MECE 422 Multidisciplinary Engineering Design Project

Revolutionizing Post-Earthquake Operations with an Innovative Search & Rescue System Powered by Smart Sensor Technology

Dr. Zühal ERDEN

ATILIM UNIVERSITY 1996

Team

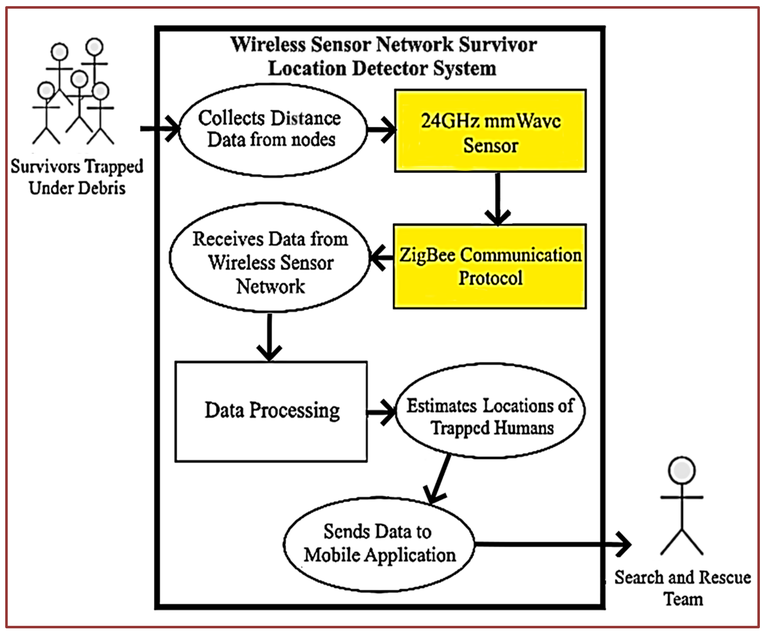
Yekta Güngör PARLAK	(EE)
Khamis Yousef AL-OBAIDLY	(MECE)
Berkay KOÇAK	(MECE)
Ömer Bahadır KUNDAK	(CMPE)
Cemre SÜMER	(CMPE)
Hasan ZİYADE	(MECE)

Purpose of the Project

The project aims to address the challenge of locating survivors trapped in post-earthquake debris by developing an innovative solution that enhances the effectiveness and efficiency of the search and rescue procedure. This will be achieved by reaching a larger number of survivors in a faster manner. With this purpose in mind, our project will enable real-time detection of trapped survivors in deep locations beneath building debris, allowing for accurate identification of their individual locations in a 3D pinpoint view.

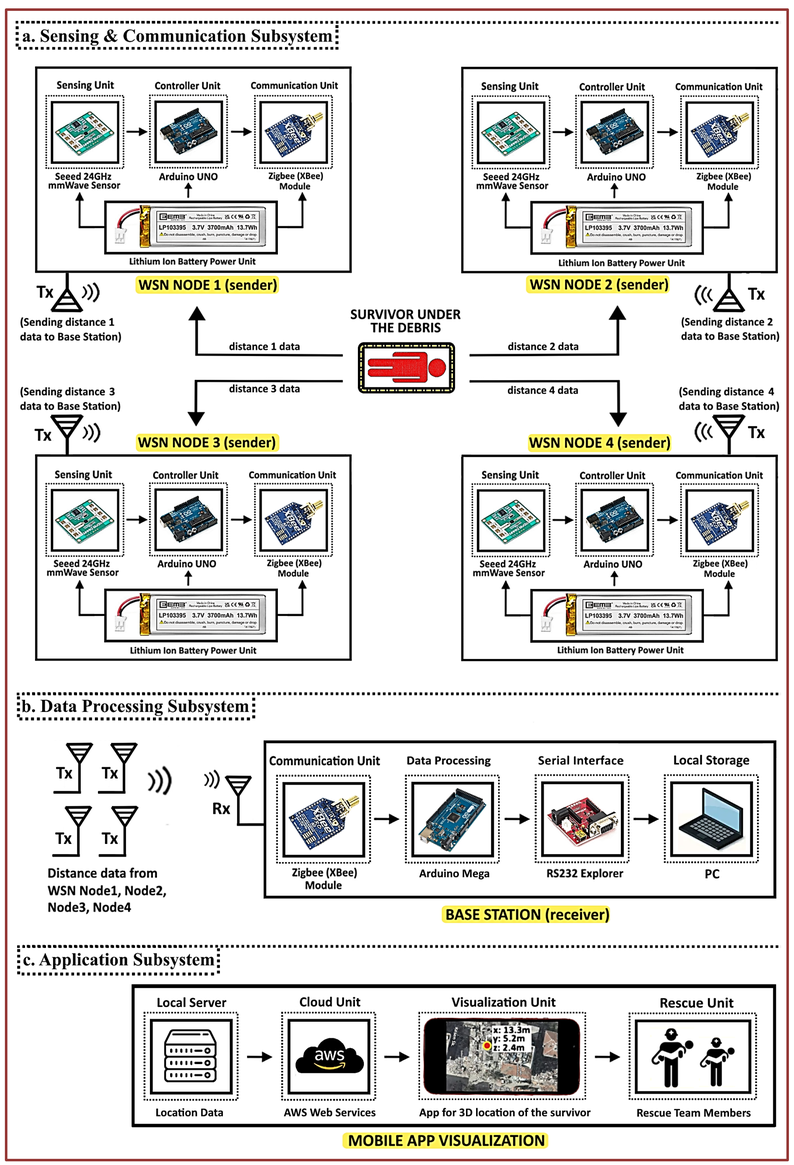
Literature Survey

For remote sensing search technologies, Pieraccini et al. (2002) demonstrated the potential of Synthetic Aperture Radar (SAR) in identifying structural changes in buildings caused by earthquakes, while N. Dahnoun et al. (2021) explored the effectiveness of millimeter-wave radar sensors in high-precision person detection and tracking for an indoor space and J. Wang et al. (2011) and F. Engmann et al. (2022) discussed the potential of Wireless Sensor Networks (WSNs) in the field of search and rescue operations. These studies collectively contributed to the growing body of knowledge surrounding remote sensing search technologies.



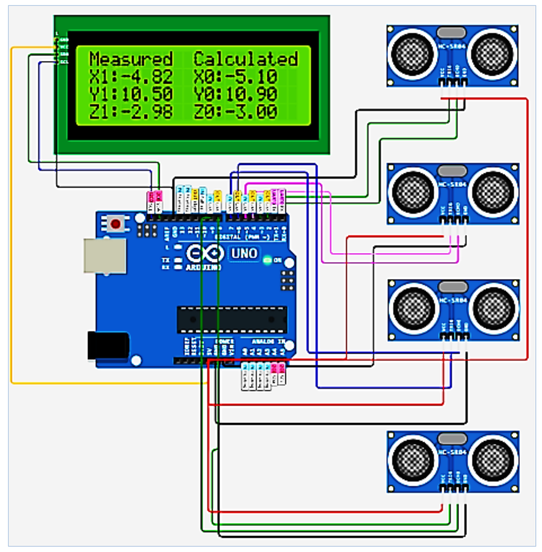
System Architecture

The designed system consists of three subsystems: the Sensing and Communication Subsystem, the Data Processing Subsystem, and the Application Subsystem. In the Sensing and Communication Subsystem, four WSN nodes with various components, such as the Power Unit, Sensing Unit, Controller Unit, and Communication Unit, work together. The nodes use a Lithium-Ion Battery for power, the Seeed 24GHz mmwave sensor for survivor detection, and the Zigbee protocol for wireless communication with the base station. The WSN nodes collect distance measurements (distance1, distance2, distance3, distance4) using the mmwave sensors and transmit the raw data to the base station. In the Data Processing Subsystem, the base station equipped with a 2.4GHz 2dBi RX Antenna receives the data and performs processing tasks. The collected distance data is then processed using the trilateration algorithm on an Arduino Mega connected to a PC via an RS232 interface. The trilateration algorithm calculates the survivor's position on the X, Y, Z plane using the four gathered distance measurements from the WSN nodes. Finally, the Application Subsystem sends the location data in real-time to a mobile app with AWS Web Services, where the pinpoint locations of survivors are displayed on a map for the rescue team's access and interpretation.

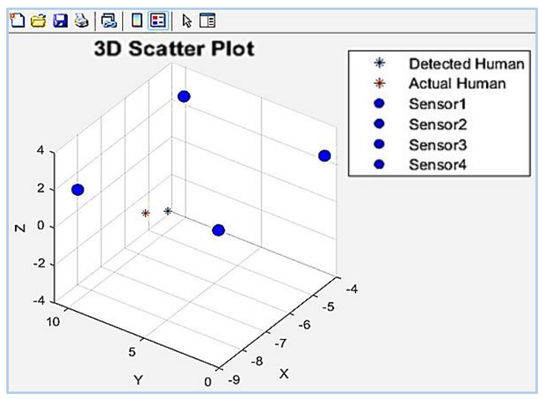


System Simulation

Arduino Simulation:



MATLAB Simulation:



Conclusion

In conclusion, our project successfully contributed to improving post earthquake operations and saving more lives through the developed search and rescue system. The selected design was represented with a clear system architecture visualization. Modeling and simulation techniques helped us refine the system behavior. Overall, our search and rescue system offers a promising solution for locating earthquake survivors.

References

- Cui, H., & Dahnoun, N. (2021). High Precision Human Detection and Tracking Using Millimeter-Wave Radars. IEEE Aerospace and Electronic Systems Magazine, 36(1), 22-32.

- Wang, J., Cheng, Z., Jing, L., & Yoshida, T. (2011). Design of a 3D localization method for searching survivors after an earthquake based on WSN. In 2011 3rd International Conference on Awareness Science and Technology (iCAST) (pp. 221-226). IEEE.

- Adu-Manu, K. S., Engmann, F., Sarfo-Kantanka, G., Baiden, G. E., & Dulemordzi, B. A. (2022). WSN Protocols and Security Challenges for Environmental Monitoring Applications: A Survey. Journal of Sensors, 2022, 1–21.