UC San Diego

# BENG186B Wireless Baby Monitoring Device for SIDS prevention

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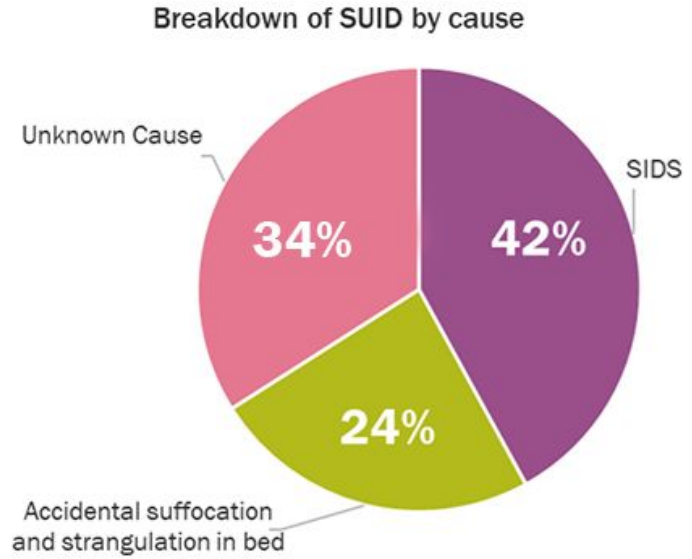
# What is SUID?

Sudden Unexpected Infant Death (SUID) is the death of an infant less than one year of age that cannot, at least initially, be explained. Between three and four thousand infants die each year from SUID in the United States alone. About 30% of these cases have an unknown cause, 30% are from accidental suffocation in bed, and 40% are due to Sudden Infant Death Syndrome (SIDS). SIDS encompasses a variety of contributing factors such as overheating, gestational developmental issues, and environmental smoke exposure.




*Data source:* National Center for Health Statistics, *Multiple Cause of Death Data [MCOD], 2018.*

# Challenge - How can it be prevented?

There are many ways that parents can help prevent their children dying of SUID, some of which are keeping the infant from overheating, putting them to bed in ways that decrease the risk of suffocation, and monitoring their breathing. The ease and reliability with which parents can monitor their infants is responsible for preventing the unnecessary deaths of children, presenting a biomedical challenge to make monitoring sleeping babies accessible to every parent of an infant.

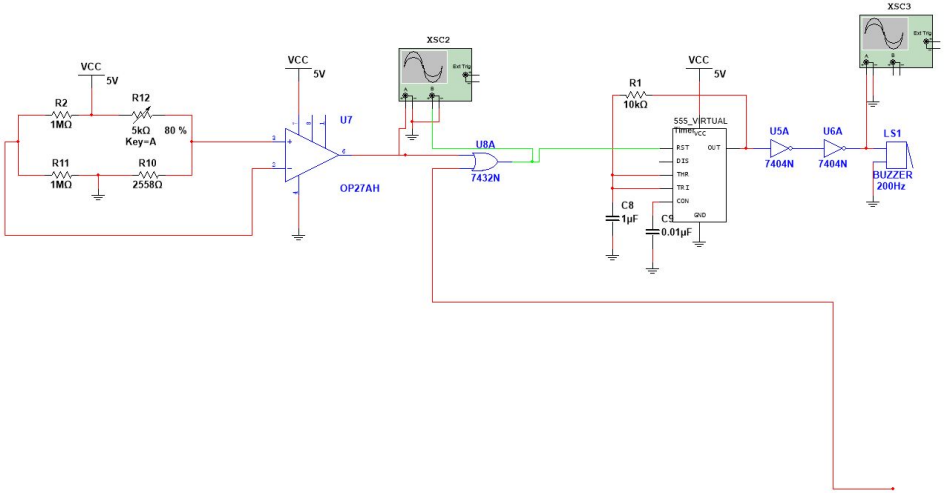
Current baby monitor devices most commonly consist of a camera and microphone setting that would require the parent/guardian to manually monitor their child. Other, more advanced devices monitor an infant's heart rate, O2 level, and body movement, but not body temperature. These models are also very expensive, hitting price points as high as $500+ USD and $120 USD on the lowest ends.

# Goal and Objectives

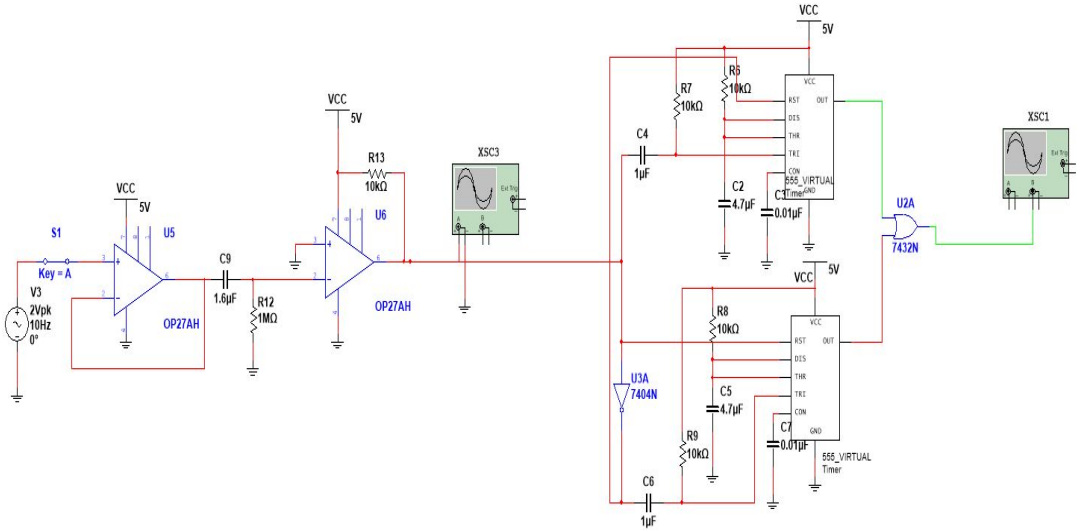
The objective is to build a reliable baby monitor that can be used by parents to monitor their babies one year and under. The hope is that the monitor will allow parents to keep their children safer. The monitor will sense infants' body temperature changes and monitor for potential apnea by comparing measured breathing and body heat against set thresholds.  If the thresholds are exceeded, an alarm will sound. Meanwhile, an Arduino will send the signal to wireless devices, creating the ability to receive alerts and monitor the child through a web-enabled smartphone without the need of the parent to be in the same physical environment. The parent can be in a different room and still receive notice that something is happening to their baby.

# Design (Thermistor)

We used a wheatstone bridge along with an R12 potentiometer that can adjust resistance based on the temperature detected. If the temperature is high, then the the resistance will decrease, and if the temperature is lower the resistance will increase. We set the trigger temperature to be 39°, significantly higher than normal human body temperature. If the temperature increases to 39 degrees, the resistance increases to 5kΩ, and the wheatstone bridge sends a non-inverting signal to OPA27A that amplifies the signal to the Arduino and the alarm.



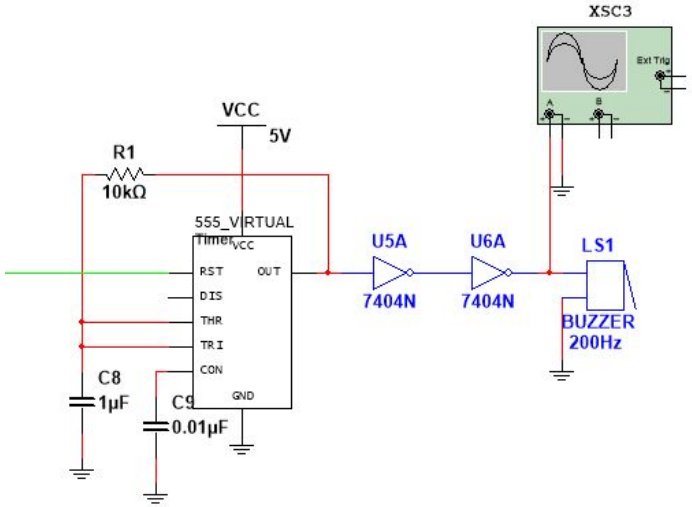
# Design (Breathing Detector)



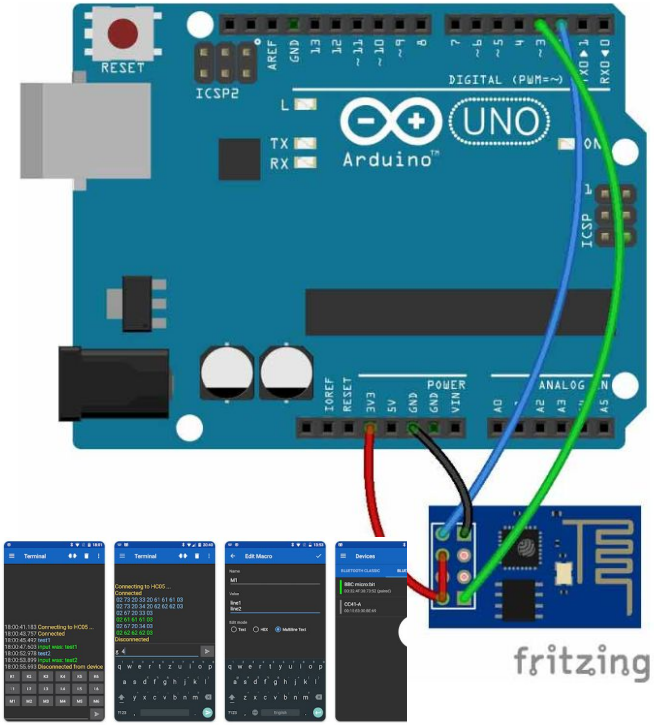

In this part, we use an AC signal source with a peak voltage of 2V and a frequency of 10Hz. This is connected to a DIP switch triggered when the infant breathes, which feeds into a high-pass filter from 2 OPA27s with a cutoff frequency of 1.6µF. This sends the AC signal to a feedback resistor and an input resistor with a gain of 1.01, then sending the amplified signal to an inverter with a threshold of 2V. It is then connected to two 555 timers that generate high pulses with durations of 11.1 milliseconds and 25.85 milliseconds. The way this design functions is that one timer triggers at the onset of breathing in, and the other timer triggers at the onset of breathing out, so the output is high whenever either one has happened recently, and when one resets the other will as well. This way, the output should remain continuously high as long as a new trigger comes in at least every 20 seconds. The overall signal output is connected to a OR gate with thermistor input that can determine the temperature of the infant so that when either requirements satisfied, it triggers the alarm.

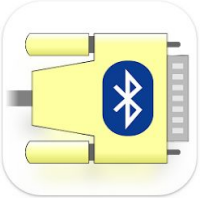
# Design (Alarm)

The signal that is sent from the thermistor and breathing detector is directed to an OR gate that is connected to a 555 timer with a duration of a 11.1 ms that generates a single pulse to the alarm through 2 inverters and then to a 200 Hz buzzer that makes noise when the thermistor or breathing detector reach their threshold values of 39C or 20s, respectively.



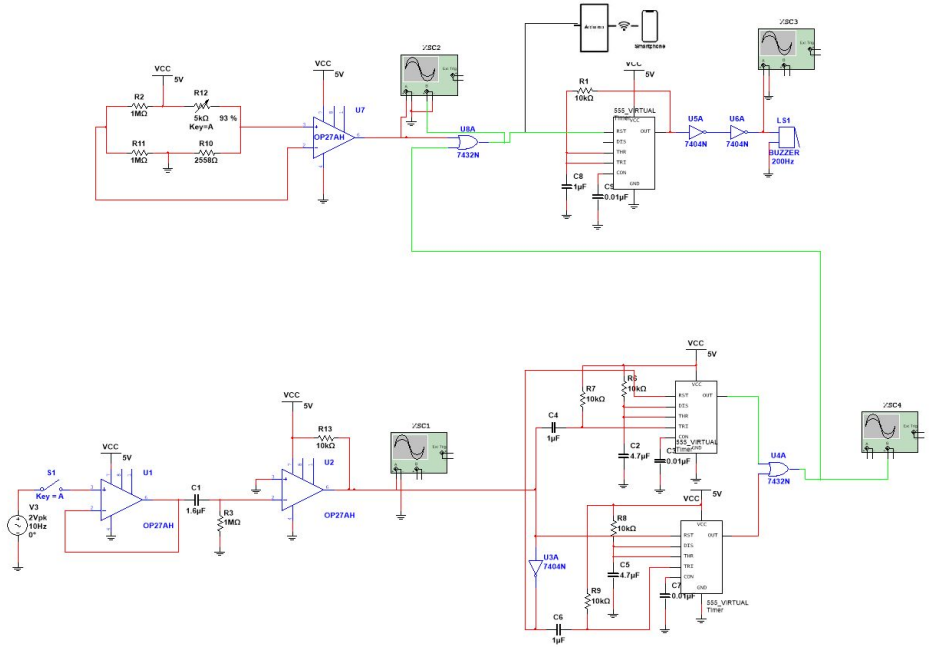
# Design (Arduino TO Wireless Devices)



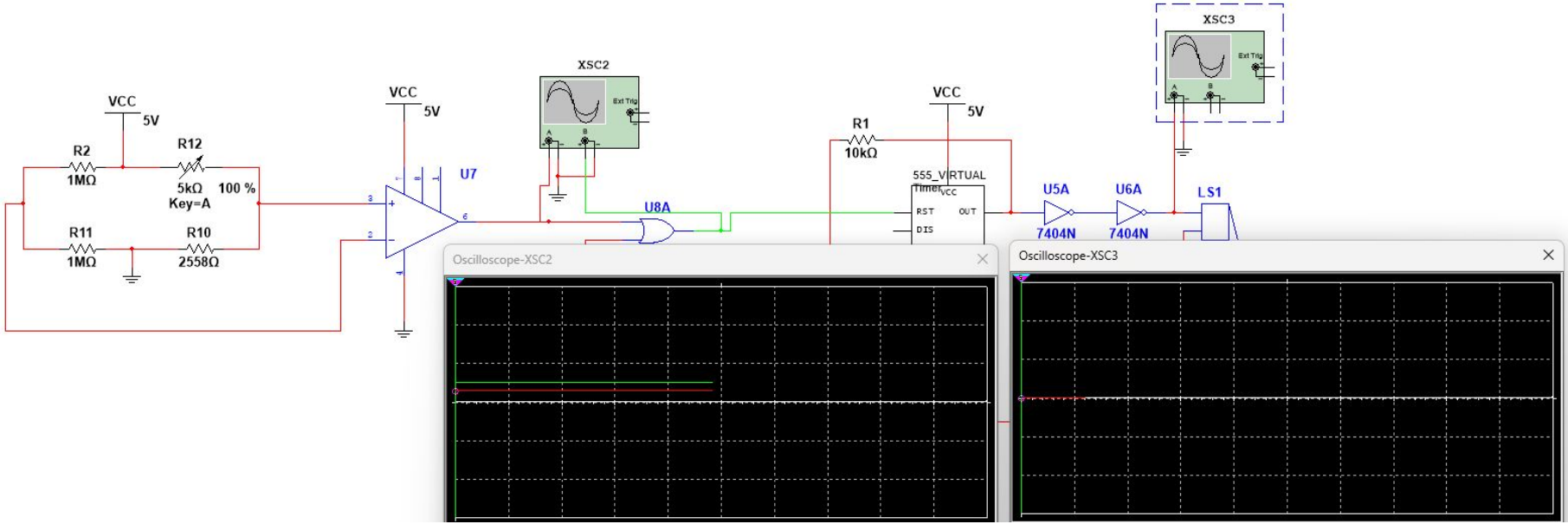



When the buzzer alarm is activated, some of the voltage is also sent to an Arduino R3 that's paired with HC05 to our phone that receives the signal once the Arduino is activated. Our App of choice is Serial Bluetooth Terminal, which can received Arduino Messages far away from the monitor.

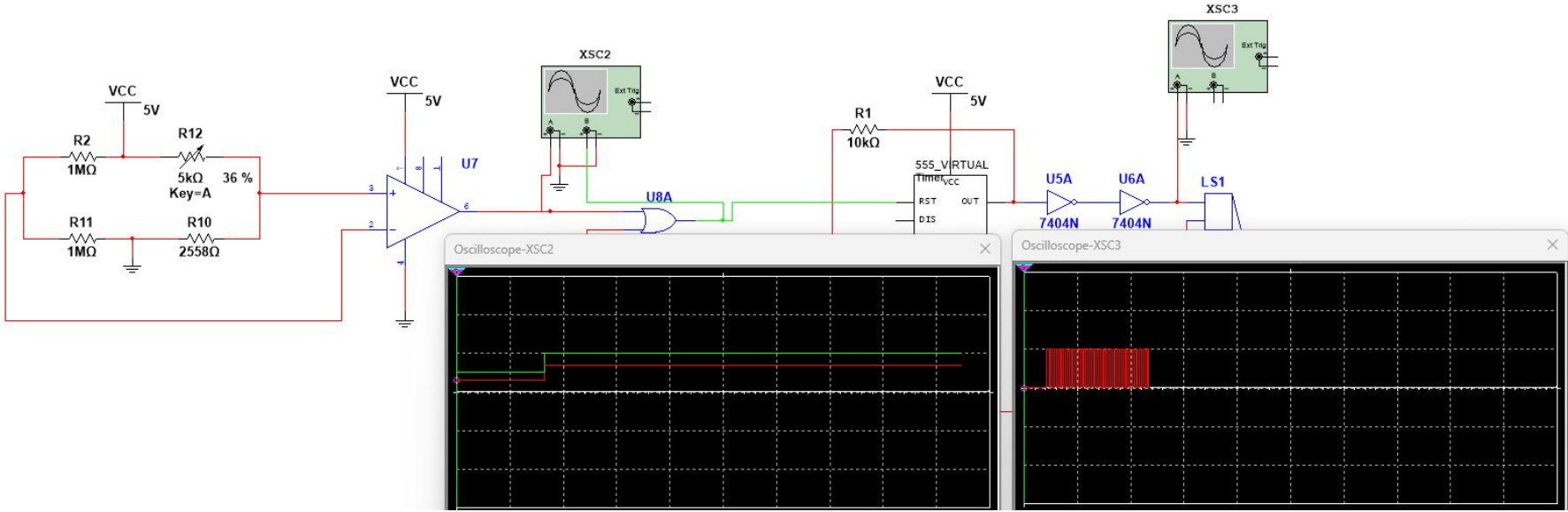
# Design (Combined)



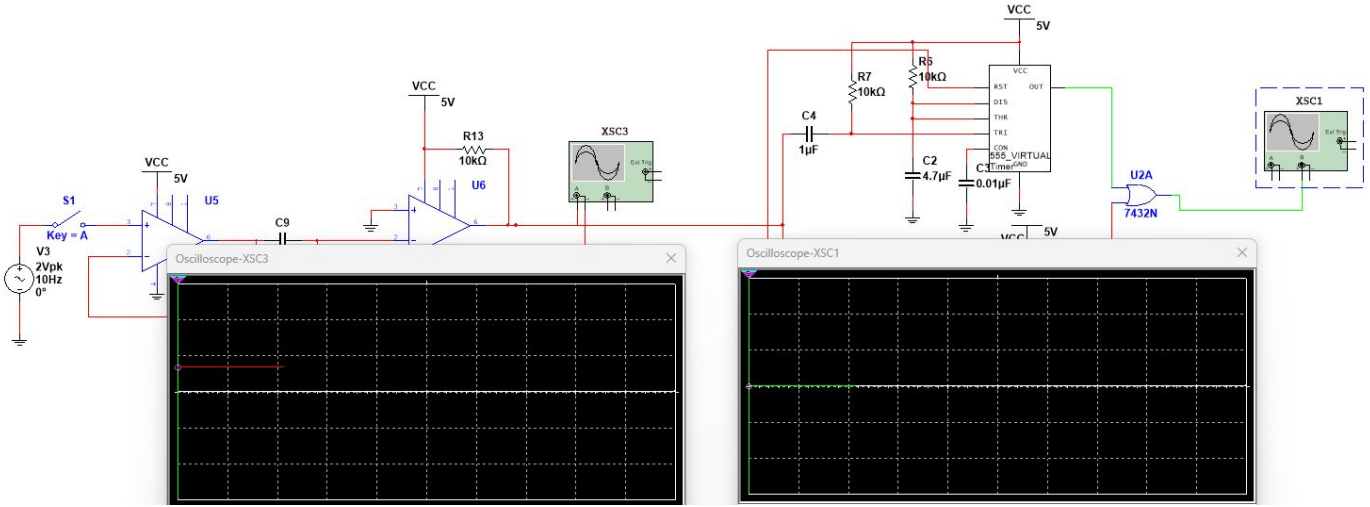
# Results (thermistor not reach 39°)



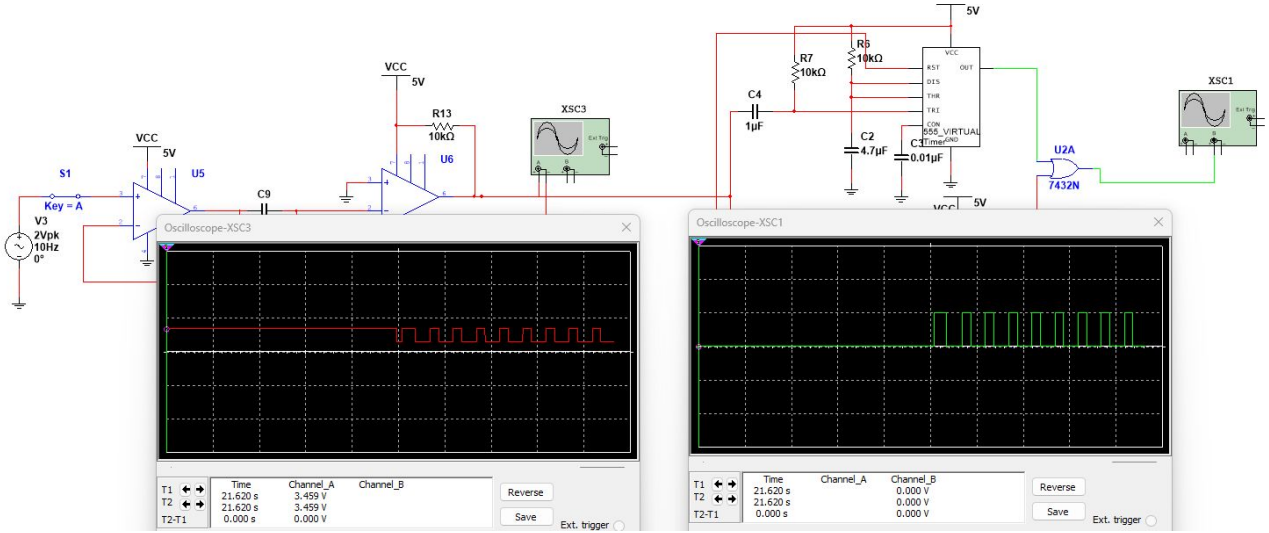
# Results (thermistor reach 39°)



# Results (Breath Monitor normal)



# Results (Breath Monitor with no breath for 20 Sec)



# Advantages and Limitations

Advantages:

- Low cost, easy to build with most of the required functionality.
- Respond fast when there are something happened to the baby.
- Able to provide a safe and reliable environment for both babies and the parents :)

Limitations:

- Without actual engineering approaches this could be limited with real world situations.
- Temperature can be affected by the surrounding temperature, if the device is not directly connected close to the infants the signal could be not reliable.
- The surrounding noise could affect the breathing detections.
- There might be delay and limited distance base on the location of the smartphone due to the Bluetooth application.
- More reliable devices with better profit already existed on the market.

# Significance to Bioengineering

- Early Detection and Response: Leverages the precision of bioengineering to detect critical changes in infants' physiological parameters, potentially saving lives by alerting caregivers to intervene promptly.
- Accessibility and Affordability: Aims to make life-saving technology more accessible and affordable because this can be modeled with inexpensive parts.
- Interdisciplinary Collaboration: Embodies the interdisciplinary nature of bioengineering, combining electronics, sensor technology, and healthcare to address a critical medical challenge.
- Advancing Pediatric Care: Contributes to the growing field of pediatric bioengineering, which focuses on creating tailored healthcare solutions for infants and children.

# Reference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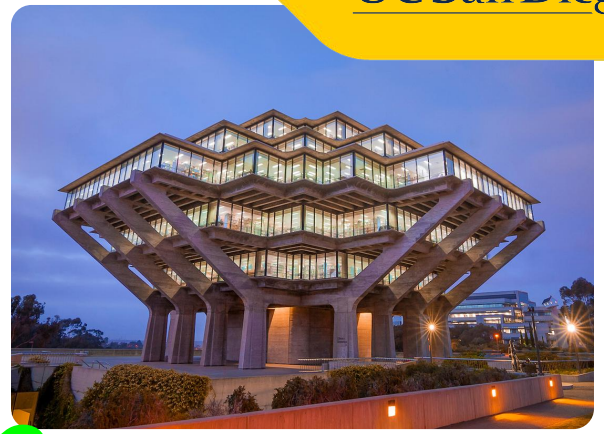
# Questions?



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# Thank you!