Safe Crib With Hazard Detection

ECE 445 Final Presentation

Team 13

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Overview

Problem

- Parents nowadays are too busy to keep an eye on their babies all the time

Solution

- A smart crib that monitors the baby's status: climbing out of the crib, crying, moving, and safe
- A screen that delivers visual notifications
- A buzzer that alarms the parents to take care of the baby ASAP

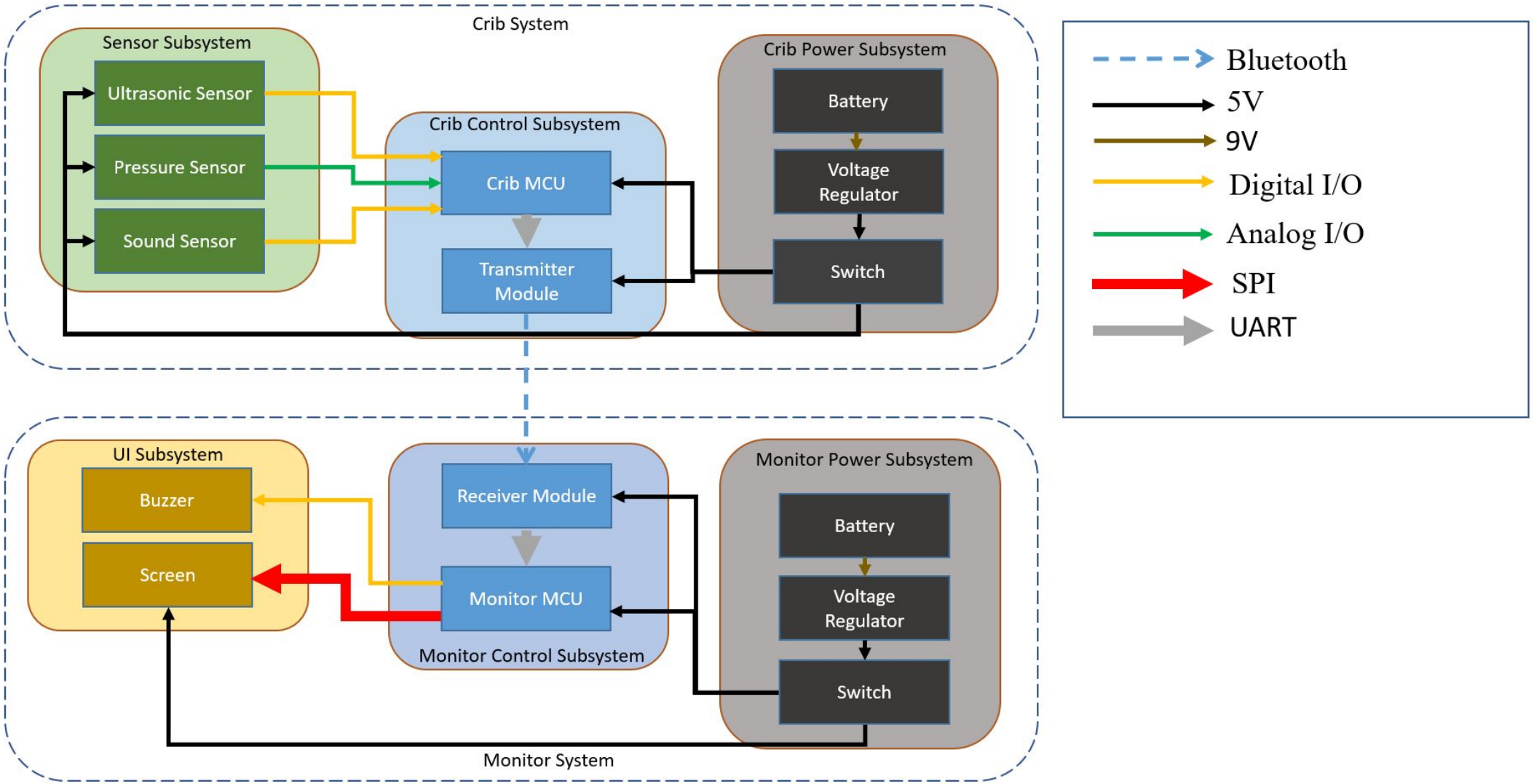
High Level Requirement

- Detect whether the baby has reached to a **height of 20 in**
- Detect whether the baby's crying is higher than **86 dB** for 2 s when measured at the microphone
- Notify the parents about the safety status within **3 s** when the monitor system is within **10 m** of the crib and at most **three interior walls** from the crib.

Brief Review

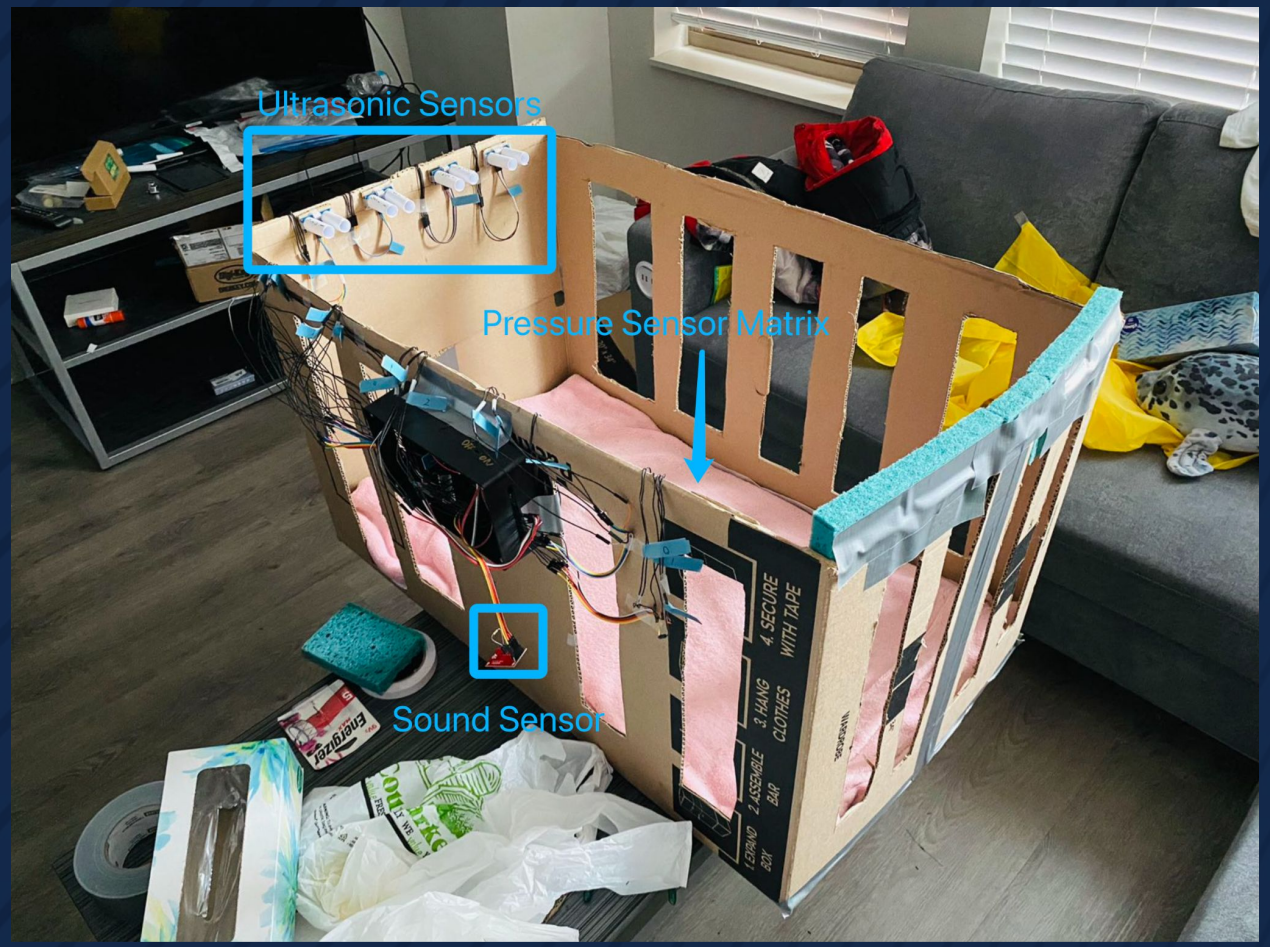
- Power subsystems
- Sensor subsystem
- Crib control subsystem
- Monitor control subsystem
- UI subsystem

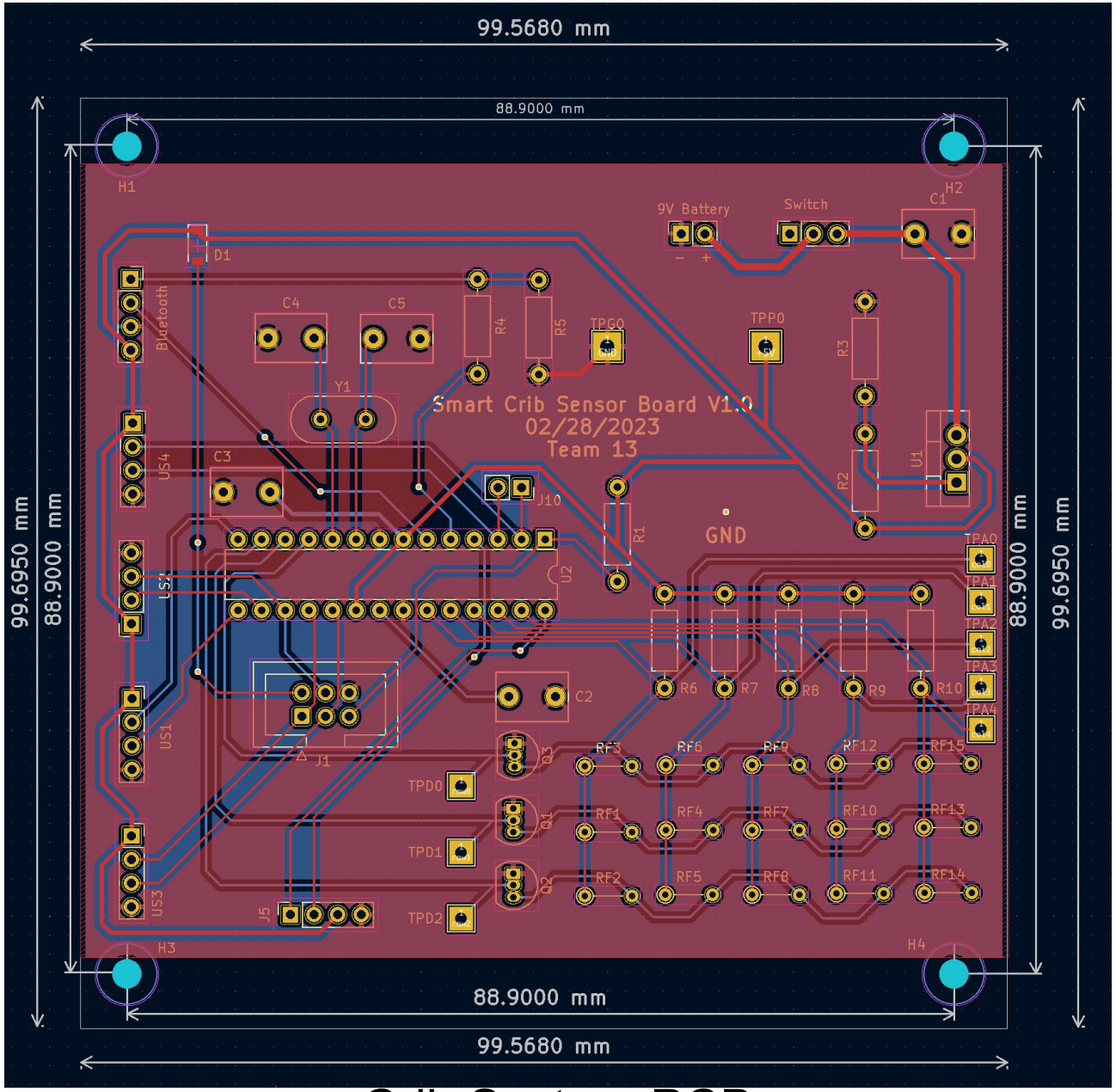
Block Diagram



No change on the block diagram since the original design

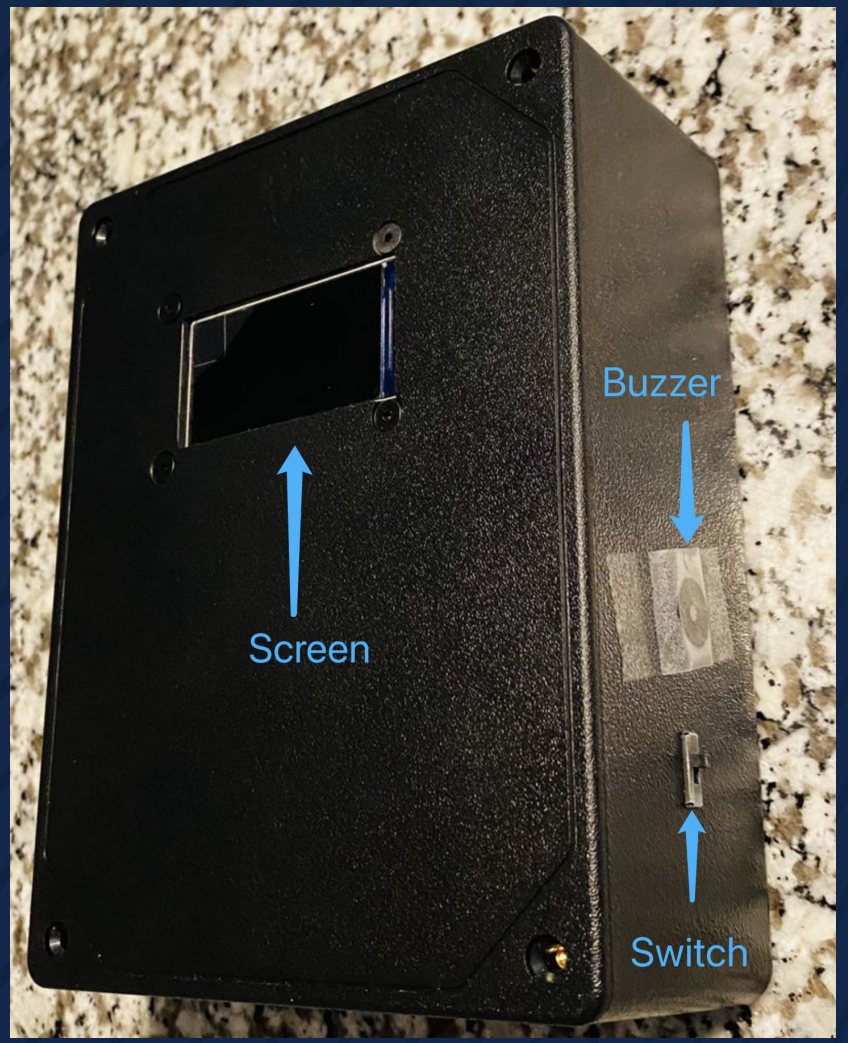
Crib System

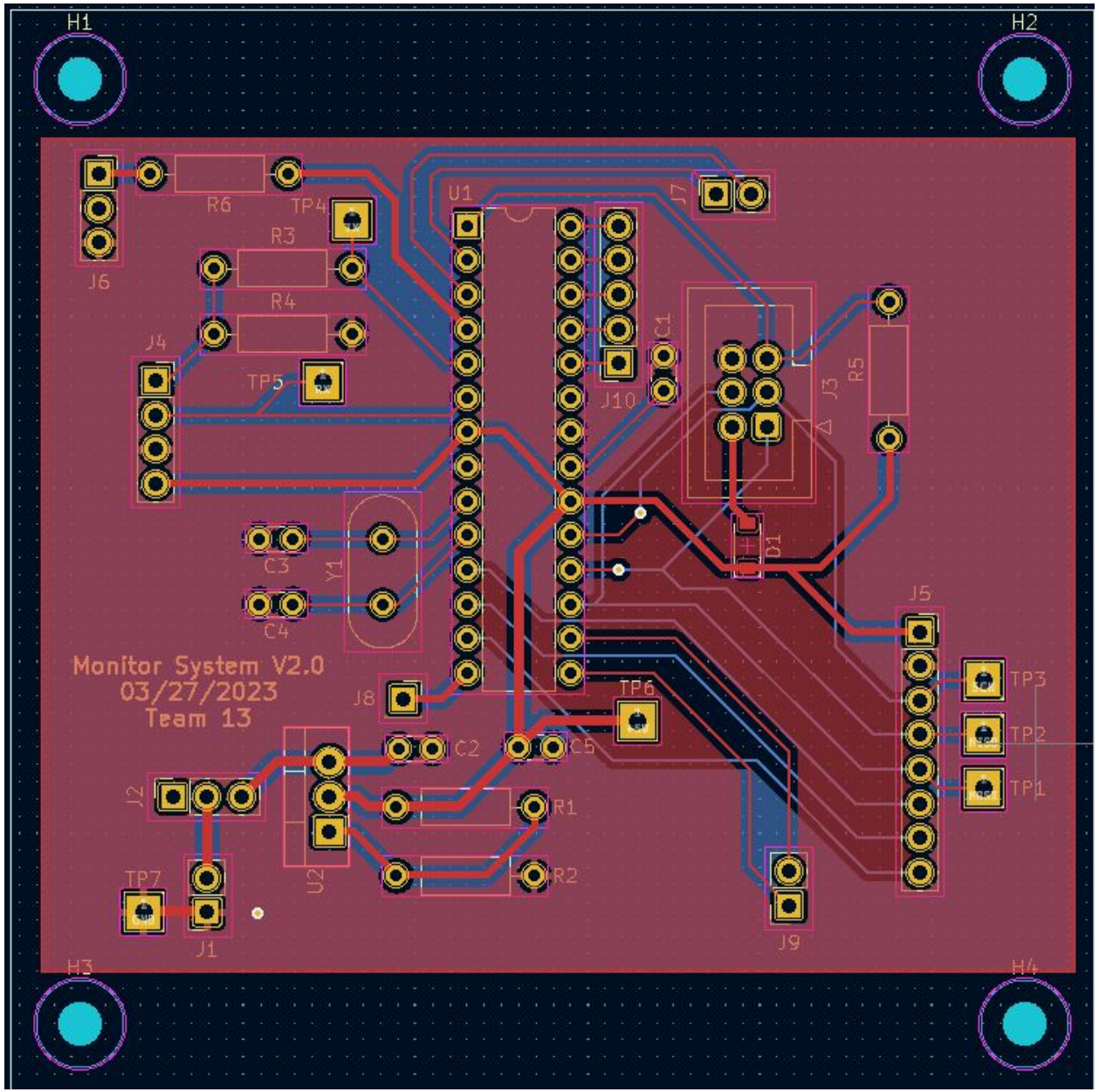

Ultrasonic Sensors
Pressure Sensor Matrix
Sound Sensor
4. SECURE WITH TAPE
3. HANG CLOTHES
2. ASSEMBLE BAR
1. STRAND BOX



Crib System PCB

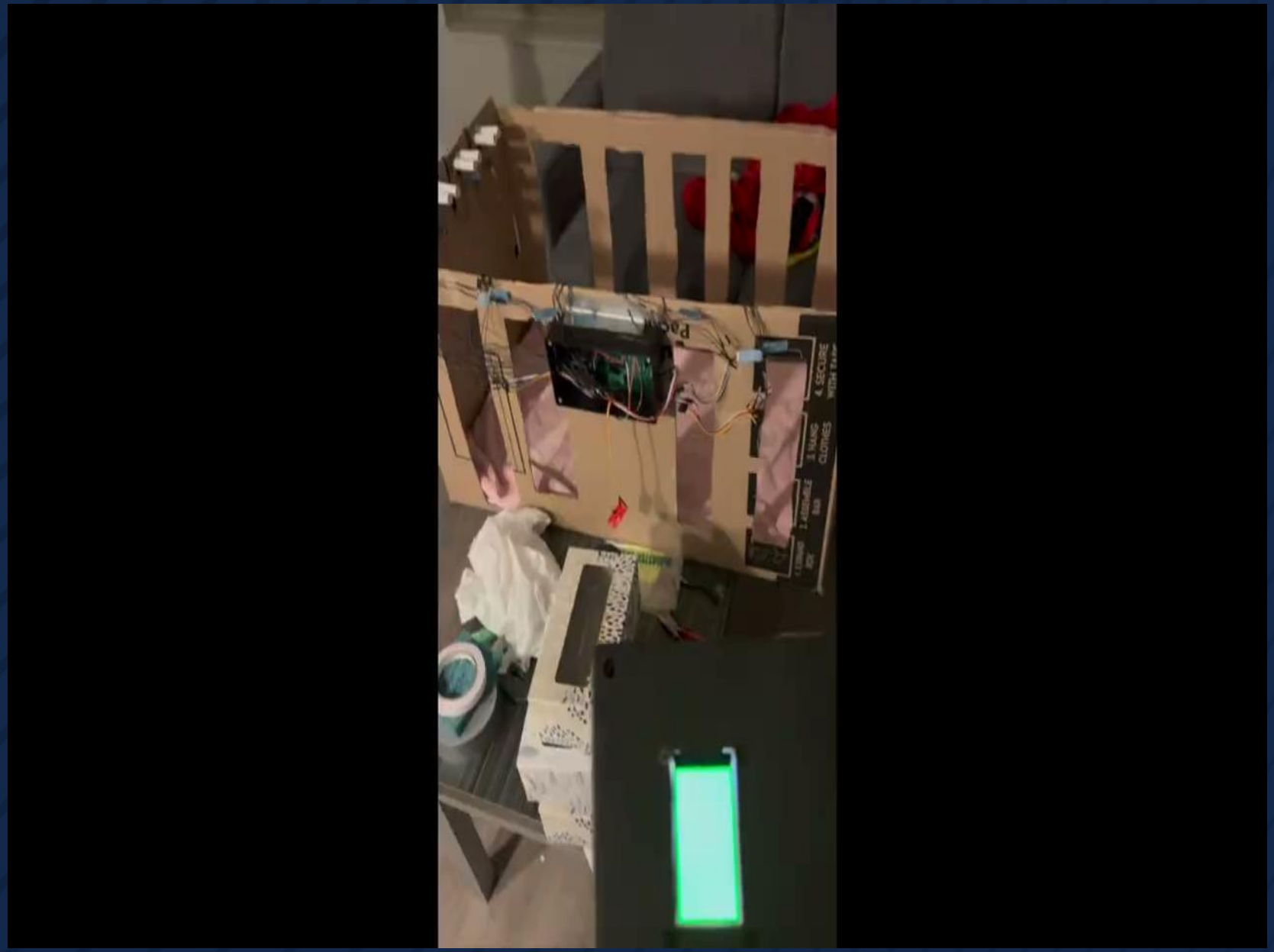
Monitor System





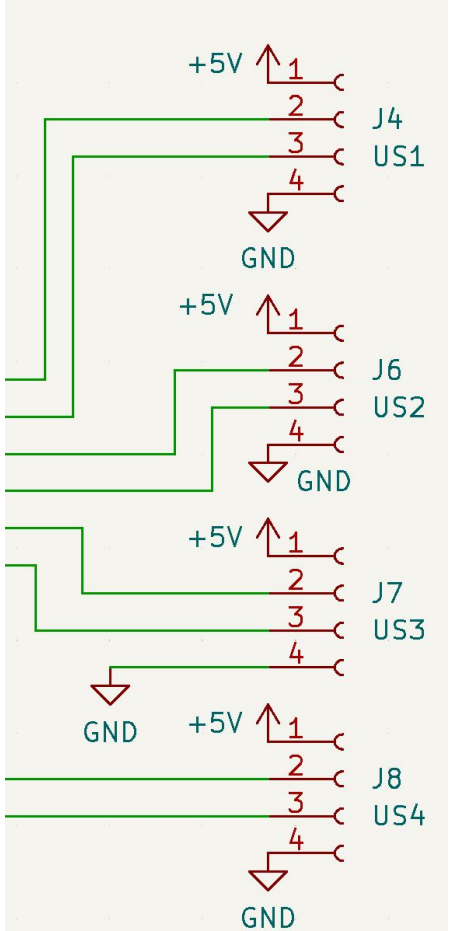
Monitor System PCB

Demo Video



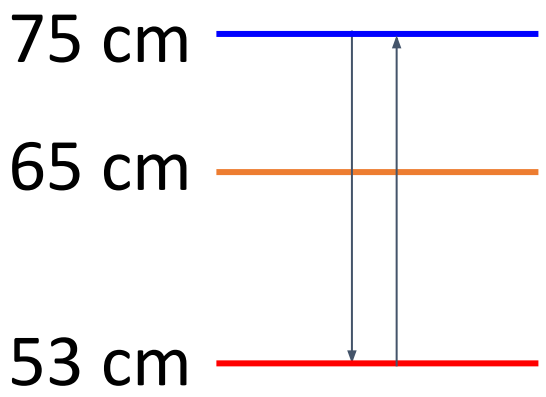
R/V Table

Requirements	Verifications
Ultrasonic sensor reports baby's position to MCU at 20 ± 0.5 in above crib bottom.	Block ultrasonic wave with hand in crib area and check monitor alert. If the alarm is triggered, then the subsystem is working.



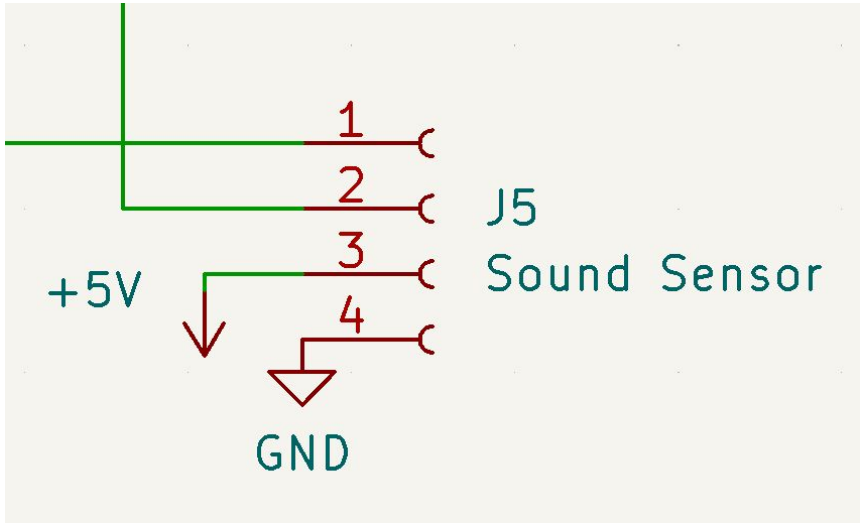
Challenge in Using the Ultrasonic Sensors

- False alarm



R/V Table

Requirements	Verifications
Sound sensor reports sound higher than 86 dB at its location accurately to MCU.	Sound source and decibel meter are placed near sensor. A 86 dB sound is played, and the alert is observed on monitor.

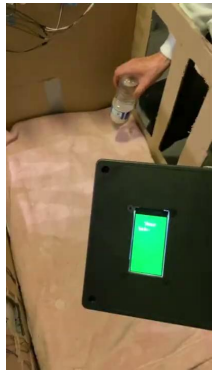


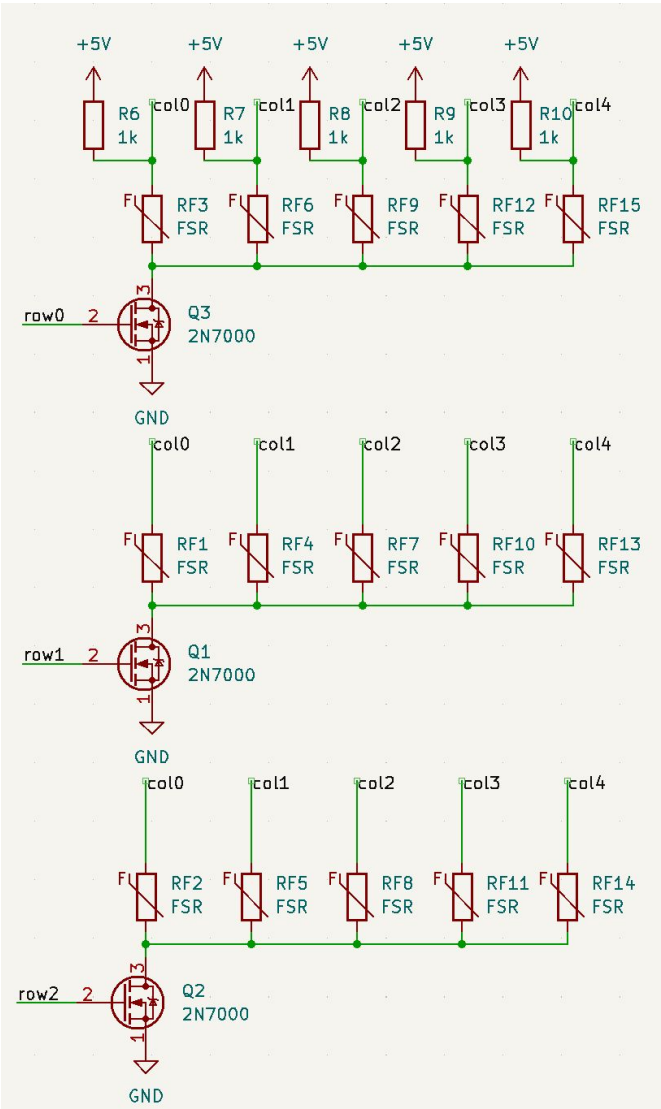
Crib Sensor Subsystem

Measured Voice Amplitude(dB)	Is system alarming that the baby is crying?
81.7	No
84.7	No
86.1	Yes
87.6	Yes

R/V Table

Requirements	Verifications
The pressure sensor array needs to detect 5 N force and changes of count and positions of triggered sensors.	Program scans 15 sensors, triggers alert on PCB if 5 N force detected, indicating normal operation.



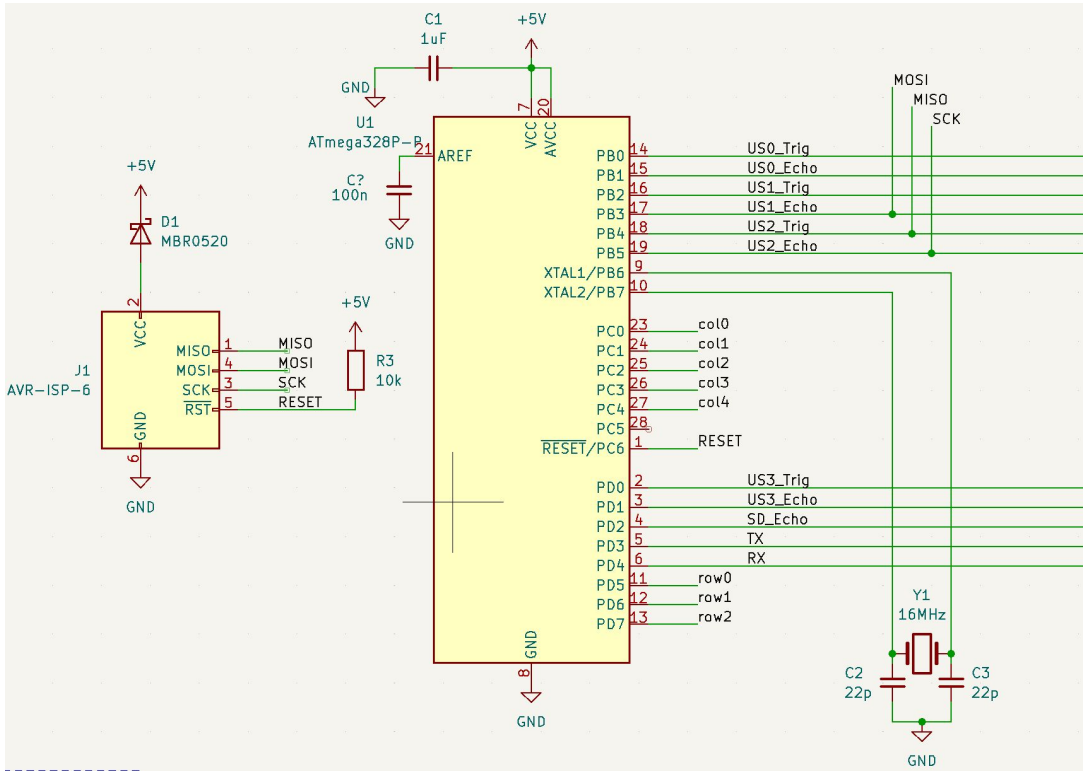


Challenge in Using the Pressure Sensors

- Countering the spread of force

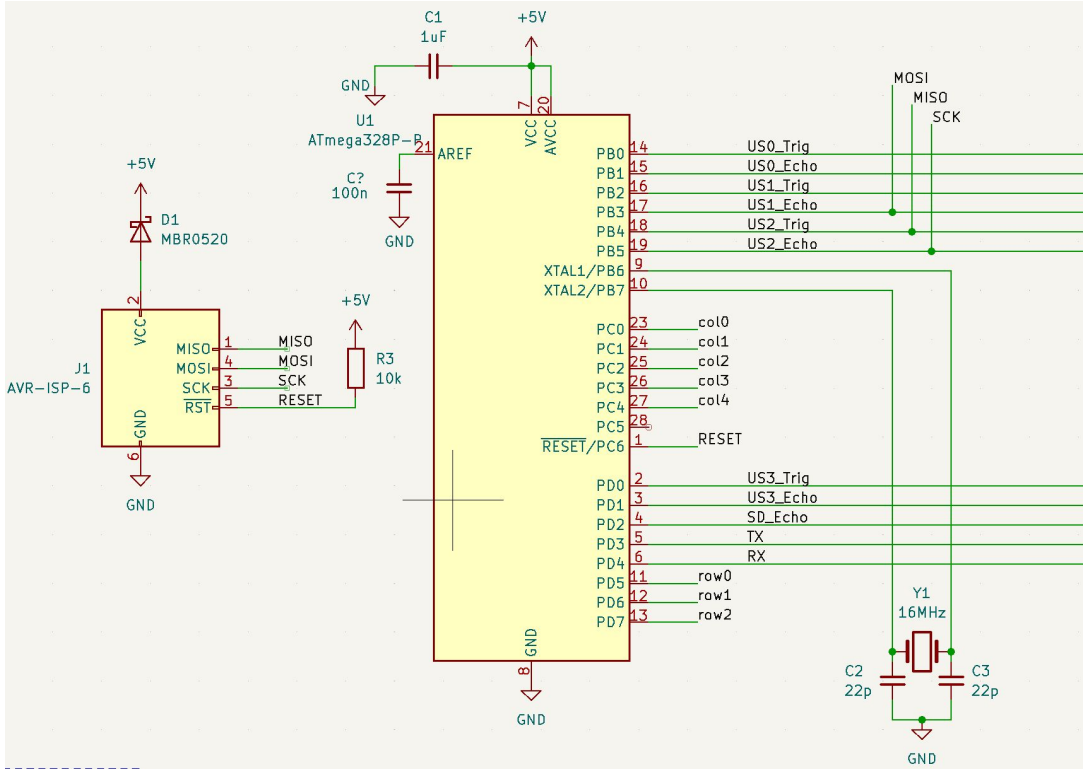
R/V Table

Requirements	Verifications
Subsystem transmits data to nearby device with less than 3 walls within 10 m range.	Place crib in a bedroom with monitor system outside. Adjust sensor measurements, check if screen receives and display updates.



R/V Table

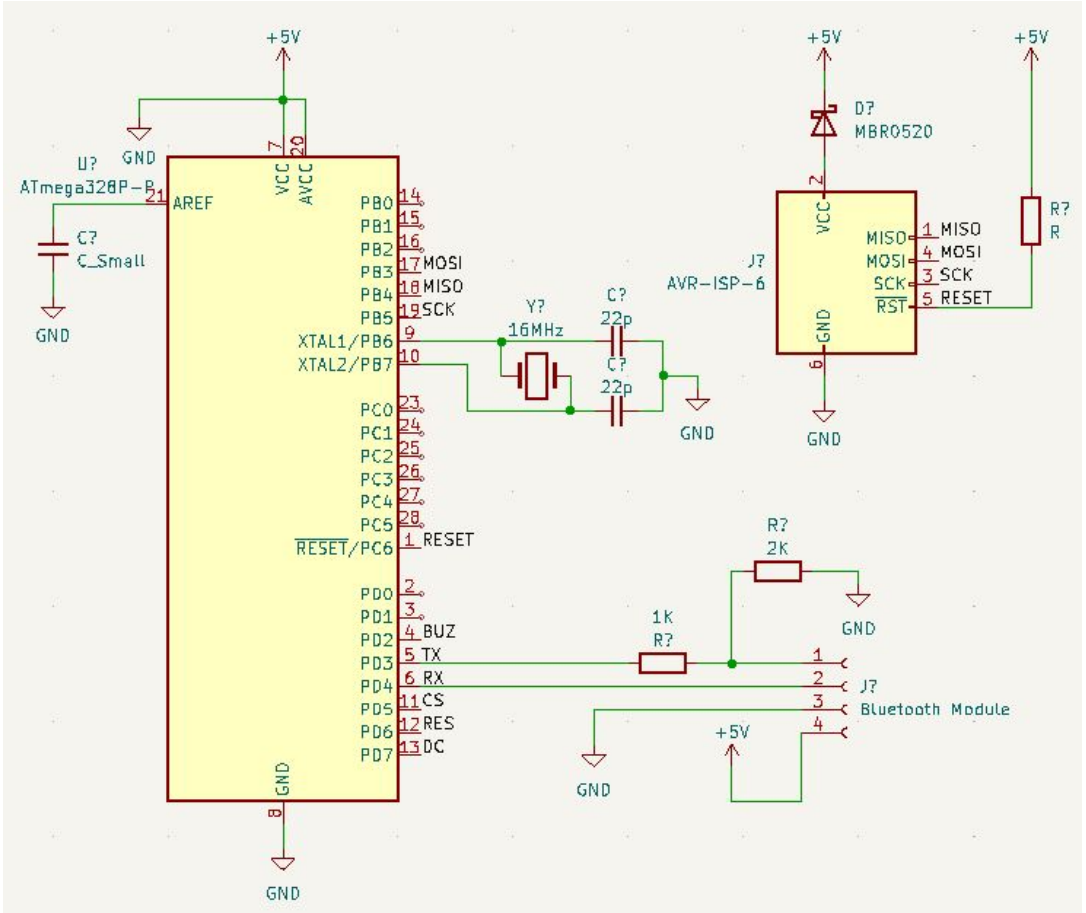
Requirements	Verifications
The microcontroller needs to processes data from 3 sensors, and updates screen in less than 3 s.	Change the measurements of each type of sensors and measure the screen update delay.



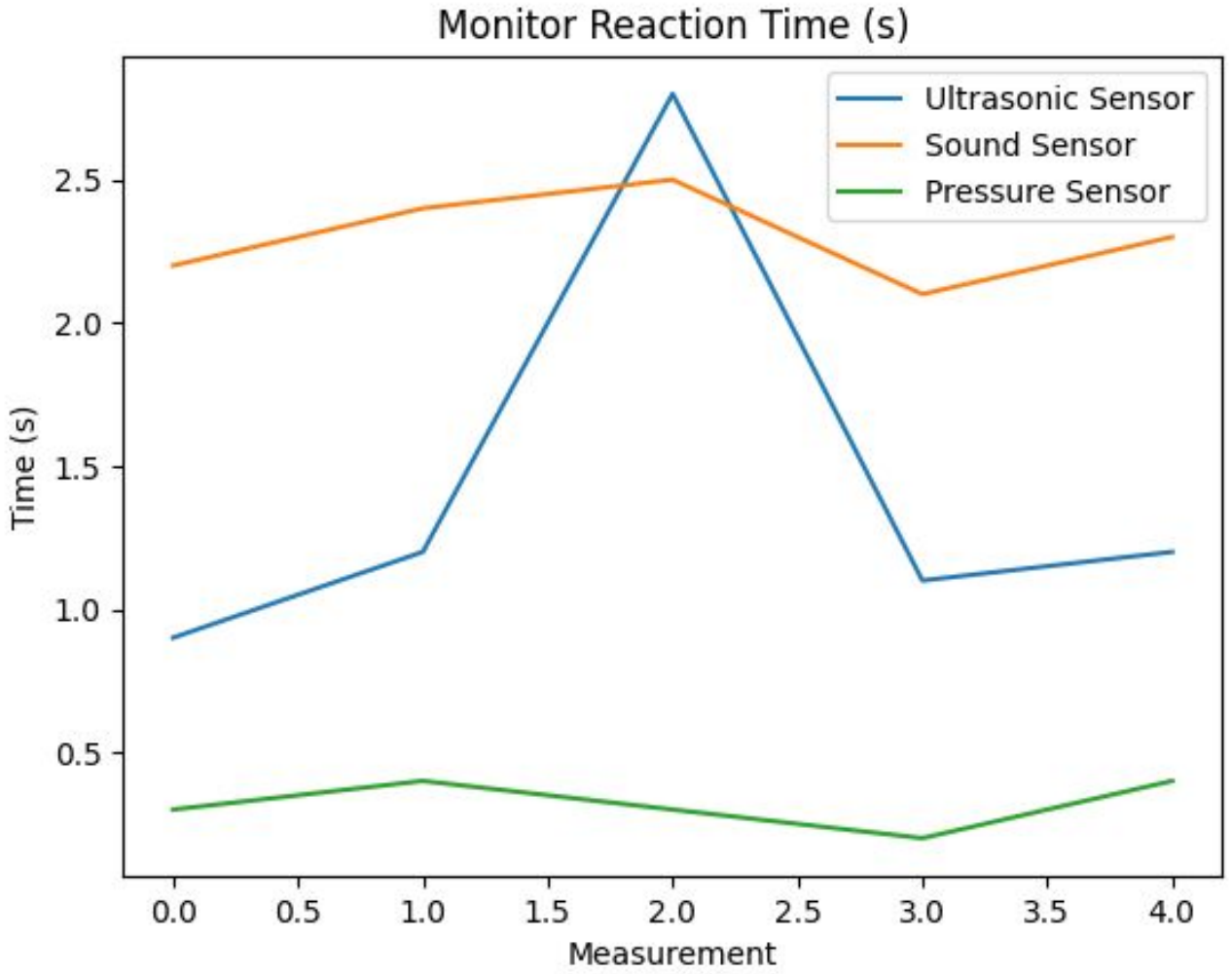
Monitor Control Subsystem

R/V Table

Requirements	Verifications
The alarm should be triggered in 3s from the event happened.	Measure from the event happening to the display of the alarm.



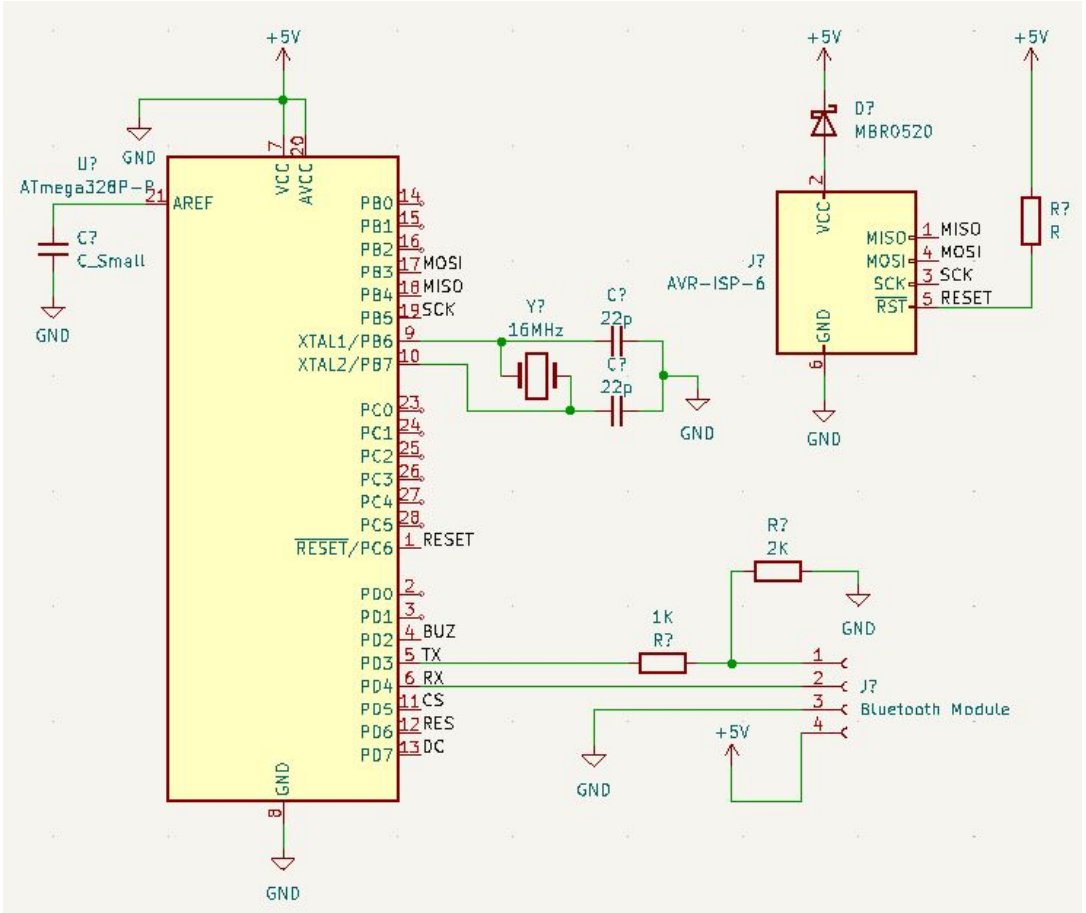
Monitor Control Subsystem



Monitor Control Subsystem

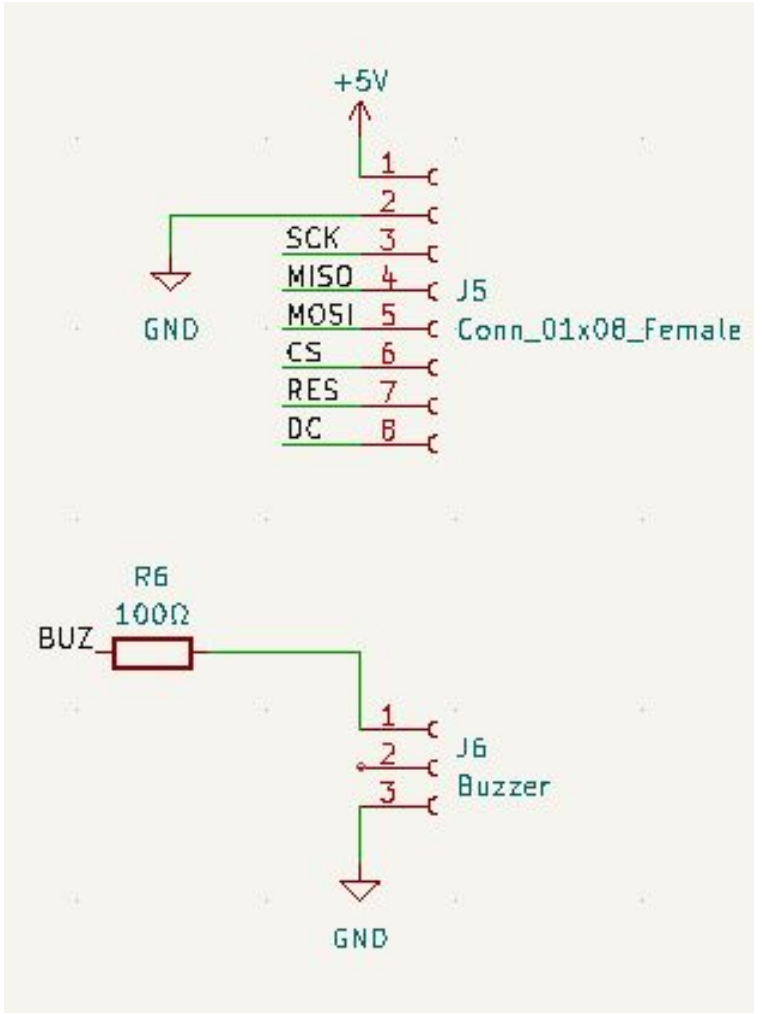
R/V Table

Requirements	Verifications
The microcontroller can use the corresponding code to display the correct message always.	Trigger the alarm for three cases and verify that the correct message is displayed.



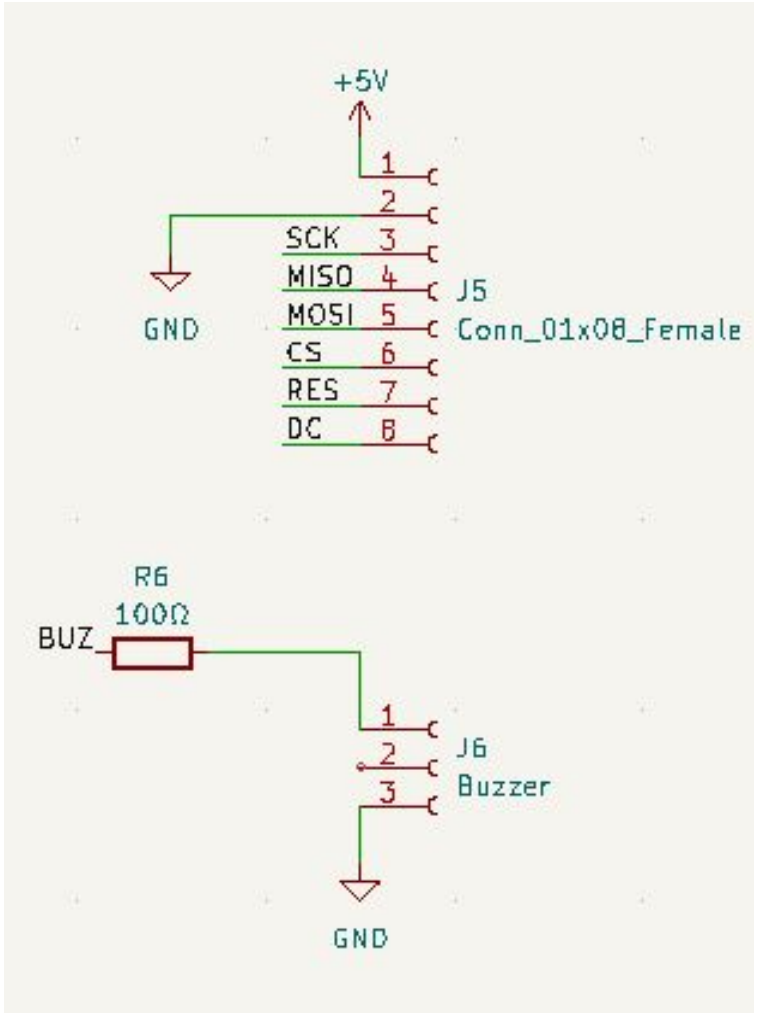
R/V Table

Requirements	Verifications
The display is able to show five different screens.	Trigger different safety events and verify that the five different screens can show up.



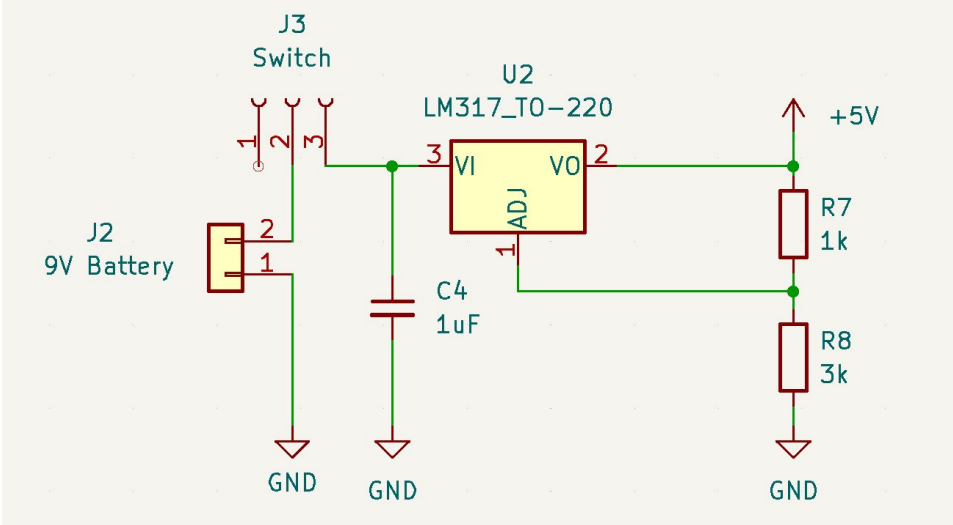
R/V Table

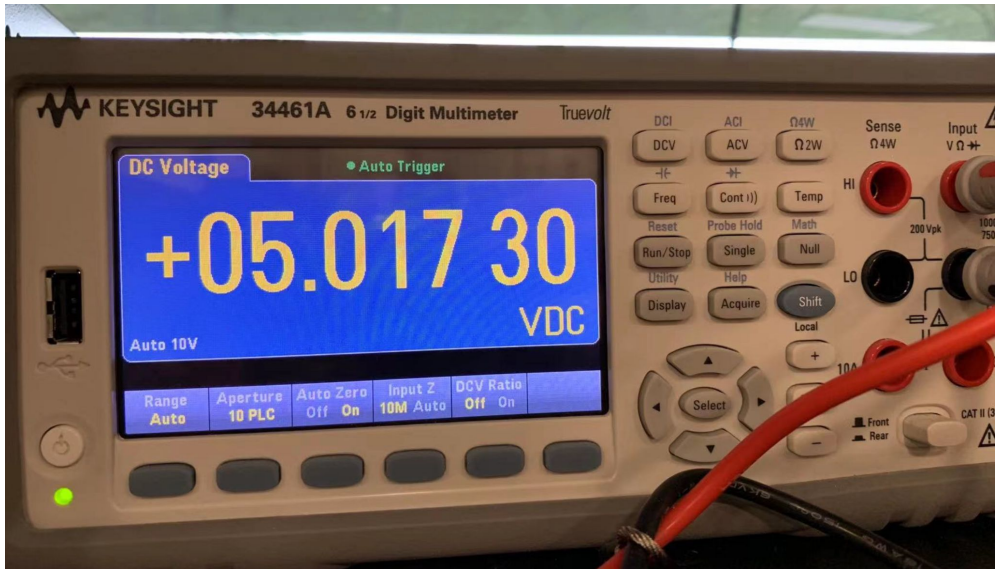
Requirements	Verifications
The buzzer can emit a sound with an intensity greater than 80 dB.	Trigger the buzzer, measure its sound intensity, and verify that it is greater than 80 dB.



R/V Table

Requirements	Verifications
The output voltage of the power subsystem must be 5 V ± 0.3 V.	Connect the probe to the subsystem measure the output voltage, which should be within 6 % of 5 V.

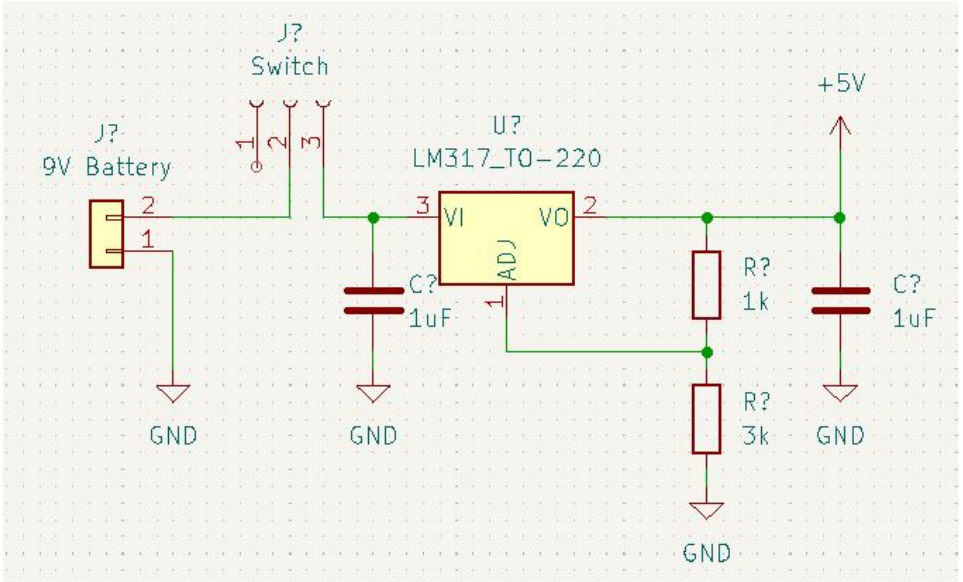


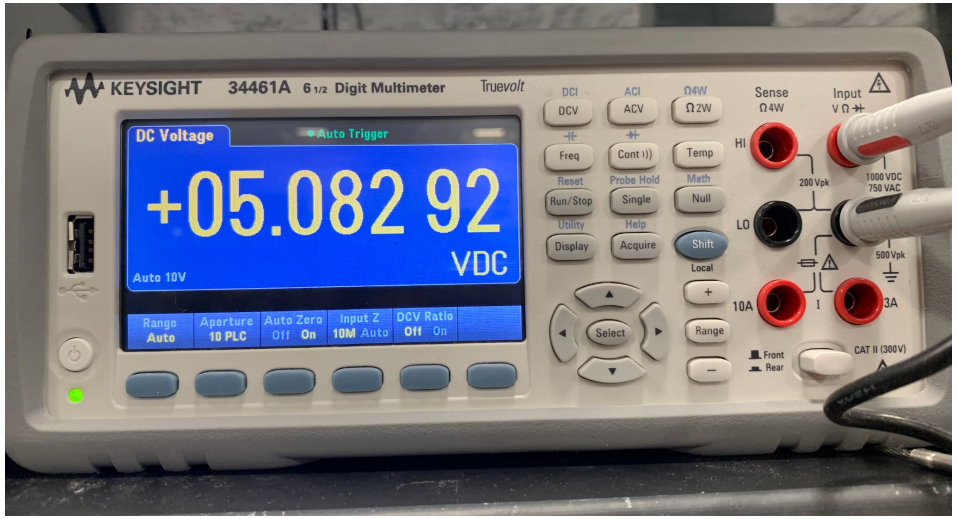


Monitor Power Subsystem

R/V Table

Requirements	Verifications
The output voltage of the power subsystem must be 5 V ± 0.3 V	Measure power subsystem's output voltage with load connected. Output voltage must be within 6% of 5V.





Ethics and Safety

- Electrical Safety
  - Power safety
  - Pressure sensors
  - Wirings
- Ultrasound
  - Low frequency ultrasound

Conclusion

- Summary
  - Learned about PCB design
  - Prototype to final product

- Future Work
  - More MCUs to alleviate the individual computational load and reduce crosstalks on the PCB

Thank You

Questions?

The Grainger College of Engineering

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