# Finga Gunz RC Car Project - MSSE 5831 - S'15

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## Summary of Project

During our time in the MSSE's Software Development for Real Time Systems class, we learned a vast amount about various microcontroller topics, including timers, digital I/O, motion control, and communications protocols. Our goal in our final project was to incorporate as many of those things as was feasible.

We thought about a couple of different ideas that were eventually scrapped. We settled on a remote control car. We felt we could incorporate many of our favorite topics into this single project, all while achieving a significantly sized scope while still having a managable project in the time allotted.

## Overview of Implementation

Once the idea for our project was settled on, we needed to start coming up with the actual details of the implementation.

For control, we needed a way to give input from the physical world. After a fair amount of research, it was decided that a Nintendo Wii Nunchuck was a viable option. It has a joystick to give direction, and two additional buttons for extra functionality. It communicates through I2C, and the documentation for receiving data from the nunchuck was readily available. The Orangutan has built in support for Two Wire Interface, thus I2C communication was available at our disposal. In moving forward, we examined the data sheet for the Atmel 1284P microcontroller and implemented I2C code ourselves.

Next was to decide on our wireless communication. We decided pretty early on that we wanted to do bluetooth, but none of the team members knew much about it. After considerable research into bluetooth, it was decided that we'd use the HC-05 bluetooth chip using the Serial Port Profile (SPP). This was ideal because we could simply use the the serial communication knowledge we had learned earlier in the class.

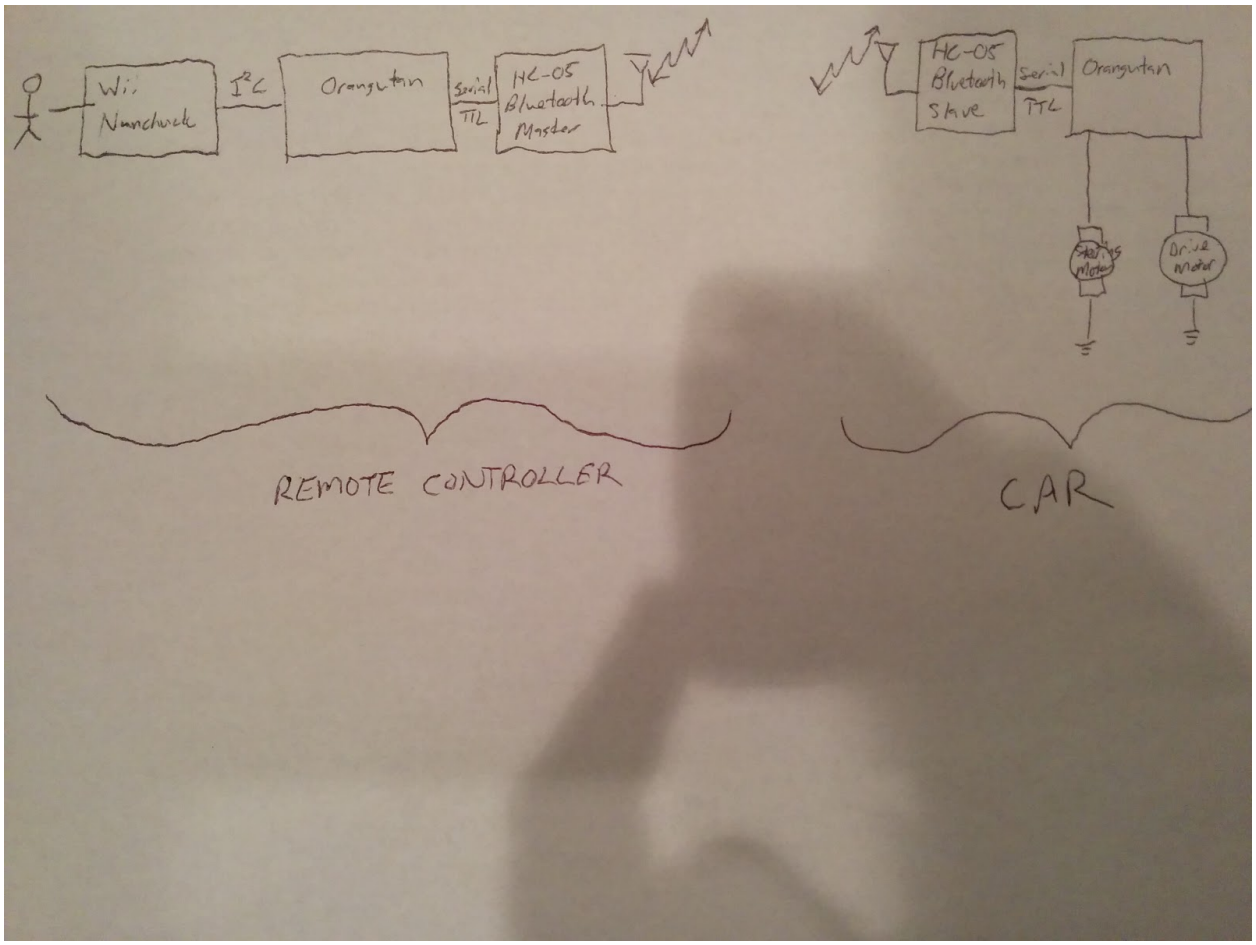
Our next item was to come up with our custom messaging for communication between the two orangutans. This was fairly trivial as we just needed to agree on what our byte order was and what determined the beginning and end of a message. The tricky part for this item was figuring out how to serialize our struct in C, send it over the bluetooth, and then deserialize the struct on the other device.

The last implementation detail was to take our message and convert it into signals to drive the car. As previously mentioned, we were interested in using as much of our knowledge from class as possible. This meant using PID loops to drive the car. Our plan was to use a

velocity PID to propel the car, and a position PID to steer the car. This sounds simple enough, but one big problem was how to home (center) the steering of the car. If the car was shut down when the wheels were not in center, we wouldn't know where the wheels are actually located. For this reason, we had to implement a homing routine for the steering such that we could always know where our wheels were located. We were even able to have some fun and implement a car horn that played La Cucaracha.

The last item of implementation was the car itself. This probably took the most research, and we actually ended up deciding on a Lego Technic custom built car. The best part was that we were able to use the motors we had gotten from class, and the encoders that were attached to them.

Using all of these implementation details, we were able to put together quite the remote control car. Included below is a block diagram of our overall system.




## What We Learned

The amount of knowledge we gained in both this class and for this project was considerable. This project allowed us to learn a lot about different communication protocols including I2C and the serial interface. We were able to learn a ton about bluetooth, including how bluetooth

devices discover and communicate with each other, and the different profile types available in bluetooth. This project also allowed us to solidify our PID knowledge through the control of the car.

Some of the issues we had was knowing which timers were being used for what and which timers we should use for our necessities. We had times where we thought we were good with the timer we had selected, but when we used one of the built in features, we'd all of a sudden lose some of the functionality we had. One example of this is the horn. To play music, the Orangutan uses timer 1, and we were previously using timer 1 for our PID loop, and when the music was player, we weren't able to control the car.

We also had a regular amount of issues when debugging the bluetooth and the I2C. We didn't run into any exceptional problems when doing these, and a normal amount of debug time was enough to resolve any of those issues.

## Unresolved Items

For this project, we were able to implement all of the items we had planned before starting. We are able to drive the car using the selected components.

## Future Work

This project could basically go anywhere from here. We have three things that we've identified as future improvements to our system.

The first item is the steering centering. The car has a bit of a hard time centering the steering on anything but a smooth surface. Because the system uses encoder error to determine if it is at the end of travel, any extra resistance, including carpet, will make the system think the steering is at the end of travel when it is not.

The second item is to make better use of the buttons on the nunchuck. Because it only has two buttons, and we were hoping to have a lot of features that we weren't able to get implemented, including switching from using the joystick to control to using the accelerometer. Since we've only got the two buttons, we ran out of buttons to get additional functionality. A second item we had talked about having was a headlight, but because we ran out of buttons, this feature was not an option.

The third future item would be to be able to drive the car with the normal bluetooth Wii-mote. This would make driving the remote control car a lot more naturally and a lot more like Nintendo's Super Mario Kart. This would allow us to get rid of one of the Orangutan boards, and would allow any user of the remote control car to simply use any Nintendo Wii-mote he has laying around.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