Sidewalk Inspection System

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Faculty Advisor: Cao Tran (ME/EE Advisor), Dr. Jung-Soo Lim (CS Advisor)
Liaison: Public Works – Bureau of Engineering

Departments of Electrical & Mechanical Engineering
College of Engineering, Computer Science, and Technology
California State University, Los Angeles

BACKGROUND

The city of Los Angeles has over 11,000 miles of sidewalk that requires examination for cracks and displacements. Sidewalks provides access to pedestrian according to the Americans with Disabilities Act of 1990 (ADA). It is an essential city infrastructure which provides convenience for urban life. The Sidewalk Inspection System will help the survey of the 11,000 miles of sidewalk for the city of Los Angeles.

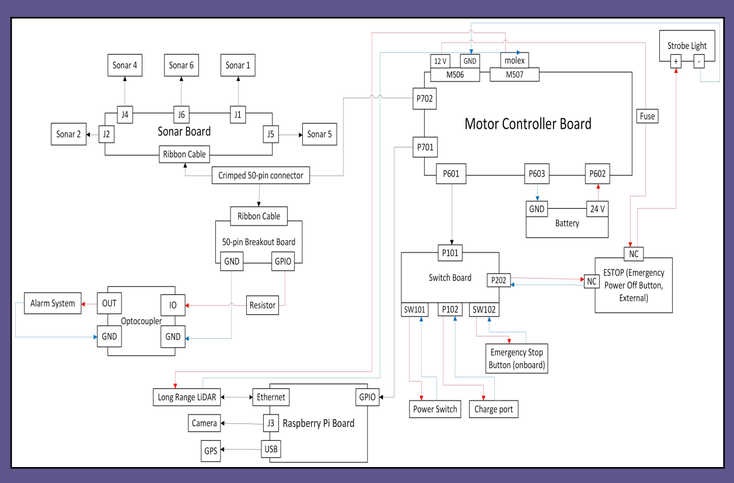
OBJECTIVE

- The ME & EE team will work alongside CS team to build mounts and apply safety precautions to the rover by adding an alarm system, emergency stop button and strobe light for operational use.
- The CS team will develop an automated rover designed to scan and measure vertical displacements between concrete slabs by using point cloud data.

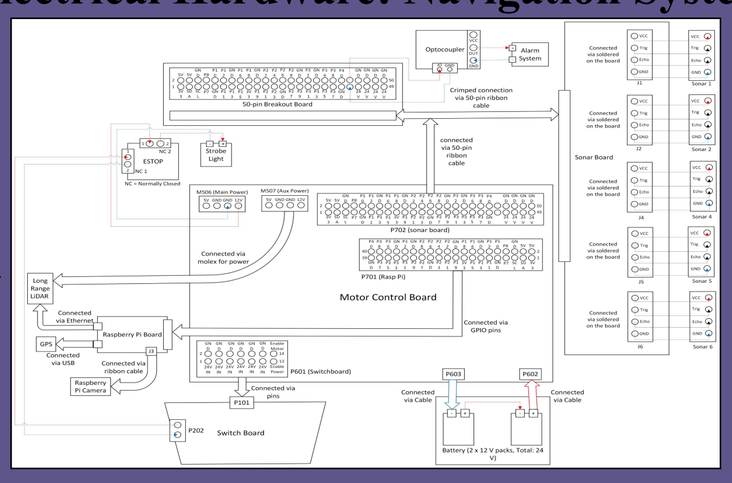
IMPLEMENTATION

- Proceed with tests, adjust wiring, mount angles, and assist the CS team with the hardware and certain software for the sidewalk inspection system.
- Applied all mounts, alarm system, emergency stop button, and strobe light at the end of the semester to ensure public safety

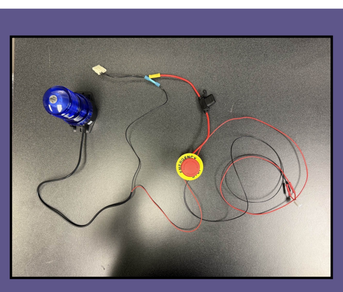
Electrical Hardware: Navigation System



Phase 1: Overall Design of the Navigation System

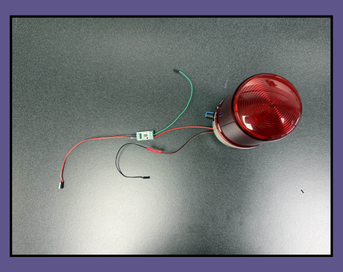


Phase 2: Wiring Diagram which have specific connections between components



Strobe Light & ESTOP

- The 1st normally closed switch uses 12 V to run it through a fuse (for protection) into the ESTOP & powers the strobe light and back to ground.
- The 2nd normally closed switch goes into the switch board where the ESTOP purposely shorts the connection

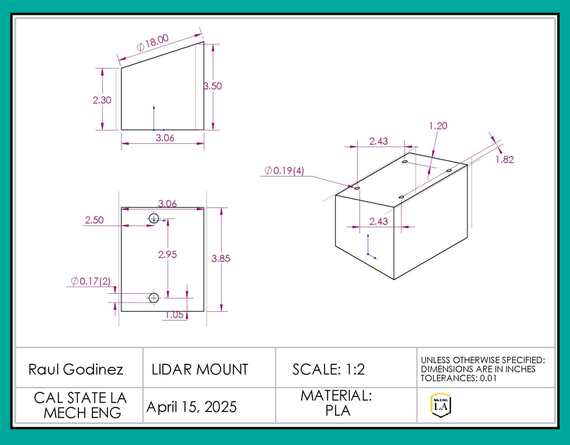


Alarm System

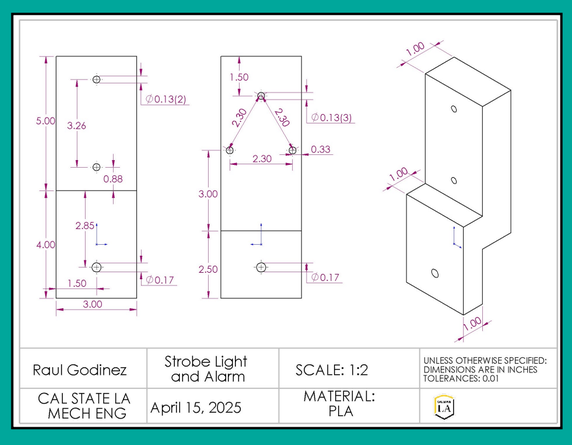
- Uses the two GPIO pins (one for 5 V and one for ground) from the Raspberry Pi to connect to the optocoupler.
- Uses 24 V (from sonar pins) to connect to the output of the optocoupler & use the alarm system to connect to it to ground

Phase 3: Final Implementation

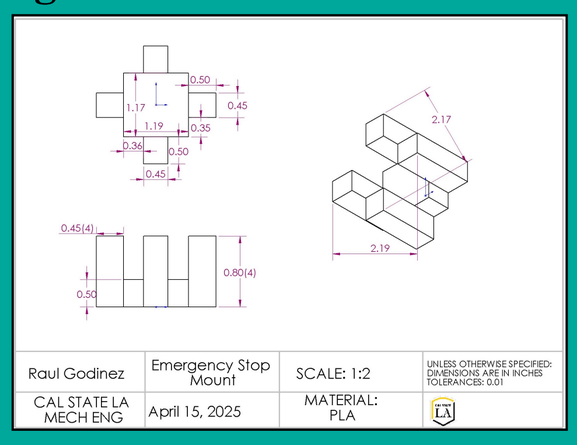
Mechanical Design: Mounts



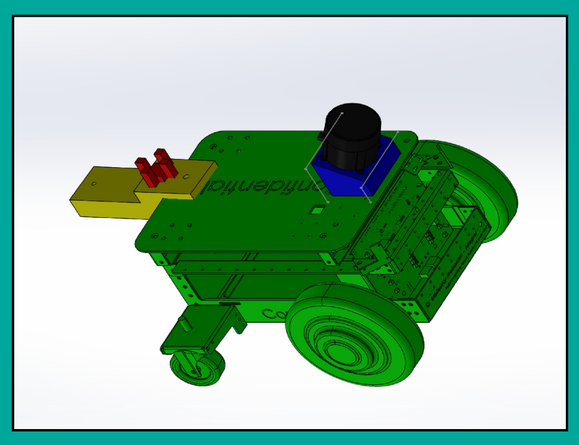
SolidWorks Drawing: LiDAR Mount



SolidWorks Drawing: Strobe Light & Alarm Mount



SolidWorks Drawing: Emergency Stop Button Mount



SolidWorks Assembly: Full Rover System

CS Team: Vertical Displacement



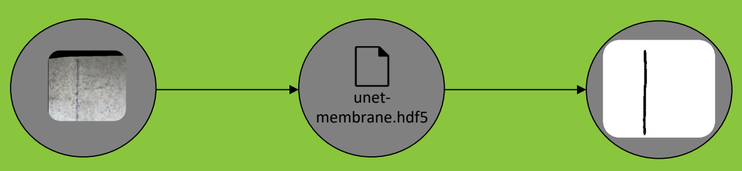
Step 1: Scan Point Cloud Data

- Using an iPhone Pro Max, 3D scan can be acquired in a point cloud data of a surface



Step 2: Orthoimage and Elevation Imaging

- Preprocessing the image, we can extract the orthoimage and elevation images



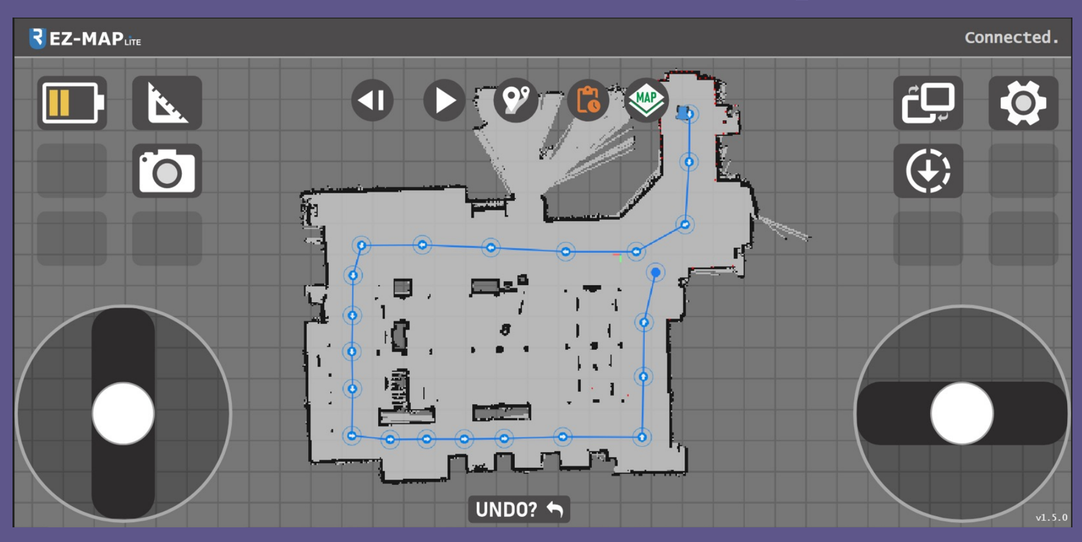
Step 3: U-Net Segmentation

- By applying U-Net, the program takes the orthoimages into a segmented data.

Step 4: Overlay and Vertical Displacement

- Combining the segmented images and elevation images, vertical displacement can be calculated at each joints.

Electrical Software: EZ Maps



A complete map of the Electronics Lab using the LiDAR to scan and map the area. Uses the sonar to avoid any obstacles by using the implemented collision detection. Uses pinpoints to navigate throughout the area

ACCOMPLISHMENTS/RESULTS

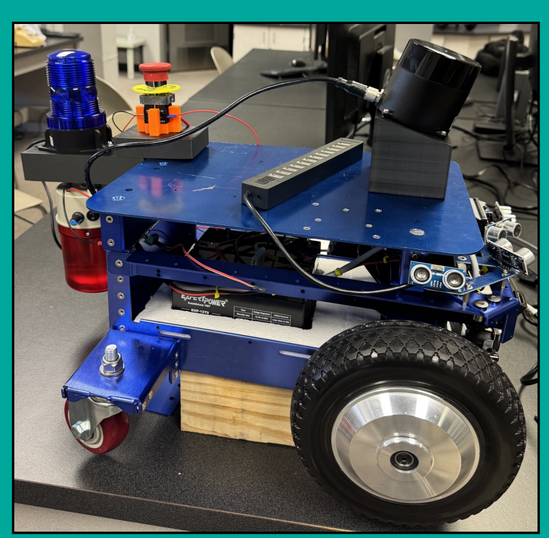
Mechanical Engineer:

- Updated LiDAR mount for better visual on the sensor
- Improved Emergency stop button mount
- Enhanced Strobe light mount and worked on integrating alarm system to same mount to reduce material

Electrical Engineer:

- Apply EZ Maps navigation software onto the sidewalk inspection system
- Design and install the emergency stop button, strobe light during operational use, and an alarm system for collision detection.

Final Product



Special Thanks!

Makerspace
CAL STATE LA
COLLEGE OF ECST

UBIQUITY ROBOTICS

CIRCUITSPACE
College of Engineering, Computer Science, and Technology
ECE CSULA