SafeVision

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The Problem

SafeVision

- Robotic arm with camera attached used for surgeries.
- The arm can collide with patients, doctors and equipment.
- The arm will stop, but only after running into something.
- If only there was some way to stop *before* hitting something...

Applications

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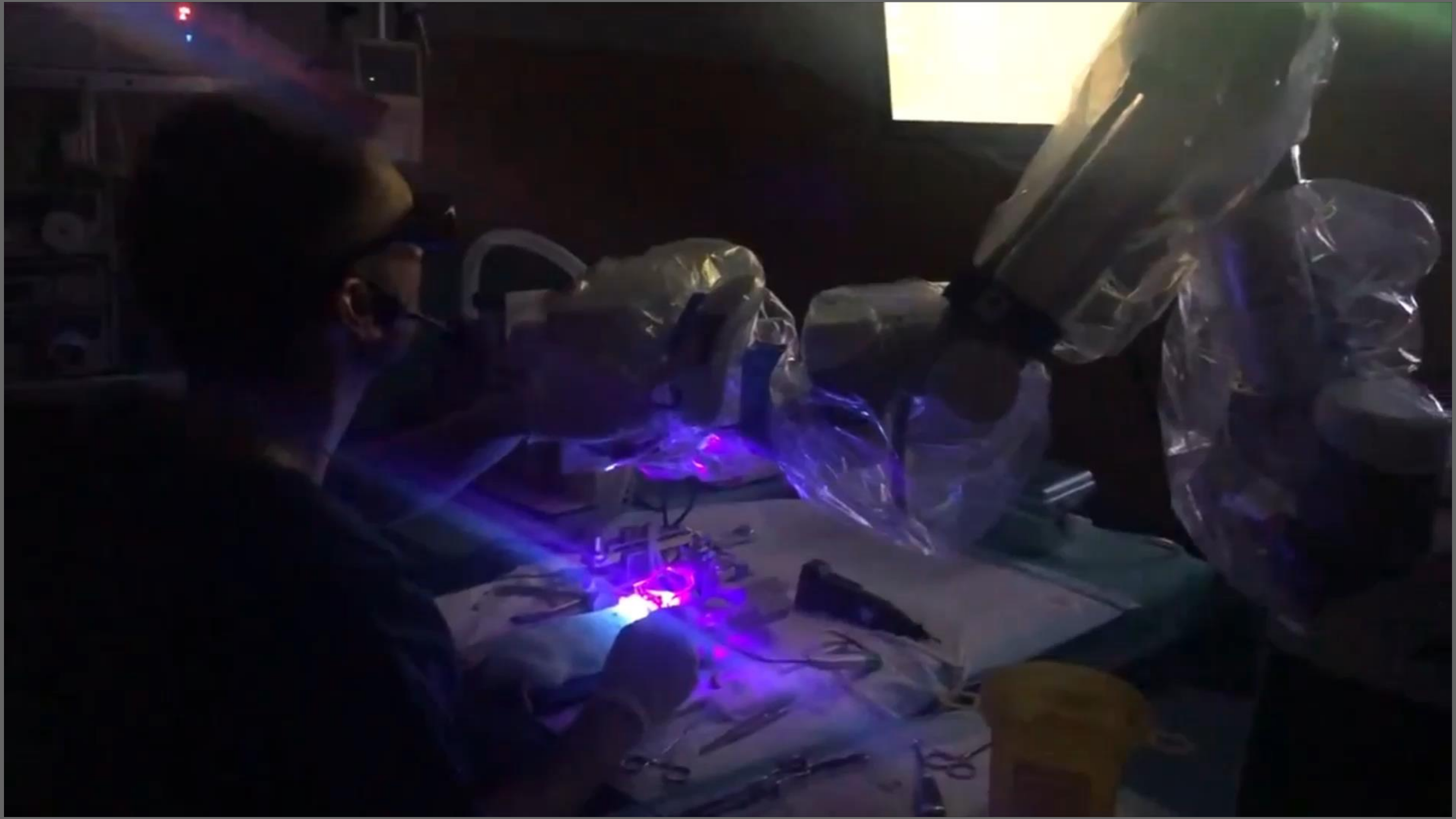
- Assisted Drive
- Free Drive
- Rest Mode
- Remotely Controlled



Requirements

- Prevent object collision
- No unexpected movements
- No purely autonomous motion
- All parts have to be approved for medical environments

The Solution

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- Create spatial awareness using a matrix of distance sensors
- Check sensors in direction of movement
- Stop movement if an object is detected

Project Description

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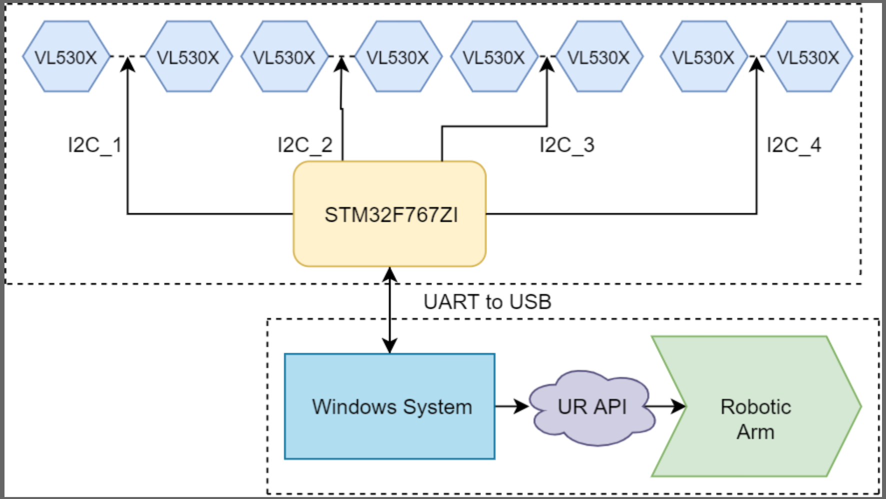
- Microcontroller
  - Optical Distance Sensor
    - I2C
  - Send distance data to the main system through UART
- Main Window System
  - Process distance
  - Control the robotic arm.



System Expectations

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- Detect people and objects before colliding.
- Take measurements at least 2Hz.
- PCB must be small enough to fit on the joint of the arm.

Processor

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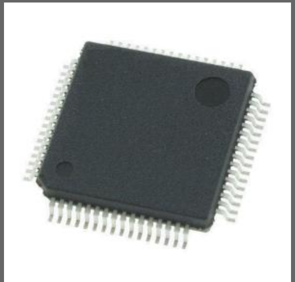
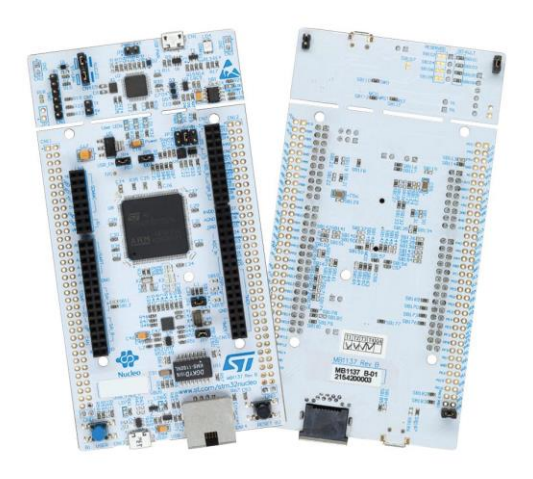
STM32F767ZI

- High-performance
- DSP with FPU
- M7 processor with 216 MHz clock and floating point instructions
- 4 - I2C busses
- UART communication
- ST Link Debugger

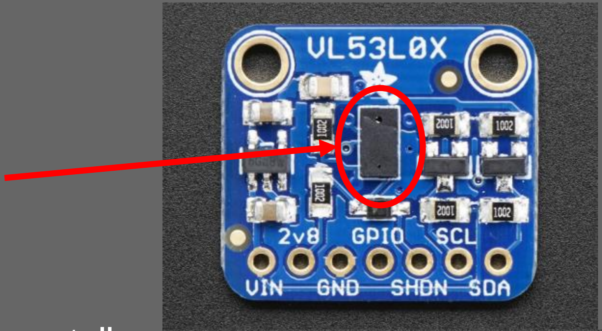


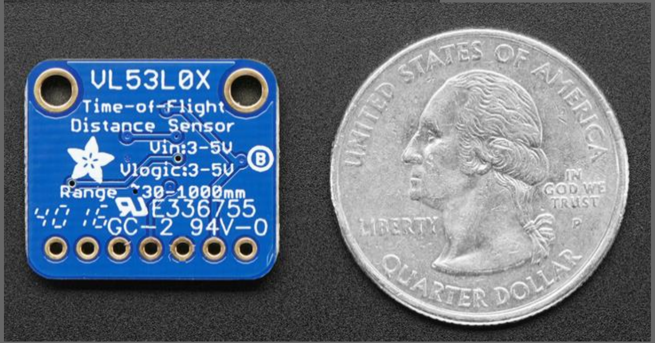


Sensors

VL53L0X Time of Flight Sensor

- Takes 20ms to get measurement.
- Accurate from 2.5 cm to 80 cm (experimentally verified).
- Communicates over I2C.





Testing

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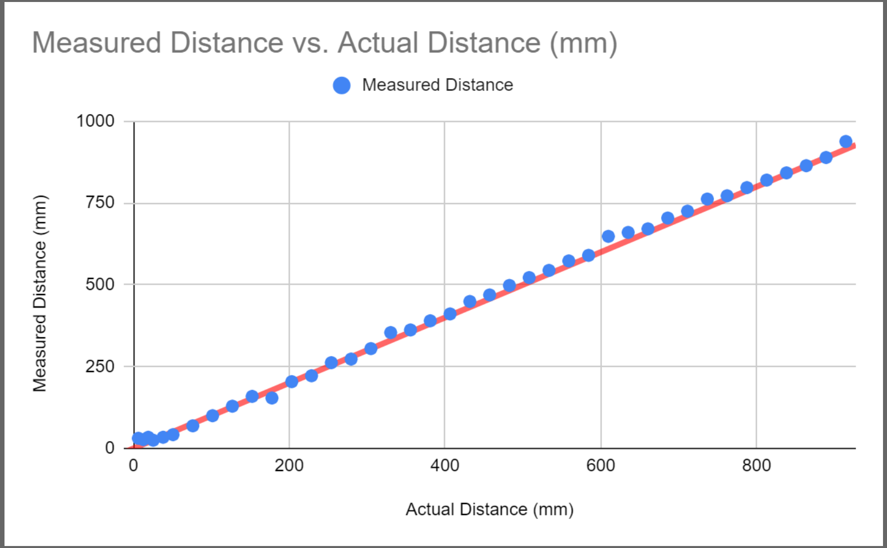

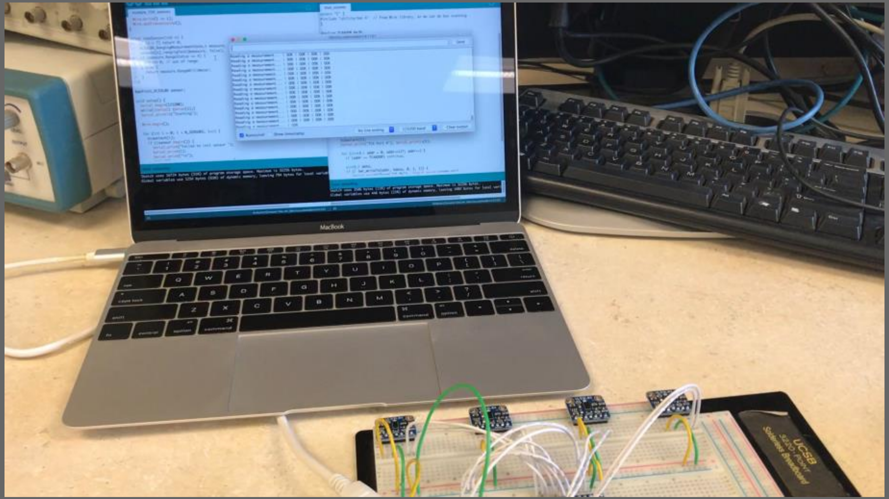

Overall Project Structure

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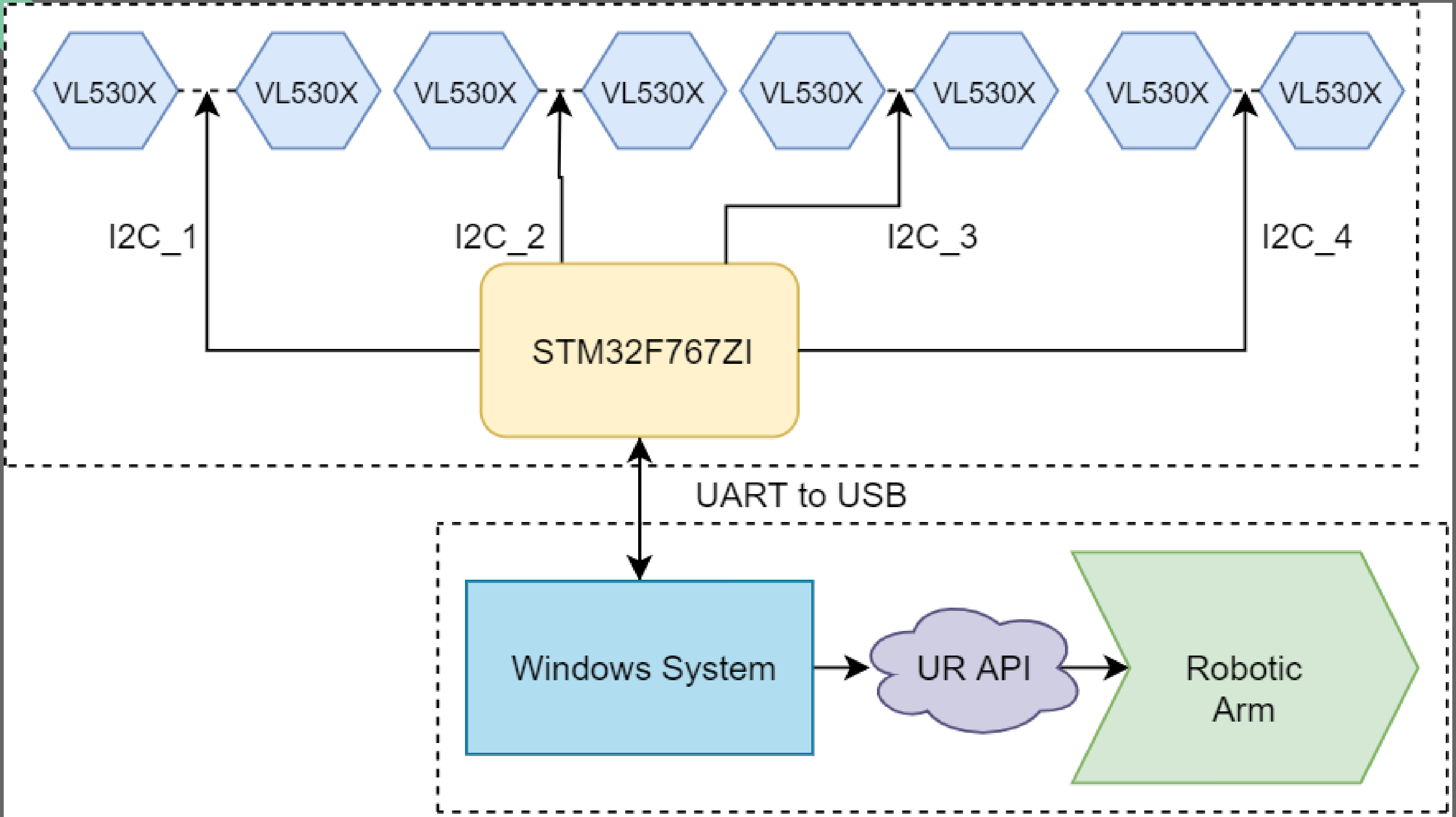

Microcontroller Software Structure

- Init Peripherals
- Setup VL53L0X Sensors and update device addresses
- Start OS Scheduler with 4 thread using RTOS
- In each thread,
    - Responsible for different I2C bus
    - Collect distance data from all device on the bus
    - Send distance data to the main window system through UART.
        - Each data point is labeled with a UID
- Mainly focus on optimizing the code to decrease the total read time.

More Testing

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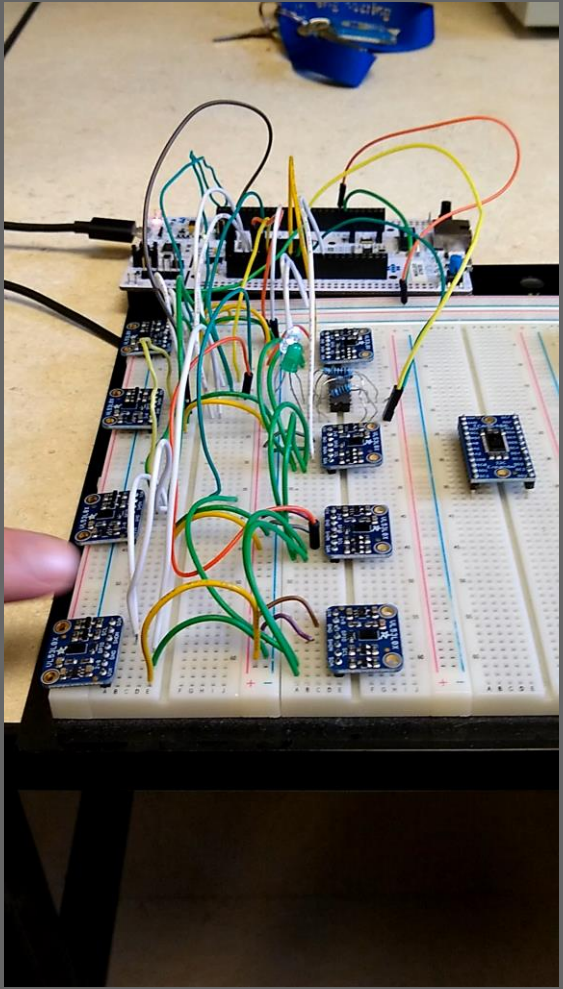

Windows System Software Structure

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- Process data received from the microcontroller
- Main System ←→ Universal Robot Arm
  - Communicate through API calls
  - Receives information of the arm’s position and movement direction
- Use data from microcontroller and arm to determine if an object is in the path of motion.

UR Simulator

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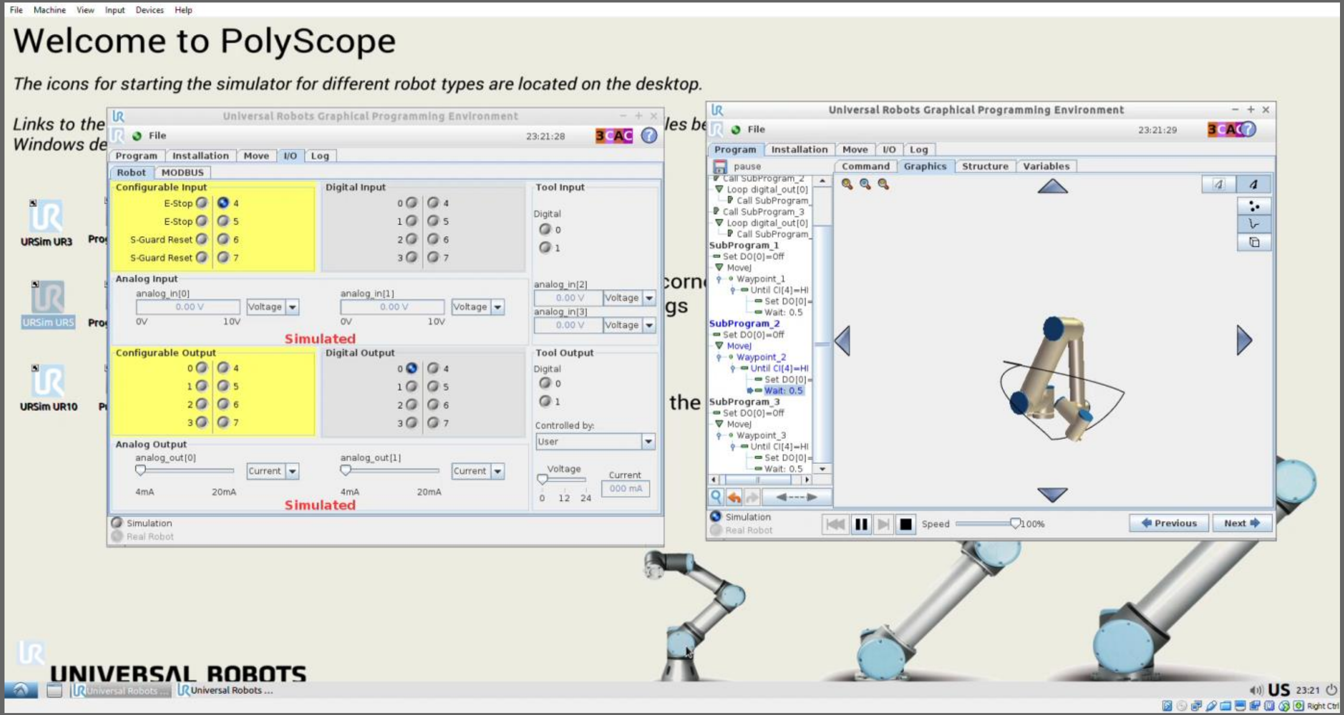

Welcome to PolyScope

The icons for starting the simulator for different robot types are located on the desktop.

Links to the ... Windows de...

Summary

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- Experimented with different sensors and decided that VL53L0X will be satisfactory for our project
- Tested on a Arduino and STM32 development board
- Tested software functionality of the processor to match project needs
- Picked out the processor and started designing the PCB
- Tested and decided on communications between interfaces
- Set up a test movement program in UR simulator to be stopped through an input

Goals

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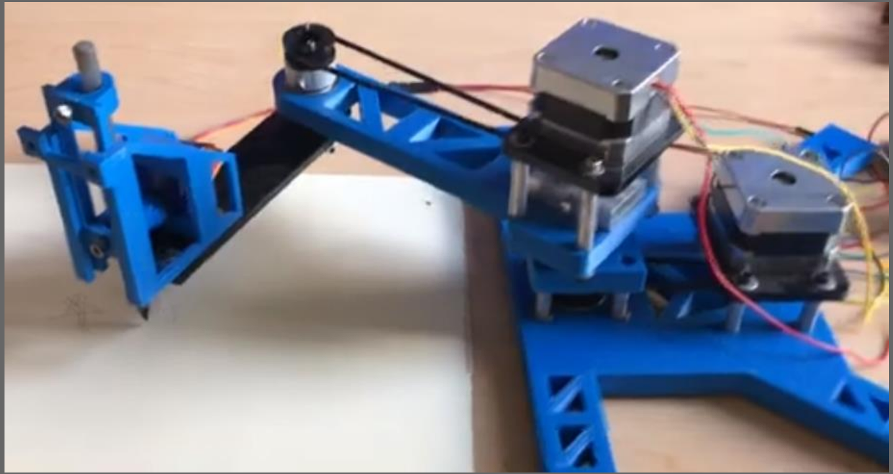
- Have complete PCB built by early winter quarter
- Set up all 30 sensors on a robotic arm as a test
- Have responses turn off movement of the arm and in UR simulation
- Prepare to test our project on the real UR arm and camera head



Acknowledgements

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Questions?

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