Smart Safety Helmet

TEAM Design | Team 67 | Term 232

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Problem statement

Developing a smart safety helmet that protects industrial workers from falling objects and alerts others in the event of an accident using alarms, sending notifications, and providing its location.

Constraints

- **Site Structure:** May hinder the localization system
- **Wearer:** Placing sensors on the helmet without burdening the wearer
- **Cost:** Additional features increases cost
- **Audibility:** Hearing the alarm in the loud site

Target Specifications

- At least 3 sensors
- Location error < 2m
- Mass < 2.5 Kg
- High quality ANSI-approved helmet
- Warning to the supervisor in less than 5 seconds

Essential Parts

Microcontroller ESP32-S3

Manufacturer: Espressif
Model: ESP32-S3
Core: Dual-core XTensa LX7
Clock Frequency: 240 MHz
Supply Voltage: 3 - 3.6 V

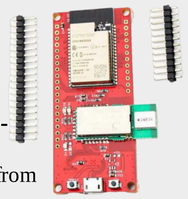
Pulse and Temperature Sensor

Product: MAX30102
Communication: I²C
Operating Temperature: -40°C\~85°C
Power Supply: 3.3V - 5V

Impact Sensors

Manufacturer: Walfront
Model:SF15-600
Length: 600 mm
Range: 0 ~ 10 kg
voltage: 3.3v
Working temperature:- 20°C~ 60°C

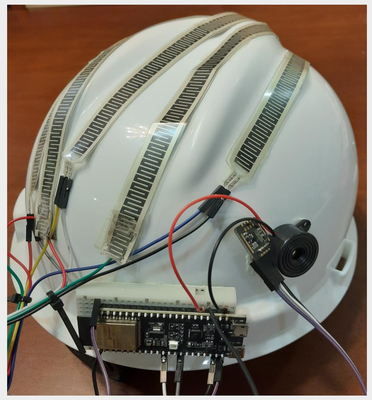
ESP32 UWB Pro



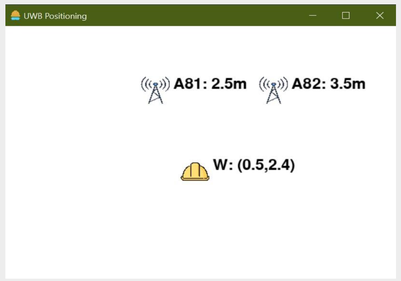
Manufacturer: Makerfabs
Core UWB: DW1000
Voltage : 4.8~5.5V
Core processor: Xtensa® single-/dual-core 32-bit LX6
UWB Channel: 6 RF channels from 3.5 to 6.5 GHz.
Additional feature: 2.4 GHz Wi-Fi-and-Bluetooth

Final Prototype Design

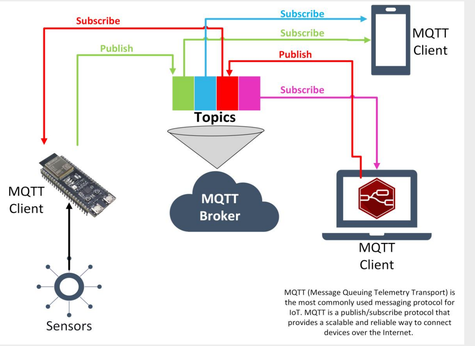
Smart Safety Helmet



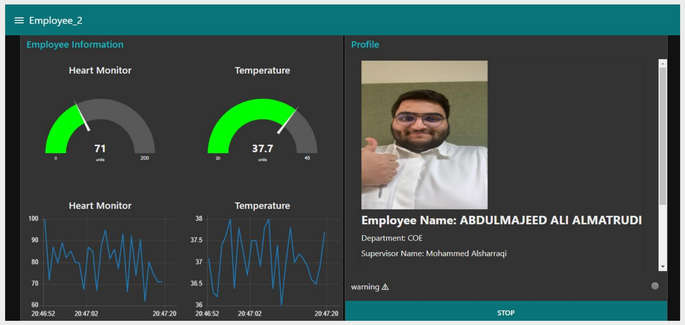
UWB Localization Map



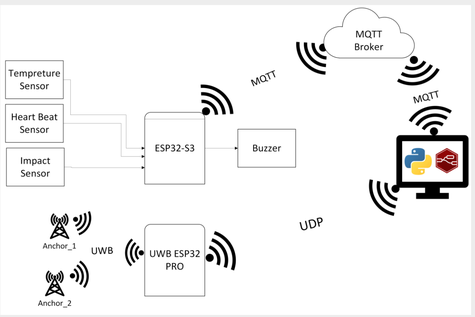
MQTT - Data cycle



Node-RED Dashboard



System Process



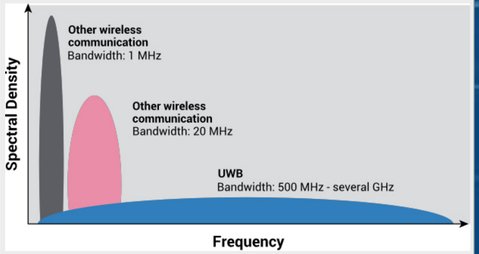
Project Impact

Economic Impact - Reduced workplace accidents, injuries, and fatalities cost savings for companies by minimizing worker compensation claims, medical expenses, and potential legal liabilities.

Societal Impact - positively fosters a culture of safety and care within industrial workplaces. It emphasizes the importance of worker well-being and promotes a sense of responsibility among coworkers and supervisors.

Environmental Impact - contributes to environmental sustainability by reducing the occurrence of accidents and injuries. This can lead to lower environmental pollution resulting from emergency response activities, medical waste, and other associated factors.

Ultra-Wideband (UWB)



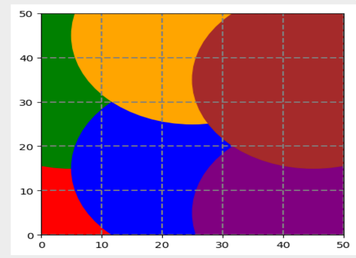
UWB Technology - Transmits information across a wide bandwidth (>500 MHz), allowing for high-data-rate, personal area network (PAN), wireless connectivity, longer-range, low-data-rate applications, and radar and imaging systems.

The mass of the prototype is less than 500g

Testing and Validations

```
from: 1782      Range: 5.43 m   RX power: -101.12 dBm
from: 1782      Range: 5.39 m   RX power: -100.58 dBm
from: 1782      Range: 5.44 m   RX power: -99.98 dBm
from: 1782      Range: 5.48 m   RX power: -99.84 dBm
from: 1782      Range: 5.32 m   RX power: -98.27 dBm
from: 1782      Range: 5.40 m   RX power: -98.91 dBm
from: 1782      Range: 5.45 m   RX power: -99.24 dBm
from: 1782      Range: 5.31 m   RX power: -99.14 dBm
from: 1782      Range: 5.42 m   RX power: -99.90 dBm
```

The testing of UWB-ESP32 range/distances readings to test the localization algorithm



Algorithm to find the optimal anchor placement in an area

Conclusion

In this project we gained valuable insights into the safety factor in industrial sites and learned many new technical skills. Our smart safety helmet has the ability to change the game in the industry and the environmental health and safety sector.

Acknowledgments

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