

The logo graphic consists of two overlapping chevron shapes pointing to the right. The front chevron is blue, and the back chevron is light green. They are positioned to the left of the text.

SafeVision

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The Problem

- 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

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





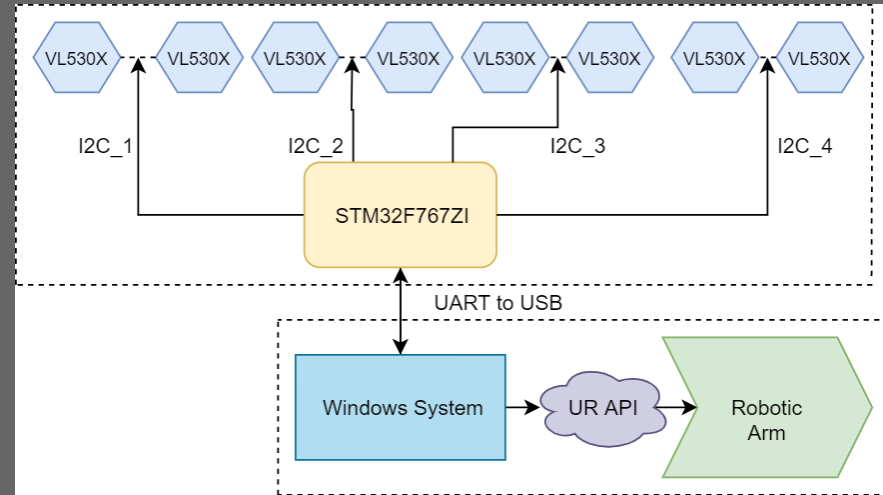
The Solution

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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

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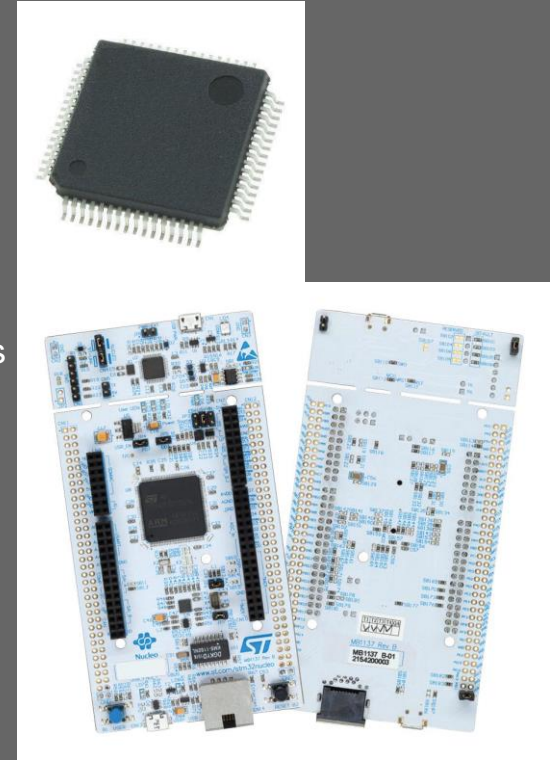
- Detect people and objects before colliding.
- Take measurements at least 2Hz.
- PCB must be small enough to fit on the joint of the arm.

Processor

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STM32F767ZI

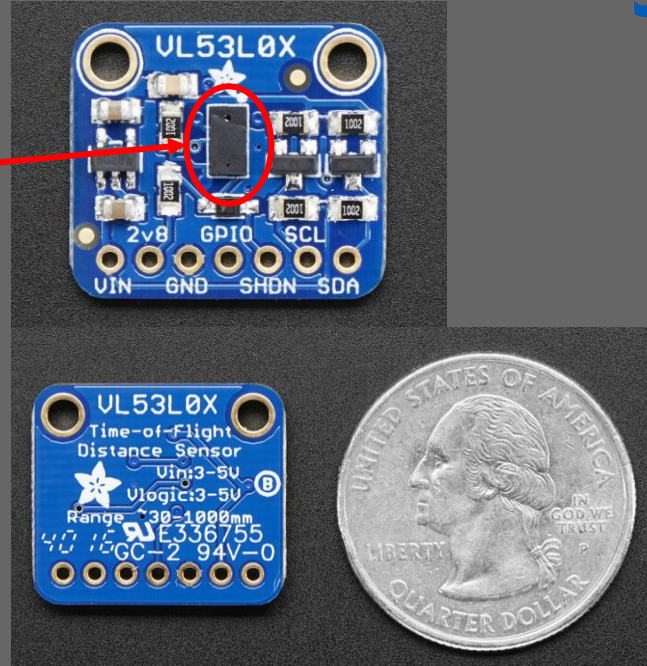
- High-performance
- DSP with FPU
- M7 processor with 216 MHz clock and floating point instructions
- 4 - I2C busses
- UART communication
- ST Link Debugger



Sensors

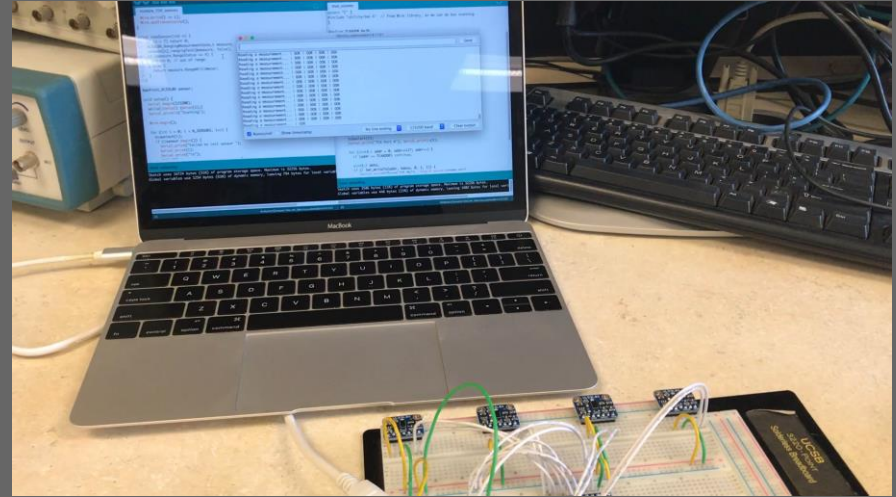
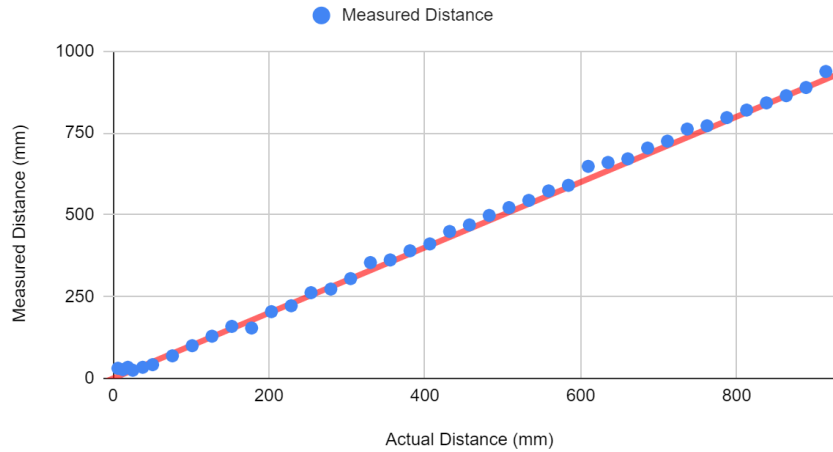
VL53L0X Time of Flight Sensor

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

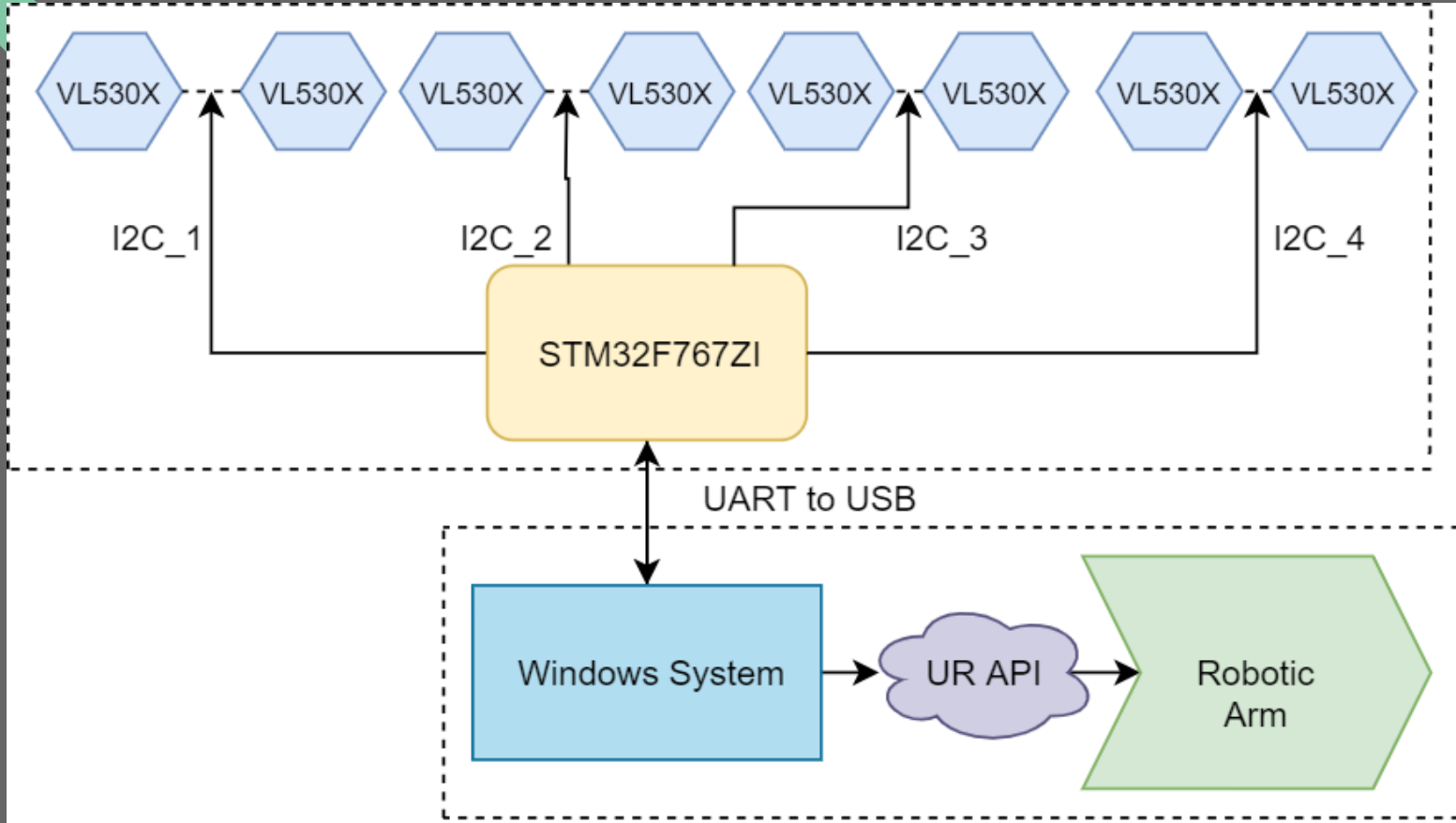


Testing

Measured Distance vs. Actual Distance (mm)



Overall Project Structure



Microcontroller Software Structure

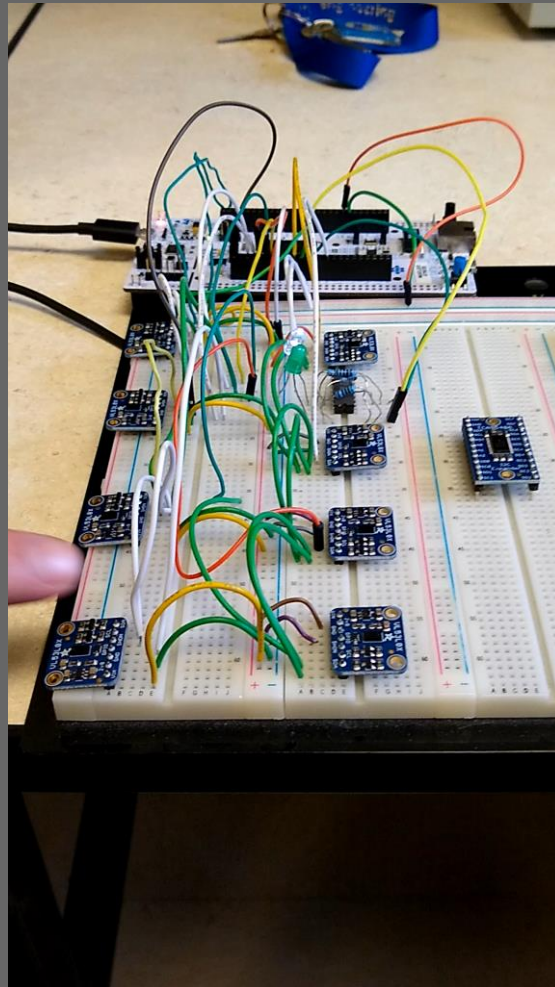
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- Init Peripherals
- Setup VL53L0X Sensors and update device addresses
- Start OS Scheduler with 4 threads using RTOS
- In each thread,
 - Responsible for different I2C bus
 - Collect distance data from all devices on the bus
 - Send distance data 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 \longleftrightarrow 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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File Machine View Input Devices Help

Welcome to PolyScope

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

Links to the Windows de

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the

Universal Robots Graphical Programming Environment

File 23:21:28 SCAC

Program Installation Move I/O Log

Robot MODBUS

Configurable Input

E-Stop 4

E-Stop 5

S-Guard Reset 6

S-Guard Reset 7

Digital Input

0 4

1 5

2 6

3 7

Tool Input

Digital

0

1

Analog Input

analog_in[0] Voltage 0.00 V 10V

analog_in[1] Voltage 0.00 V 10V

analog_in[2] Voltage 0.00 V

analog_in[3] Voltage 0.00 V

Configurable Output

0 4

1 5

2 6

3 7

Digital Output

0 4

1 5

2 6

3 7

Tool Output

Digital

0

1

Controlled by:

User

Analog Output

analog_out[0] Current 4mA 20mA

analog_out[1] Current 4mA 20mA

Simulation

Real Robot

Universal Robots Graphical Programming Environment

File 23:21:29 SCAC

Program Installation Move I/O Log

Command Graphics Structure Variables

pause

Call SubProgram_2

Loop digital_out[0]

Call SubProgram_3

Call SubProgram_3

Loop digital_out[0]

Call SubProgram_3

SubProgram_1

Set DO[0]=Off

Move

Waypoint_1

Until C[4]=Hi

Set DO[0]=

Wait 0.5

SubProgram_2

Set DO[0]=Off

Move

Waypoint_2

Until C[4]=Hi

Set DO[0]=

Wait 0.5

SubProgram_3

Set DO[0]=Off

Move

Waypoint_3

Until C[4]=Hi

Set DO[0]=

Wait 0.5

Simulation

Real Robot

Speed 100%

Previous Next

UNIVERSAL ROBOTS

Universal Robots ... Universal Robots ...

US 23:21

Right Ctrl

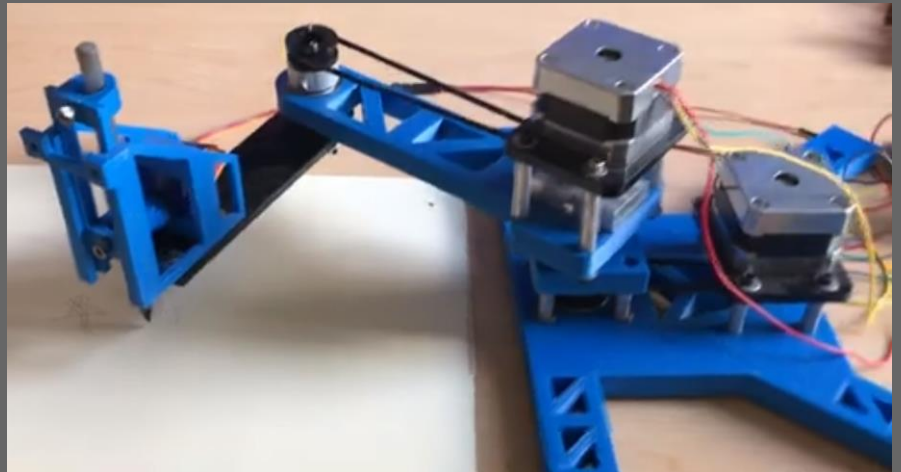


Summary

- 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

- 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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Yoga, Adi, and Kyle

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Questions?

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