle. While the remote user will have some capabilities, that portion of the system mostly consists of an app that sends commands to the vehicle and receives data back. In the main controller however, there is a much larger amount of logic. Figure 2 (top of next page) shows the primary logic process of the system. Upon start-up, the E-Box will communicate with the GPS receiver to determine if a differential fix can be made or not. If it is not possible to obtain a valid fix, then the system will go into a standby state where it can either accept manual commands from the remote system or wait until it obtains a valid fix. When a valid fix is made,

then the system will begin to accept position commands to move to a new location. Upon receiving one of these commands, the system will calculate the movements needed to reach the new location based on the current location reported by the GPS receiver. If at any time the system loses its differential fix, it will then return to manual mode and quit performing auto-navigation tasks. In order to correctly calculate the correct path to take to go from the current location to the target location, it may be advantageous to have an electronic compass on the Gaucho. This is mainly useful because depending on which direction the Gaucho is currently facing, it may have to turn around before it can start moving in the correct direction. It is possible though to detect the current orientation using the GPS data, so this is something that may be added later on as time permits.

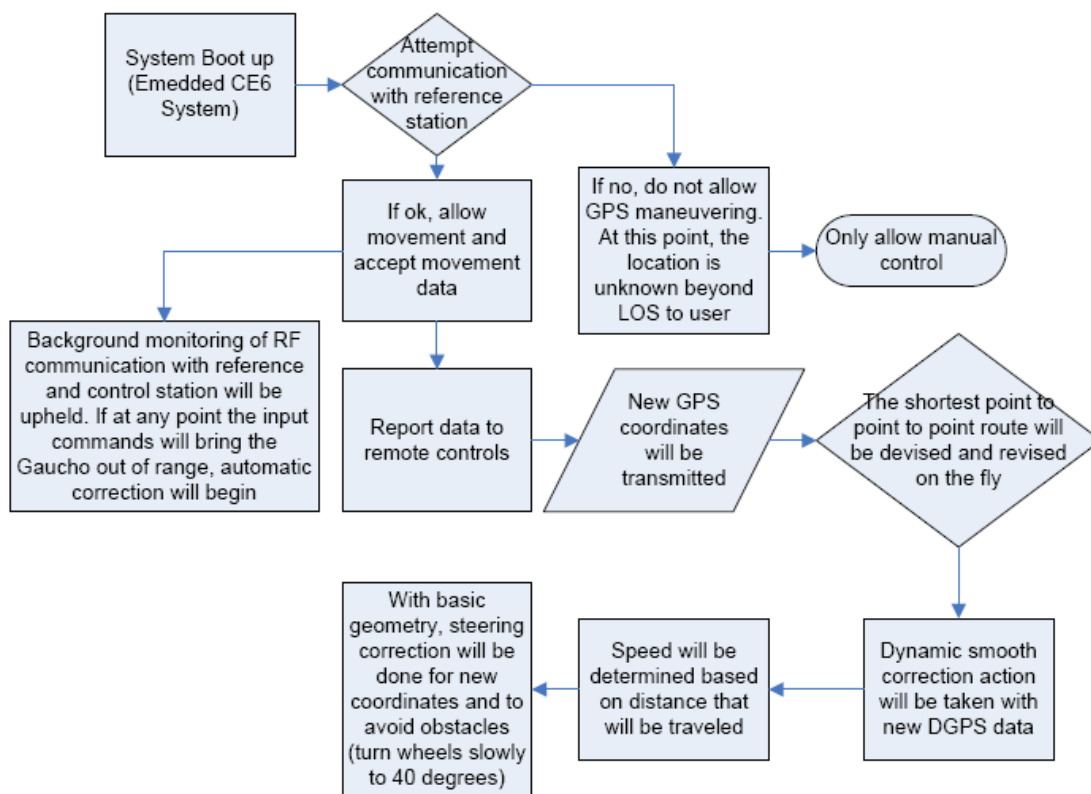


Figure 2 – Primary logic process for the embedded system

Simulations and tests are impossible at this point since the embedded system on the Gaucho actually does not work. This is due to the code not compiling under the demo any longer. Research with the original developer is underway. All this work will be shared

Our schedule is as follows: the primary focus over winter break will be to get the code on the Gaucho to function. That is the number one priority. The rest of the project depends on this. Once this is completed, the differential GPS, E-Box, and network infrastructure will be developed into a working platform. These core functions must be completed by 2nd semester midterm. Further refining and additional development will ensue for this stage.

Bibliography

Andrew D. Canopy from RLS
Graduate paper on embedded Gaucho system
RT-20 GPS manual

Equipment List

RF transceiver – Lawn II
Gaucho including MC9212DG256CPV
Freescale Codewarrior Compiler
12v to 9v regulator
2- Novatel RT20 GPS Modules
Ebox x86