Control System Integration for Automating an Electric Golf Cart

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Introduction – Project Intention

- Mount sensors and control systems onto an electric golf cart
- Test platform for deep learning algorithms
- Level four autonomous transportation system

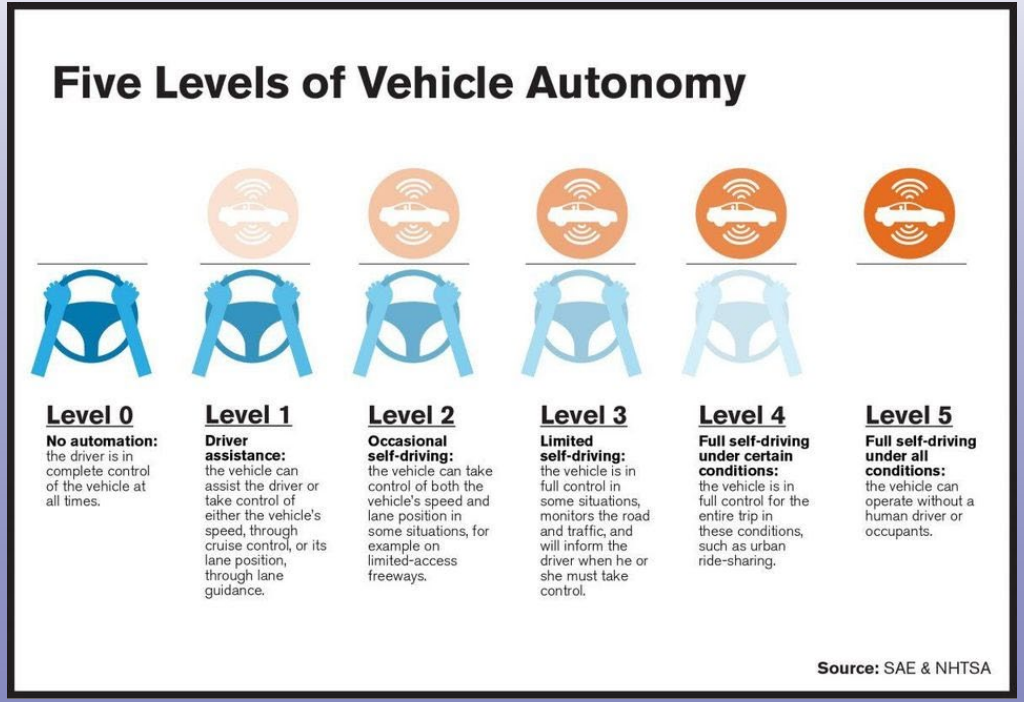

Figure 1: The 5 Levels of vehicle autonomy. Source: [1].

Scope of this Research Project

- Utilize existing systems
- Digital control of cart
- Peripheral sensors and GPS localization test platform
- Initial design to be remote controlled

Figure 2: University of Waterloo self-driving golf cart prototype.
Source: [2].

Existing Systems

- Cart electrical infrastructure is the base for devices [3]
- Previous work: steering and braking control
- Operator retains full control of vehicle
- Human operator systems still in place

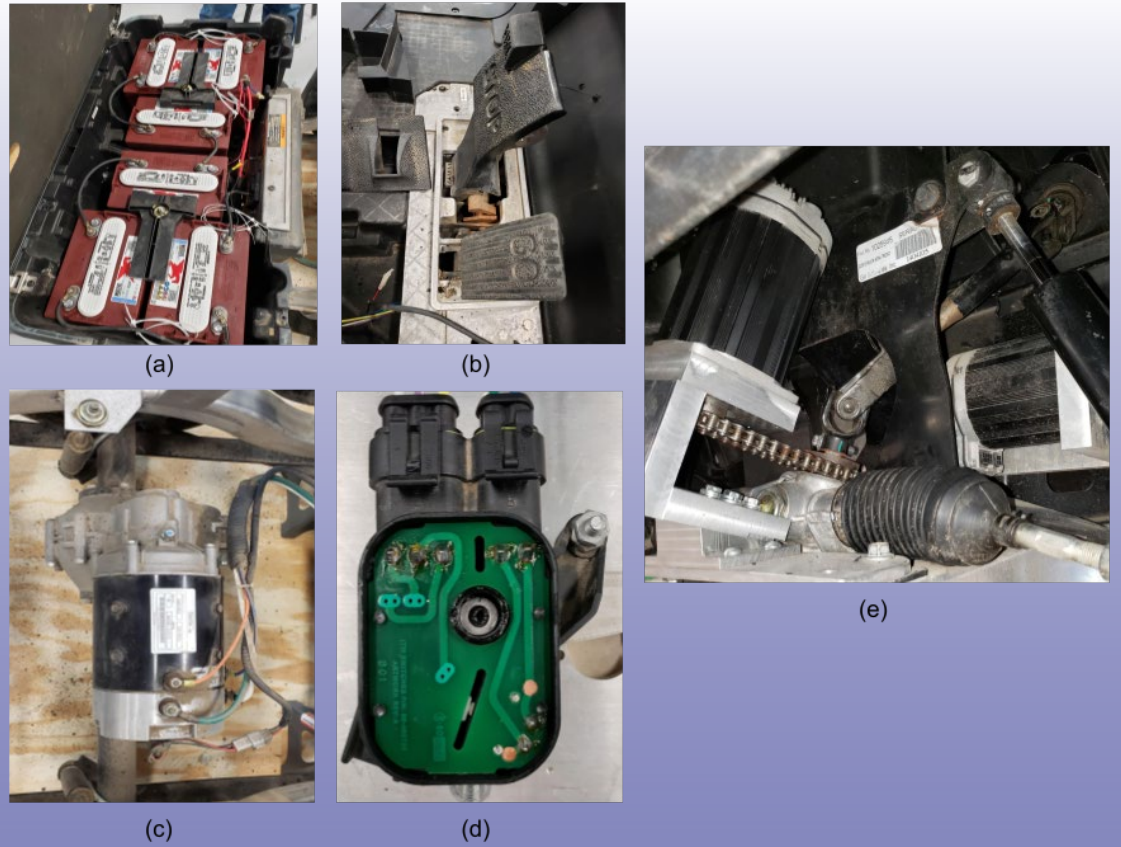

Figure 3: (a) Battery bank; (b) pedal assembly; (c) RWD 48V DC motor; (d) MCOR4 throttle controller; and (e) Teknic servos motors.

Methodology – Design Considerations

- Remote control (RC) initial design consideration
- First steps to achieving rudimentary cart autonomy
- Utilizing microcontrollers, RC transmitters/receivers, and control devices/circuits
- Steering, braking, and acceleration

Figure 4: Remote control transmitter for initial cart control.

Design Consideration Details

Control System Flow Chart Breakdown

- Visual layout of RC control
- Systems implemented with existing systems
- Device feedback necessary for optimization

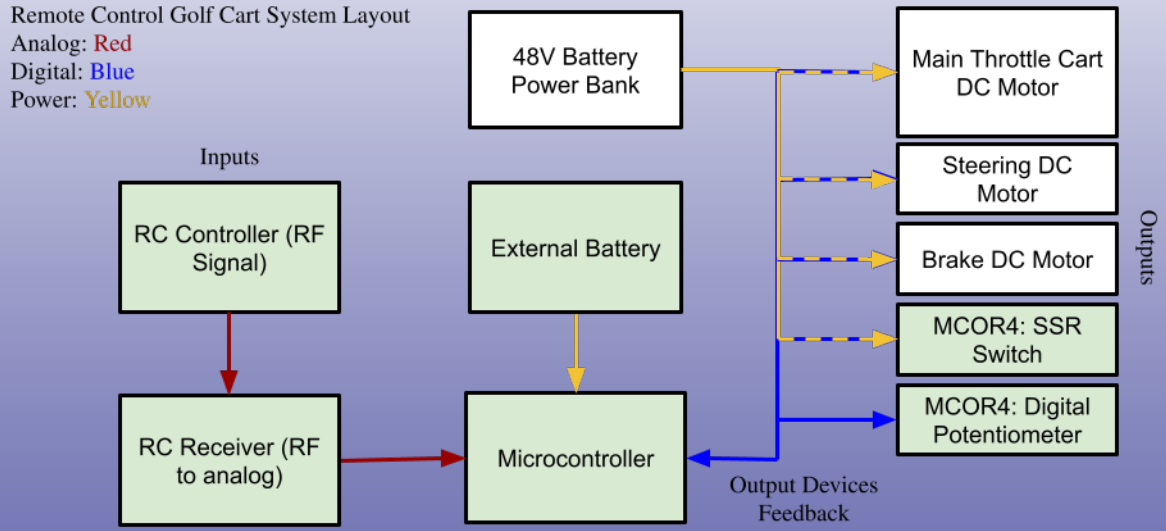

Figure 5: Control system logic flowchart. Green shading indicates new devices to be mounted.

Design Consideration Details

Device Mounting

- Locations of devices to be mounted on the cart:
  - M: Microcontroller
  - P: High-Capacity External Battery
  - A: MCOR4 Digital Implementations
  - B: Braking servo
  - S: Steering servo
- More devices and sensors to be added

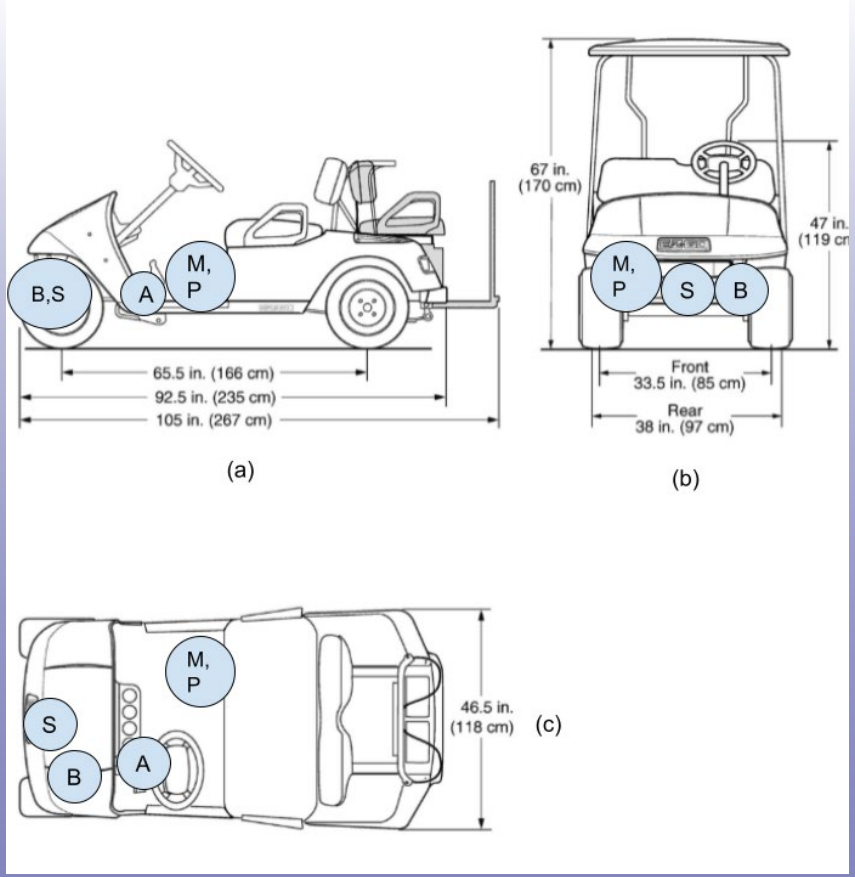

Figure 6: RC golf cart device mounting locations (a) side view; (b) rear view; and (c) top view. Source: [4].

Design Consideration Details

RC Control

- RC control via Arduino, servo motors, and controller
- At-home simulations done during lockdown
- Results determined next steps in control design

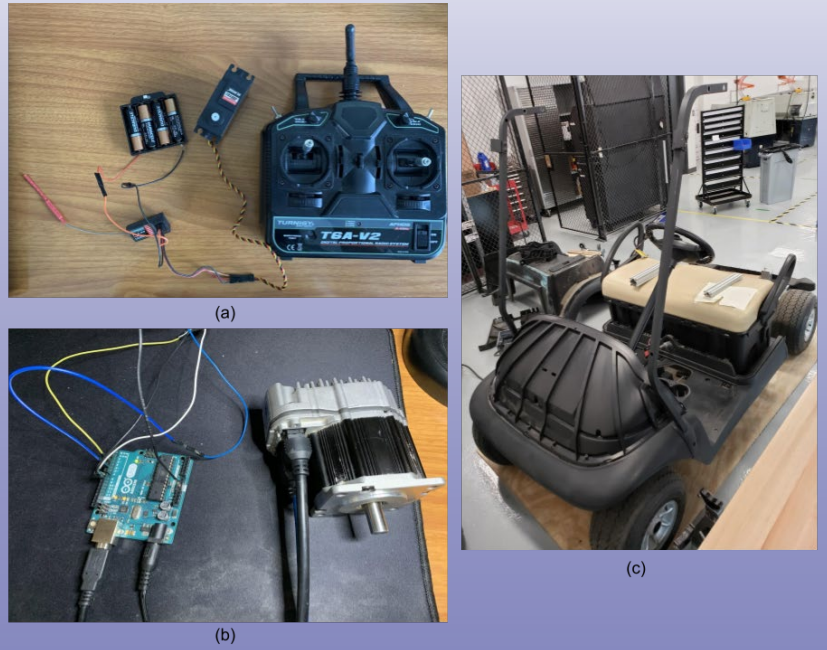

Figure 7: (a) Initial test setup of RC controller to servo communication; (b) Arduino and Teknic SDHP DC servo test; and (c) present day golf cart chassis.

Future Milestones

- Optimization of RC control
- Peripheral sensor mounting and calibration
- Rudimentary autonomous trials
- Localization and mapping

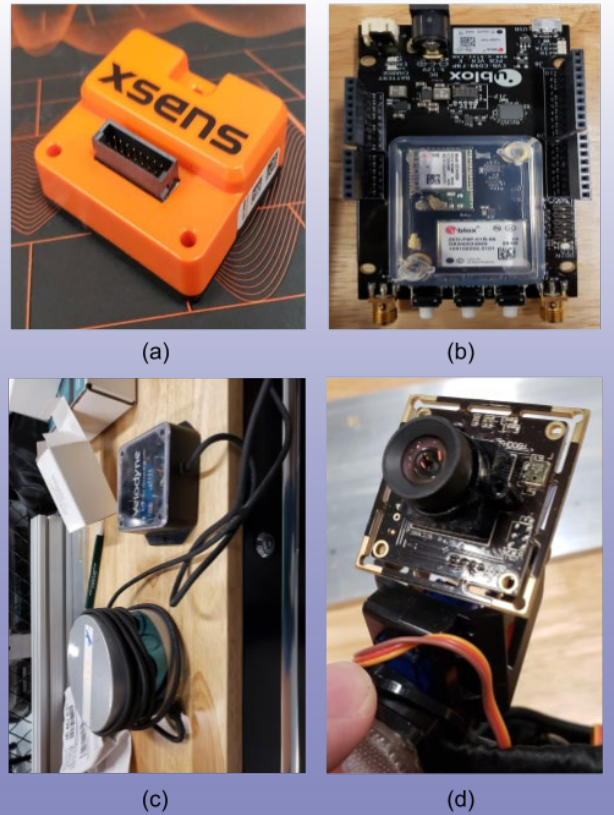

Figure 8: (a) Xsens IMU controller; (b) ublox GPS module; (c) Velodyne LiDAR puck; and (d) Sony digital camera.

Engineering Education

- Education topics:
  - Teamwork/Leadership
  - Project Management
  - Design Constraints
- 5 sub-teams of 5 or more undergraduate students
- Faculty and GA advisors
- Research of IEEE standards [5,6]

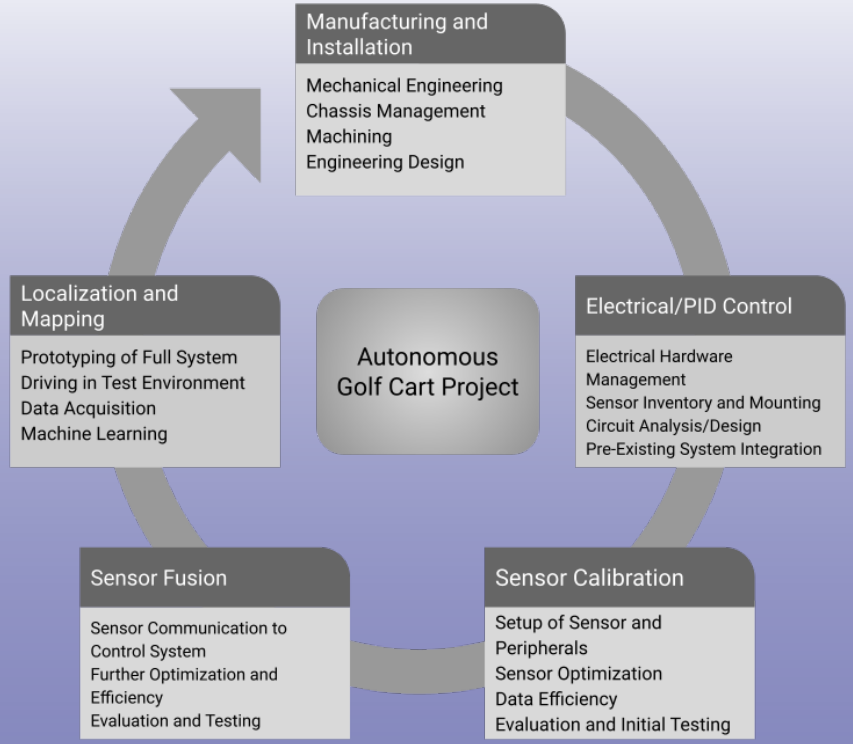

Figure 8: Project group sub team workflow.

Conclusion

- Pandemic required new viewpoints and approach to project design
- Next steps are to advance RC design and incorporate perhipherals sensors
- Continue research to achieve level 4 cart autonomy [1]

References

[1] SAE, NHTSA, & Governors Highway Safety Association. (n.d.). Retrieved from https://rb.gy/jb7w3o

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[4] GolfCartExperts, golf-cart-dimensions. golfcartforsales.com, 2020.

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Thank you!

Any Questions?