UW CIVIL AND ENVIRONMENTAL ENGINEERING HYDRO-CUB

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Background and Motivation

- The Washington State Department of Transportation (WSDOT) is tasked with inspecting sewers, culverts, and other water management infrastructure. Much of this work requires going deep into cramped tunnels or similar features that are not easy for humans to access. WSDOT is currently using small robots to inspect these spaces which are too costly to deploy at scale and potentially overengineered for their use case.
- Last year (Winter 2020), a team of students began working on the Hydro-CUB: an affordable, capable replacement for more expensive equipment. The team made some significant strides but, because of the COVID-19 pandemic, they encountered supply chain issues and other logistical problems that prevented them from completing a prototype. They were able to get a suitable body (an all-terrain RC car) for the prototype and program a microcontroller (ATMega) to control steering and motor speed/direction via a USB handheld controller. A pair of servos is also controlled by the USB controller and made to mount a 5-megapixel wifi streaming camera (Arducam). The team also successfully programmed a separate ATMega to operate an Arducam.

Previous team remaining issues

- Motor has 1 speed control, and it is extremely hard to control
- Wires is exposed to environment, potentially short the circuit in action, need waterproofing
- LED bar is located on the car rather than the camera itself, so possible poor light when camera not facing forward.
- Fiber communication is not implemented

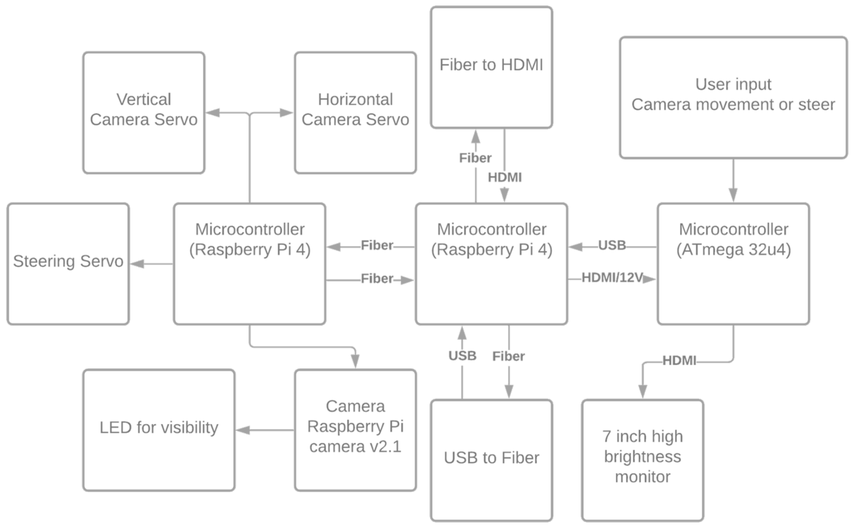
Design Goals

- Adjust the torque and speed for the motor to make smoother.
- Design a aluminium case around the circuit for waterproofing as well as heat dissipation.
- Implement a fiber connection between the car and the controller.
- Design a external controller for the worker enable live stream to a monitor.
- Custom 3D printing controller casing

System Requirements

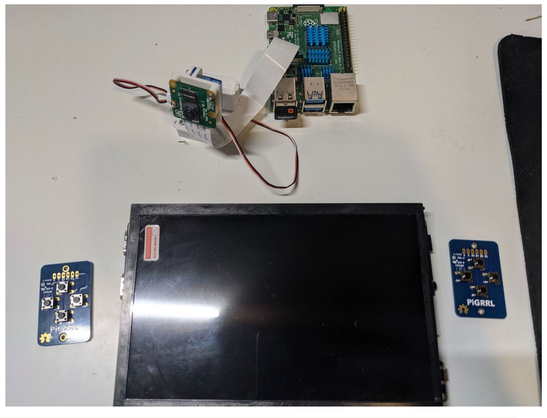
- The robot needs to be hand-portable for field work.
- The robot needs to have a good grip on uneven surfaces with the ability to handle up to 10% slope.
- The robot needs to be waterproof for working in water-based environments.
- The robot should have a minimum 30 minutes of running time.
- The robot needs a minimum of 300 ft. transmission distance
- The robot needs to focus on torque and power instead of speed.
- The robot needs a low center of gravity.
- The robot needs to be small to fit in a 3-4 ft. circumference pipe.
- The camera on the robot needs to have a resolution of at least 1 megapixel.
- The camera on the robot needs to be able to look straight down the front of the robot.
- The camera on the robot needs proper lighting so the robot's operator has a clear view.
- The robot should be controlled with a handheld remote for ease.
- The robot should use wired connection.
- The cost of the robot should be less than $5000 (USD) per robot.

Prototype Design Block Diagram



Result

- 3D printing prototyping is finished, in future, the part should be printed from other vendor for higher quality.
- Successfully program the raspberry pi to receive signal and control the camera via custom PCB
- livestream is available via wire connection



Future Work, References, and Acknowledgments

- implement long range communication via optical fiber (fiber is already ordered and fitted but not programmed)
- Currently the camera servo movement is jerky but looking to smooth it via software control (in progress until the end of this quarter)

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