Slope Stabilizer Robot Project Proposal

Sara Chung, Raymond Shen

Use Case

Problem:

- Restaurant wait staff to carry drinks up slopes, increasing the risk of spills and affecting service quality, while posing as an increase risk of injury to the staff.
- Companies handling hazardous chemicals need a way to transport materials while keeping them stable and minimizing human exposure to dangerous substances.
- Traveling on slopes leads to a higher risk of spills and injuries.

Solution: Self-stabilizing delivery bot capable of transporting hazardous materials on slopes while adjusting to movement and weight changes to prevent spills.

ECE: Software, Hardware, FPGA, Robotics

Requirements

Core Functional Requirements:

- **Load Capacity:** Carries 1 to 4 cups of water
- **Slope Handling:** Can move on slopes ranging from 0° to 60°.
- **Spill Prevention:** Ensures that a 90% full glass has no spillage.
    - More water in the cup, the more stable the robot is
- **Speed Consistency:** Travel speed of 1 ft/sec across different loads.

Technical Challenges

Accuracy of IMU data

- Cheap IMU data is not very accurate
- May need to use additional sensors or purchase more expensive IMUs

Autonomous drive while testing

- Robot needs to move autonomously from sensor feedback

Using FPGA as the control unit for the robot

- FPGA needs to handle sensor data and perform calculations to determine the platform and wheelbase motor output

Technical Challenges (cont.)

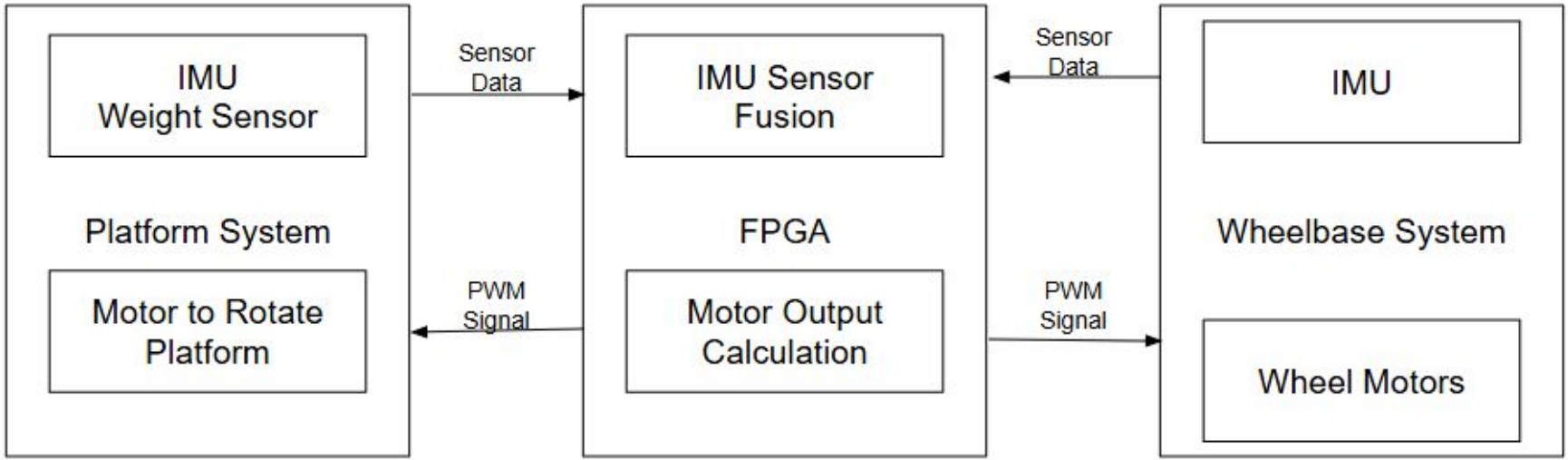
Needs to move at a constant speed, regardless of weight

- Will utilize a weight sensor, so that the motor output can be calculated to accommodate varying weights

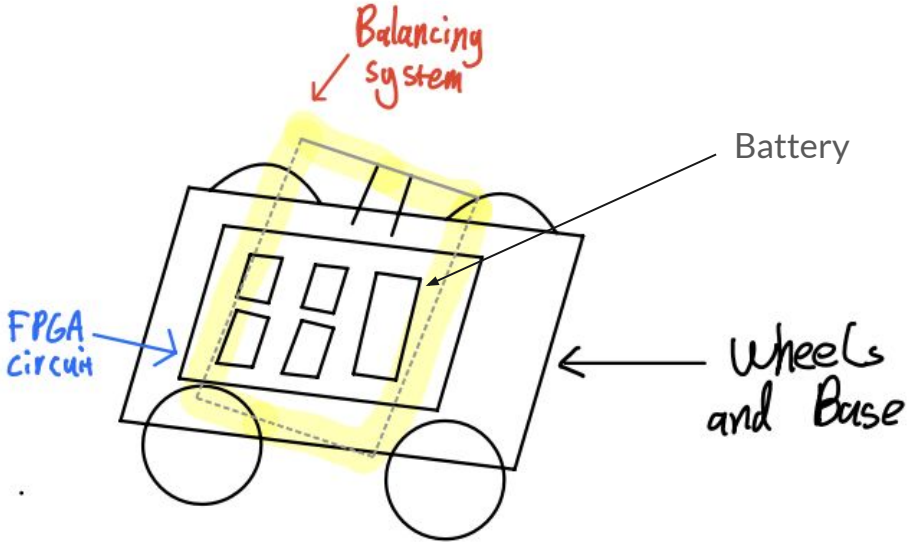
Needs to change angle of platform to balance water while moving

- Fast, real time calculations need to be performed to ensure the water doesn't spill
- A flat surface may not always prevent spilling; may need to account for the acceleration and speed of the robot and angle the platform to counteract

Solution Approach: FPGA & Sensors



Solution Approach: Bot Design



Testing

FPGA Unit Testing

- Test that the FPGA is capable of driving the wheels
- Test that the IMU data can be received by the FPGA
- Unit test the FPGA modules necessary to drive outputs

Robot Tests

- The ramp can vary its slope from 0 to 60 degrees
- Robot capable of driving from flat surface onto ramp
- Platform changes angles depending on angle of robot wheelbase

Verification

Functional Verification

- The robot should move up the ramp at a constant speed of 1 ft/sec, regardless of slope
- The robot should balance water without spilling while driving up ramp, regardless of slope
- While stopped, the robot should be able to maintain its position on the ramp, while the ramp changes its slope
- While stopped, the robot should be able to balance the water without spilling, while the ramp changes its slope

Division of Labor

Sara Chung - Hardware

- **Circuit Design** - linking all components
- **Power System** - battery to power the bot
- **Robotics** - base & wheels, stabilizing system

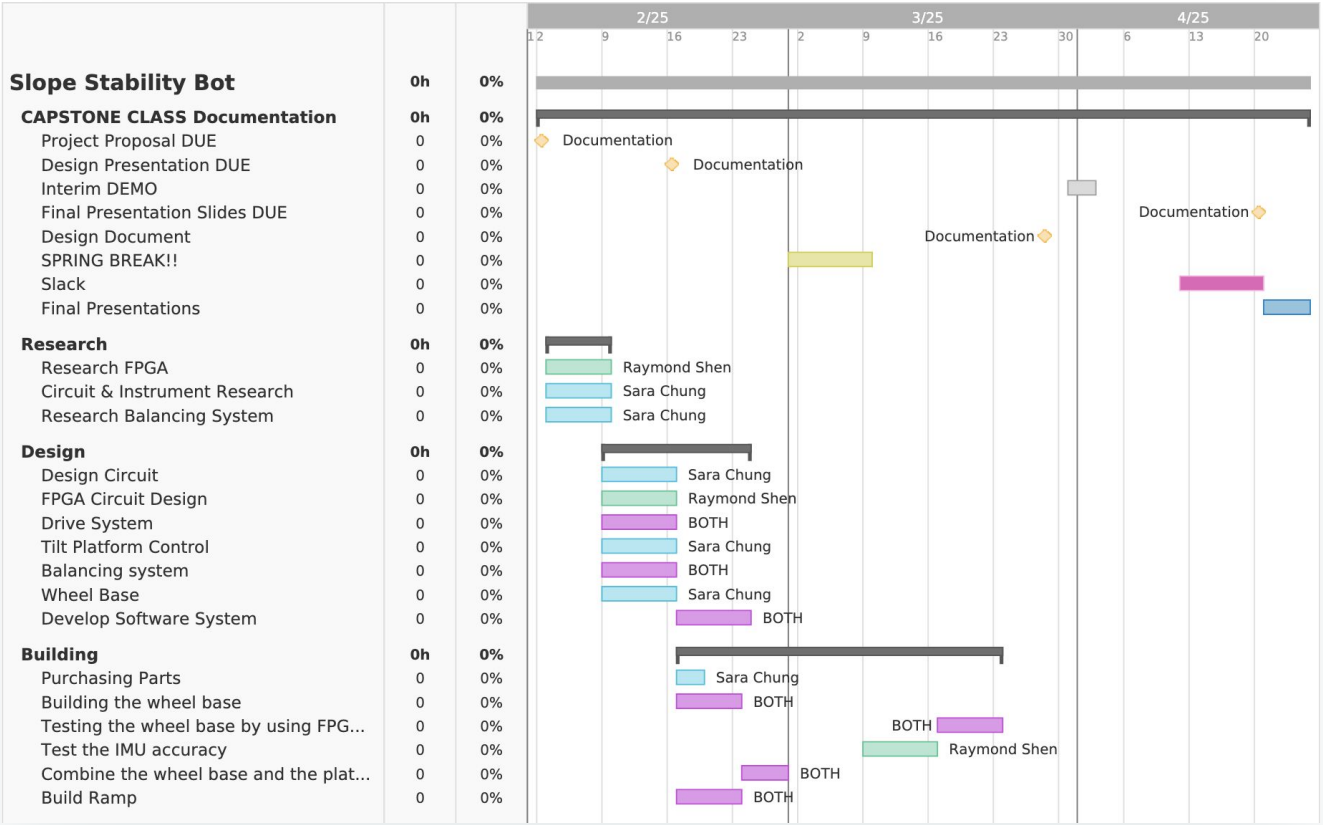
Raymond Shen - Hardware

- **FPGA** - Control Unit of the System
- **Sensors** - IMU & Weight Sensor

Both

- **Software** - Robot Movement and Sensor Data Analysis
- Testing our Bot

Schedule


2/25
3/25
4/25
12
9
16
23
2
9
16
23
30
6
13
20
Slope Stability Bot 0h 0%
CAPSTONE CLASS Documentation 0h 0%
Project Proposal DUE 0 0%
Design Presentation DUE 0 0%
Interim DEMO 0 0%
Final Presentation Slides DUE 0 0%
Design Document 0 0%
SPRING BREAK!! 0 0%
Slack 0 0%
Final Presentations 0 0%
Research 0h 0%
Research FPGA 0 0%
Circuit & Instrument Research 0 0%
Research Balancing System 0 0%
Design 0h 0%
Design Circuit 0 0%
FPGA Circuit Design 0 0%
Drive System 0 0%
Tilt Platform Control 0 0%
Balancing system 0 0%
Wheel Base 0 0%
Develop Software System 0 0%
Building 0h 0%
Purchasing Parts 0 0%
Building the wheel base 0 0%
Testing the wheel base by using FPG... 0 0%
Test the IMU accuracy 0 0%
Combine the wheel base and the plat... 0 0%
Build Ramp 0 0%
Documentation
Documentation
Documentation
Documentation
Raymond Shen
Sara Chung
Sara Chung
Sara Chung
Raymond Shen
BOTH
Sara Chung
BOTH
Sara Chung
BOTH
Sara Chung
BOTH
Raymond Shen
BOTH
BOTH

Minimum Viable Product

Our bot must ascend a **slope ranging from 0° to 45°** while carrying **a glass of water**, maintaining a speed of **1 ft/sec** without **spilling a cup that is 90% full**.