UW CIVIL AND ENVIRONMENTAL ENGINEERING HYDRO-CUB

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WSDOT

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Background and Motivation

- Washington state's current infrastructure needs to be physically observed and assessed in order to determine the problems that need to be repaired and reworked, however not all of the sewers and culverts in Washington state were designed to allow a fully grown person to easily access them.
- Currently, our client (WSDOT) uses a bot called the HIVE bot that was originated from the Minnesota Department of Transportation. The HIVE bot is used to go into and record inspections of culverts around Washington state.
- Our task was to assess the issues with the HIVE bot and to improve the current design through a prototype design.

Issues With The HIVE Bot

- The Sony HD Action camera allowed access to live stream video recording of the bot during the culvert inspection with a Wi-Fi dependent iOS application, however this prevented the bot from going through the entire length of the culvert without losing connection.
- The cameras had a limited range:
- The servos, which controlled the cameras, had a limited horizontal angular range of motion of ~45 ° from its neutral position; they did not utilize the full 180° angular range of motion.
- The HIVE bot had loose wires and a battery pack that was not securely attached to the body which posed safety hazards as the bot is used in wet environments.
- Poor speed control, only had 1 extremely fast speed.
- Low suspension: electronics were closer to the water during operation which posed a safety hazard. The bot also had poor surface traction.

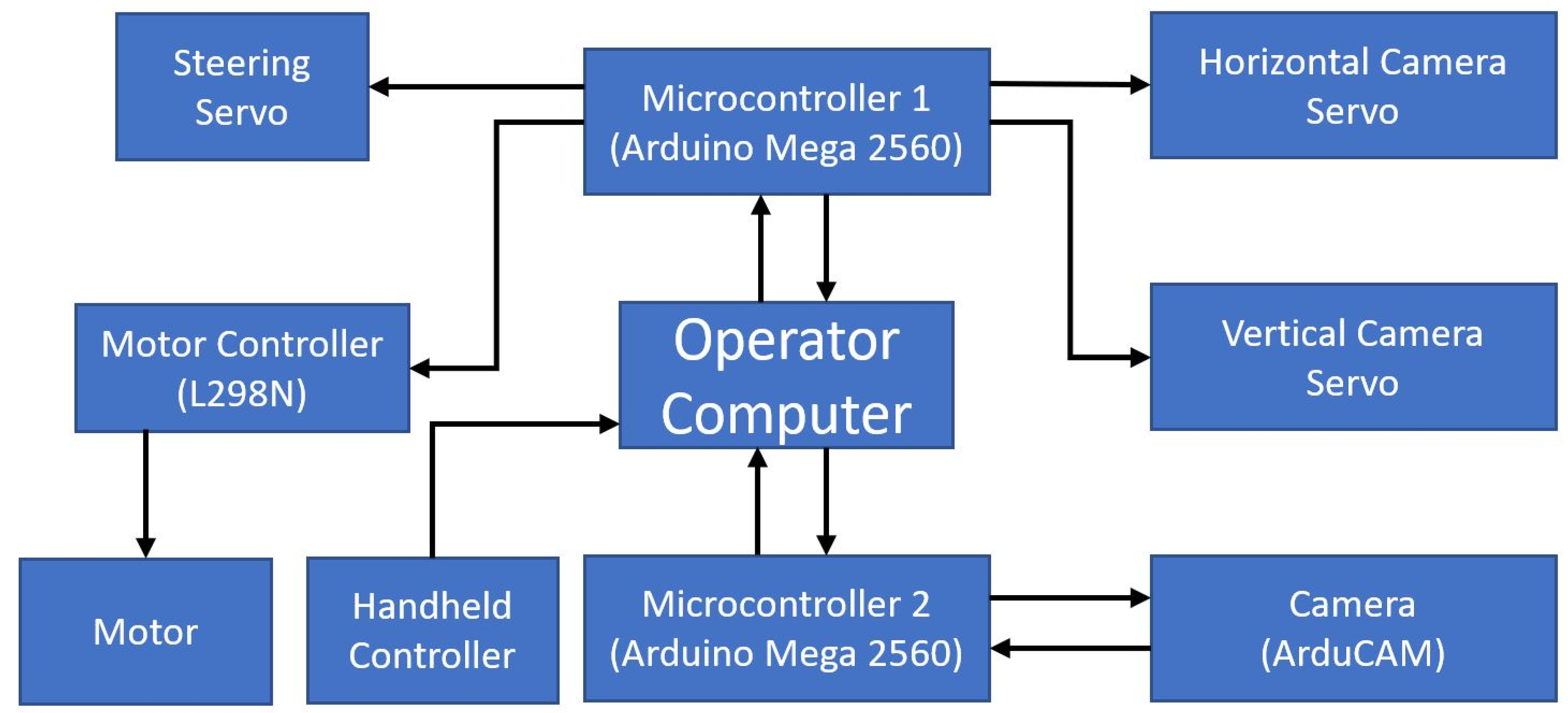
Prototype Design Goals

- Overview: make prototype design of a bot that will be used in the future for field testing purposes and to assess features for the final design. Our prototype will focus on the following improvements to the current HIVE bot design:
- Implementing variable speed drivetrain
- Improving servo movement to give the camera a wider rotation angle placement of cameras for the most optimal view.
- Make the bot all terrain.

System Requirements

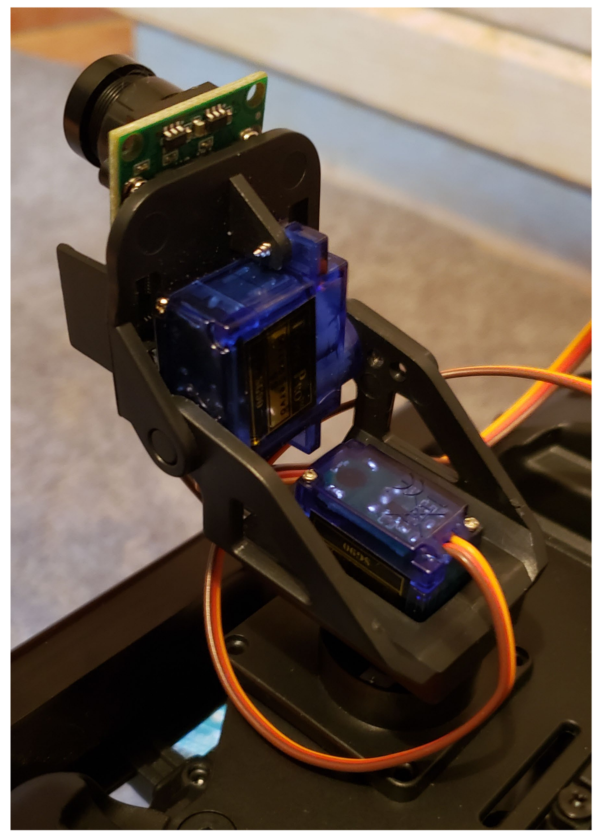
- The robot needs to be hand-portable for field work.
- The robot needs to have a good grip on uneven surfaces with the ability to handle up to 10% slope.
- The robot needs to be waterproof for working in water-based environments.
- The robot should have a minimum 30 minutes of running time.
- The robot needs a minimum of 200 ft. transmission distance, the longer the better.
- 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 not depend on Wi-Fi.
- The cost of the robot should be less than $5000 (USD) per robot.

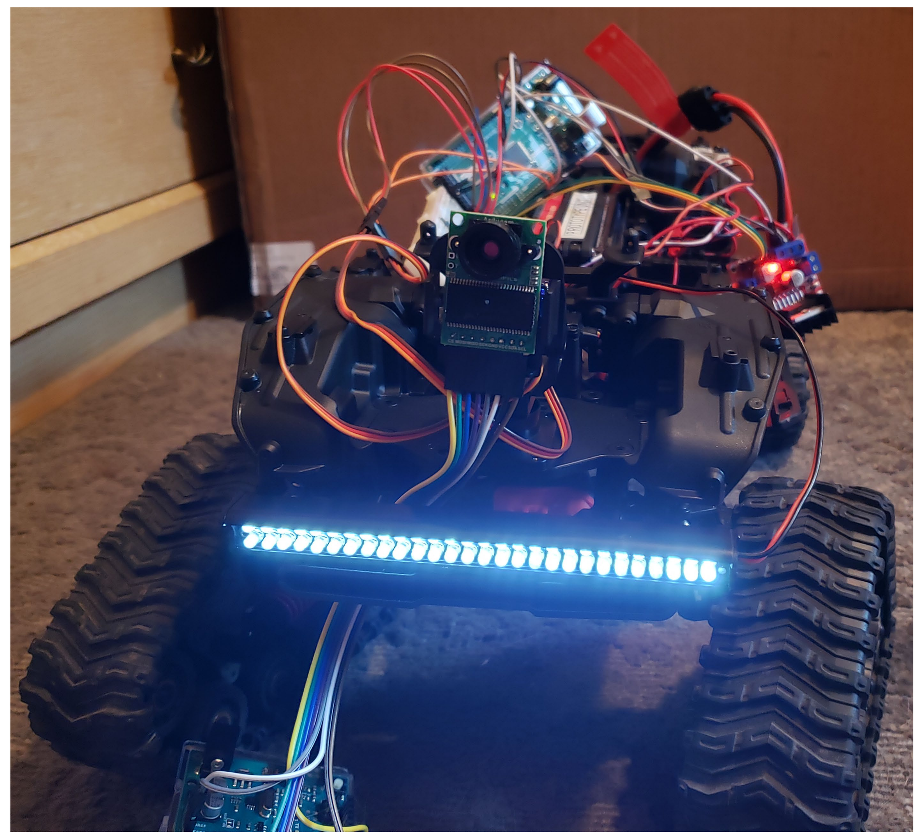
Prototype Design Block Diagram

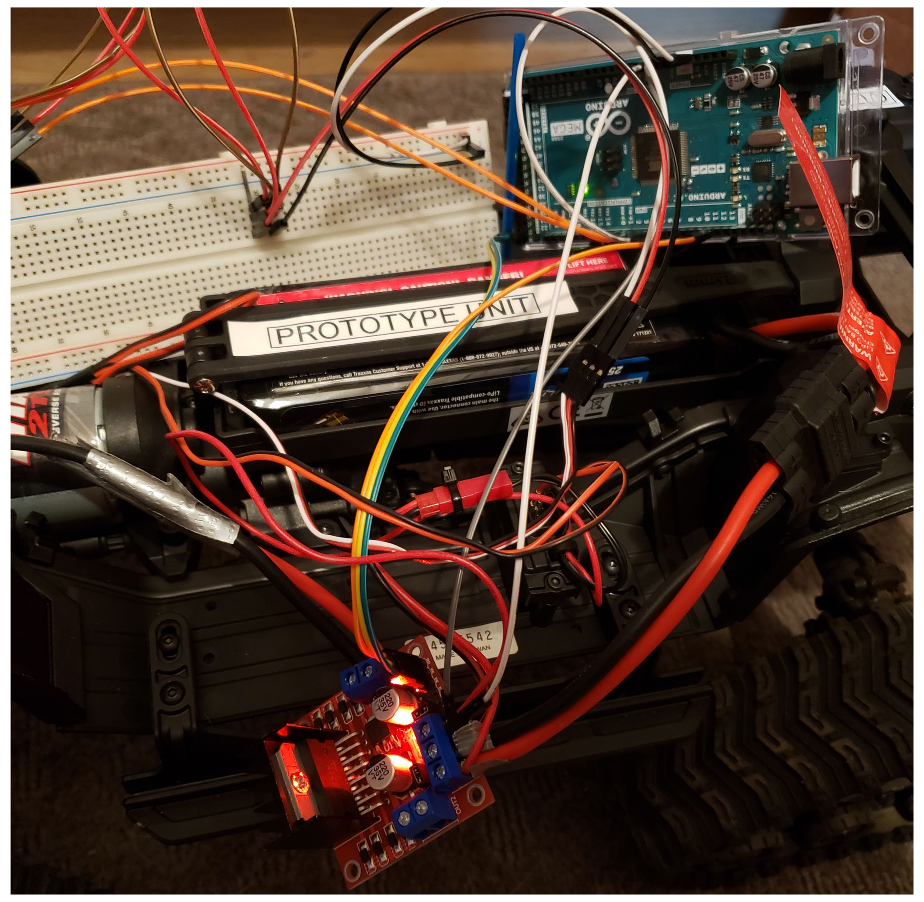


- To control the robot, a handheld controller (currently an Xbox controller) will be used.
- A computer will be used for overall control of the robot. The computer will display the visual feed from the camera as well as take the input from the controller and send it to the robot.
- Two Arduino Mega boards are used as microcontrollers, one for the camera and another for the servos and motor.
- The robot uses three servos: two control the horizontal and vertical movement of the camera, the third controls the steering of the robot's wheels.
- To control the motor's direction and speed, a L298N motor controller is used.

Results/Pictures







- Our prototype identifies the strong points of our initial design, as well as weaknesses that will be worked on by future teams.
- We have provided an extensive list of suggestions and advice on how to improve this initial design for a final product.
- Basic functions, such as operation of the camera, movement of the camera, and steering have been completed.
- We have provided the groundwork for another capstone team to pick up where we left off.

Future Work, References, and Acknowledgments

- Implement fiber optic cable for power, USB, and as recovery cable
- Replace Ardu-CAM with a camera that works with live stream recording
- Full on-site testing at culvert

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