Intro

During our research into the different ways to convert the mechanical systems of a golf cart: steering, braking, and throttle, we came across a couple of ways that may be feasible considering our different constraints. The first of the two main ways that these modifications could come about is through transforming the physical-mechanical systems themselves into digital systems interfaced onto the cart. The second would be creating digital systems that interact with the current physical systems.

Steer-By-Wire

One approach to modifying the golf cart to add steer-by-wire capability consists of simply attaching a DC motor to the steering column. Connecting this motor to one of the embedded systems would allow the cart to steer through commands sent to the microcontroller. This option would be very straightforward and easily account for our need to manually override the steering if needed. If selected, important considerations to this approach include motor strength, attachment method as well as design.

Another approach to implementing steer-by-wire capability consists of utilizing a linear actuator to physically move one of the wheels itself rather than interacting with the steering column. This was the approach taken by Neil Nie in his second implementation of steer-by-wire functionality, outlined in his article "Autonomous Golf Cart Power Steering Using a Linear Actuator (Part 1)". However, in his implementation, Nie completely removed the steering wheel and column to do so, relying on controller joysticks for manual control. Provided that we have the option of overriding the linear actuator, we believe that it is possible to keep the existing steering system in place and implement a similar linear actuator system for steer-by-wire. If we decide to take this path for implementation, we need to do more research into linear actuators to determine if this option is viable, given our need for user override.

Brake-By-Wire

The main approach to modifying the golf cart to add brake-by-wire capability is to physically pull the brake pedal using a linear actuator. The way that we would accomplish this is by attaching a metal cable to a linear actuator that is stored right on top of the front wheel suspension. We would then drill a hole through the face plate of the cart and feed the metal cable through the hole attaching it to the brake pedal. The main benefits that come from this system are that we don't have to modify the physical braking system too heavily. This is especially helpful because completely overhauling the braking system would be extremely costly monetarily and time-wise. The knowledge needed to perform this would also be quite extreme considering the fact that we aren't mechanics experts. Another great thing about this implementation is that it allows the user to continue to use the break manually as they see fit. The great thing about using a linear actuator is that it gives us precise control over the brakes. The linear actuator can move at very small increments, which should prove extremely useful for slowing down precisely. The last great thing about this system is that in theory, it would use similar code to one of the steering implementations we are planning to consider. For this implementation to be successful we would have to perform research into the type of linear actuators that would work best with our golf cart and research which code bases work best for our uses.

Throttle-By-Wire

Through our research on numerous throttle-by-wire systems on self-driving golf carts and other autonomous vehicles, we have come to the conclusion that the best way to move forward is by using a digital potentiometer. All the golf carts that we are in consideration for this project control their throttle through the use of a physical potentiometer. The way that this sensor works is that there are three wires extending from the sensor. There is a signal wire, a ground wire, and a power wire. The signal wire is connected to a mechanical contraption called a wiper. This wiper slides across a resistive track that indicates how much the cart should throttle. As can be assumed from the name a digital potentiometer has the same functionality as the physical one just without any of the mechanical pieces. In theory, we should be able to use the digital potentiometer and an Arduino to control the throttle using code. However, if this endeavor deems too difficult there is always the tactic of physically compressing the gas pedal using some type of actuator. Although I will admit that we would have to get creative with this type of solution, due to the fact that there won't be much space to place more mechanical systems with how we plan on completing the brake-by-wire. The key to success on the digital potentiometer method is more concrete research in the steps required to program the potentiometer for our cases. Especially because the programming of digital potentiometer leans more to the electrical engineering side as we'll need to physically configure the board to work as a throttle. The next key would be to acquire the wiring document for the cart we plan on using, so we can properly interface the potentiometer and minimize costly wiring mistakes.

References

Autonomous Golf Cart Power Steering Using a Linear Actuator (Part 1) – Neil Nie

Conversion of a Formula SAE Vehicle to Full Drive-by-Wire Capability

Autonomous Ground Vehicle Prototype via Steering-, Throttle-, and Brake- by Wire Modules