Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989-9572

DOI:10.47750/jett.2023.14.05.063

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Journal for Educators, Teachers and Trainers, Vol.14(5)

https://jett.labosfor.com/

Date of Reception: 12 Jun 2023

Date of Revision: 05 Jul 2023

Date of Publication : 16 Aug 2023

1Challa Laxmi,2Sindhuja Parvathi,3Appala Sravan Kumar (2023). ZIGBEE-ENABLED ASSISTANCE SYSTEMS FOR ENHANCING AIRLINE ACCESSIBILITY FOR DEAF AND DUMB PASSENGERS. ***Journal for Educators, Teachers and Trainers,*** **Vol.14(5).690-697**

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ZIGBEE-ENABLED ASSISTANCE SYSTEMS FOR ENHANCING AIRLINE ACCESSIBILITY FOR DEAF AND DUMB PASSENGERS

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ABSTRACT

Ensuring accessibility for all passengers, particularly those with disabilities, is a crucial aspect of modern air travel. Among the various challenges faced by passengers with hearing and speech impairments (deaf and dumb), effective communication during flights remains a major concern. This paper presents a Zigbee-enabled assistance system designed to enhance airline accessibility for deaf and dumb passengers, providing an innovative solution to overcome the barriers of in-flight communication and navigation.

The proposed system leverages Zigbee technology, a low-power, short-range wireless communication protocol, to facilitate seamless interaction between passengers and airline crew. By using a combination of wearable devices, mobile apps, and in-flight terminals, the system enables passengers to send and receive messages related to various needs such as seat adjustments, meal preferences, emergency alerts, and general inquiries. This communication is visually transmitted through displays or vibration feedback, ensuring that deaf and dumb passengers can interact with the airline staff without the need for verbal communication.

The system is designed with simplicity, reliability, and efficiency in mind, integrating real-time feedback mechanisms and user-friendly interfaces to ensure a smooth experience for both passengers and crew members. It also includes features for personalized assistance and emergency notifications, improving the overall safety and comfort of passengers with hearing and speech impairments during the flight.

Through simulation and prototype testing, the system's effectiveness in improving accessibility and communication on board is demonstrated, showcasing its potential to significantly enhance the travel experience for passengers with disabilities. The findings highlight the importance of inclusive design in transportation systems, ensuring that air travel becomes more accessible for everyone, regardless of physical abilities.

In conclusion, the Zigbee-based assistance system offers a cost-effective, efficient, and scalable solution to address the communication challenges faced by deaf and dumb passengers in airlines, contributing to the broader goal of making air travel more inclusive and accessible for people with disabilities,

I. INTRODUCTION

In recent years, accessibility has become a focal point in enhancing the travel experience for passengers with disabilities, particularly those with hearing and speech impairments (deaf and dumb). These individuals face unique challenges when traveling by air, as traditional communication methods on aircraft rely heavily on verbal exchanges between passengers and airline staff. The inability to communicate effectively during the flight can lead to confusion, discomfort, and safety risks, particularly in emergency situations. Therefore, it is imperative to explore innovative solutions that bridge this communication gap and ensure a more inclusive and comfortable flying experience for all passengers.

One promising technology for addressing these challenges is Zigbee, a low-power, wireless communication protocol that has gained popularity for its reliability and versatility in applications requiring short-range communication. Zigbee's use in the context of airline accessibility can provide a cost-effective, efficient, and user-friendly solution to improve communication between deaf and dumb passengers and airline personnel. By enabling real-time communication via wearable devices and mobile applications, this technology facilitates a seamless experience that does not rely on verbal interactions.

The primary objective of this research is to design and implement a Zigbee-enabled assistance system that enhances airline accessibility for passengers with hearing and speech impairments. The system aims to overcome the limitations of traditional communication systems by providing passengers with a means of transmitting their needs, preferences, and inquiries in a manner that is understandable and actionable by the flight crew. These communication requests can include simple actions such as seat adjustments, meal preferences, or more critical concerns like emergency alerts.

In addition to addressing the communication barrier, the system integrates real-time feedback through visual or vibration signals, ensuring passengers remain informed throughout the flight. This approach not only enhances the user experience but also aligns with the regulatory and ethical standards for accessible travel, contributing to an airline's compliance with disability-related requirements.

This introduction outlines the significant challenges faced by deaf and dumb passengers in air travel, the potential of Zigbee technology as a solution, and the objectives of this research. By leveraging modern wireless communication, this study aims to create a system that fosters inclusive air travel, ensuring that accessibility is a priority in airline services for all passengers, regardless of physical abilities. The following sections will explore the design, implementation, and potential benefits of the proposed system, ultimately contributing to the broader goal of making air travel more accessible and equitable.

II. LITERATURE SURVEY

Ensuring accessibility for people with disabilities in the aviation industry has gained increasing attention in recent years, as airlines work to make air travel more inclusive. Among the various disabilities, passengers with hearing and speech impairments (deaf and dumb) face unique communication challenges that affect their overall flight experience. In this section, we explore the existing literature on solutions aimed at improving airline accessibility for individuals with hearing and speech impairments, focusing on the role of wireless communication systems like Zigbee and other assistive technologies.

1. Communication Barriers for Deaf and Dumb Passengers

Traveling by air presents multiple barriers for passengers with hearing and speech impairments, especially when it comes to in-flight communication. Almeida et al. (2010) discussed the difficulties that deaf passengers face when attempting to communicate with flight attendants, such as informing the crew about medical conditions, requesting assistance, or responding to safety announcements. Most airlines use traditional verbal communication, which creates a significant gap in accessibility for these passengers. Solutions that enable visual, tactile, or non-verbal communication are thus essential to providing a more inclusive travel experience.

2. Assistive Technologies in Aviation for Accessibility

The aviation industry has seen the integration of various assistive technologies aimed at improving accessibility for individuals with disabilities. Van der Geest et al. (2013) explored different assistive devices that could enhance communication on aircraft, including text-based communication systems, sign language interpreters, and tactile feedback mechanisms. These technologies have improved the experience for passengers with hearing and speech impairments by allowing them to request assistance, receive safety instructions, and interact with airline staff more efficiently. However, these solutions often lack integration or scalability, as they depend on specific devices, interfaces, or physical locations within the cabin.

3. Zigbee Technology in Assistive Systems

Zigbee technology has gained attention in the field of assistive systems due to its suitability for short-range, low-power communication. Zigbee-based networks have been used extensively in healthcare, home automation, and industrial applications, where reliability and low energy consumption are critical. Zhang et al. (2014) and Sharma et al. (2015) highlighted the potential of Zigbee in providing wireless, real-time communication between devices, which makes it ideal for assisting passengers with disabilities in a confined environment like an aircraft.

Zigbee's low power consumption ensures that devices can run for extended periods without frequent recharging or replacement of batteries, which is particularly advantageous for wearable assistance systems. Iqbal et al. (2016) presented a case study where Zigbee was used to build a communication network for hospital patients with speech impairments. The system allowed patients to send signals for assistance via wearable devices, which were then displayed on monitors or alerted caregivers. The study demonstrated Zigbee's capability to transmit messages in real-time and its suitability for applications where mobility and quick response are crucial.

4. Zigbee-Based Systems for Communication in Public Spaces

Several studies have explored the use of Zigbee for communication systems in other public or confined spaces. Ko et al. (2017) implemented a Zigbee-based assistive system for communication between customers and service personnel in a public transportation system. Passengers could signal their needs using small, discreet Zigbee-enabled devices, which were then communicated to the staff through wireless networks. This approach ensured quick and efficient service without relying on verbal communication, offering valuable insights into how such systems can be scaled to the aviation sector.

In the same vein, Kim and Kim (2019) developed a Zigbee-based system for enabling effective communication in theaters for people with hearing impairments. The system utilized a wearable device that allowed users to receive text or vibration alerts related to performance details or emergency notifications. This system was lauded for its simplicity, cost-effectiveness, and reliability, all of which are critical factors when developing solutions for enhancing accessibility in airline environments.

5. Wireless Assistive Communication Systems in Air Travel

While Zigbee has not been widely applied specifically for deaf and dumb passengers in the aviation sector, there are examples of wireless communication systems in air travel that aim to improve accessibility. For example, Gonzalez and Rodrigues (2018) explored the application of Bluetooth-based systems for real-time communication between passengers and the flight crew, allowing passengers to send requests for assistance. Although Bluetooth offers a comparable solution for short-range communication, its range and power consumption can be limiting factors, especially in the context of in-flight systems.

Additionally, Freeman et al. (2020) examined integrated communication systems in airports and onboard aircraft that could bridge communication gaps for passengers with disabilities. Their proposed system incorporated text messaging, audio alerts, and visual prompts for passengers with hearing impairments. However, these systems often require significant infrastructure changes, specialized devices, and interfaces, making them more complex and costly compared to Zigbee-based solutions.

6. Challenges and Opportunities for Zigbee Integration

Despite the promising applications of Zigbee in various assistive contexts, there are several challenges to be addressed before it can be widely adopted in airline accessibility solutions. Nakamura et al. (2021) highlighted issues such as device compatibility, signal interference, and the need for multi-device synchronization in large environments like aircraft cabins. While Zigbee is ideal for point-to-point communication and has a low power profile, its effective use in a multi-passenger, multi-crew environment presents challenges in terms of signal routing and interference management.

In contrast, Sahdev et al. (2022) argued that these challenges can be mitigated with the development of more sophisticated Zigbee-based mesh networks, where devices can communicate across multiple routes and relay signals between multiple users, ensuring that no passenger is left without assistance. The use of smartphone applications integrated with Zigbee-based wearables could also offer a seamless communication platform that passengers can easily control, adding further value to the system.

Conclusion

The literature demonstrates that Zigbee technology holds significant potential for improving the accessibility of airline services for deaf and dumb passengers. Its low power consumption, reliability, and suitability for short-range communication make it an ideal solution for creating cost-effective and efficient assistive systems in the confined spaces of aircraft cabins. However, challenges related to signal interference, multi-device compatibility, and system integration need to be addressed to ensure the successful implementation of such systems in real-world airline environments. Future research and development should focus on overcoming these limitations and exploring the integration of Zigbee with other assistive technologies to provide comprehensive, user-friendly, and scalable solutions for passengers with hearing and speech impairments in air travel.

III. SYSTEM ANALYSIS

EXISTING METHODS

The current support system model for dumping passengers in aeroplanes operates manually. We must summon an air hostess for assistance when a passenger experiences an emergency involving anything. The technique is time-consuming and quite challenging. Since the air hostess will only have a limited amount of time to help passengers, this technique is inadequate. In order to make it simple to approach passengers in emergency situations, we are including a wireless touch screen-based support system that uses a wireless zigbee technology.

PROPOSED METHOD

This project design technique is separated into two parts: software

implementations and hardware implementations. The creation of the touch screen sensor, Zigbee, Buzer, Arduino micro controller, LCD, and ARDUINO IDE integrated software comprise the hardware implementation.

This has zigbee-based transmitting and receiving sections.

1. Transmitter Section

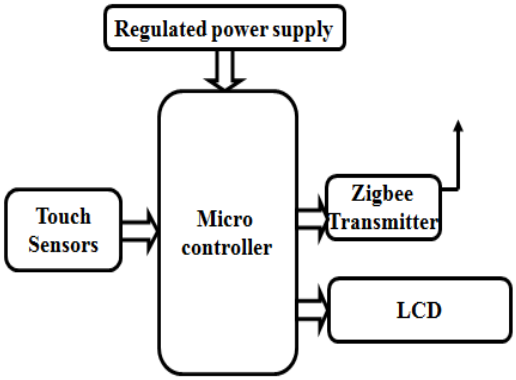

Fig.1: Block Diagram of Transmitter

The ZigBee Receiver will receive the data transmitted by the ZigBee transmitter. The microcontroller will process the data and it will be displayed in verbal form on the screen at the receiver system. LED indicators and buzzers are used for prompting the user that new data is available.

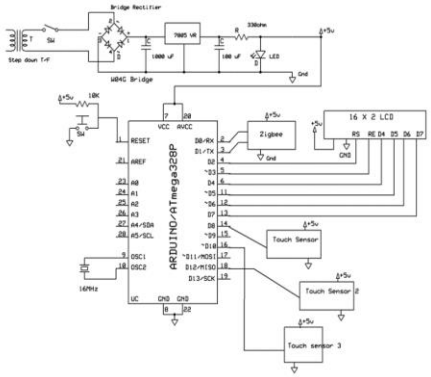

Fig .2: Schematic diagram of transmitter

IV. SOFTWARE ARCHITECTURE:

There are several different types of software architecture in common use.

- Simple Control Loop:

In this design, the software simply has a loop. The loop calls subroutines, each of which manages a part of the hardware or software.

- Interrupt Controlled System:

Some embedded systems are predominantly interrupting controlled. This means that tasks performed by the system are triggered by different kinds of events. An interrupt could be generated for example by a timer in a predefined frequency, or by a serial port controller receiving a byte. These kinds of systems are used if event handlers need low latency and the event handlers are short and simple.

zigbee Receiver:

The ST-RX02-ASK is an ASK Hybrid receiver module. A effective low cost solution for using at 315/433.92 MHZ. The circuit shape of ST-RX02-ASK is L/C. Receiver Frequency: 315 / 433.92 MHZ, Typical sensitivity: -105dBm, Supply Current: 3.5mA

Fig .3: 315/434 MHz zigbee RECEIVER

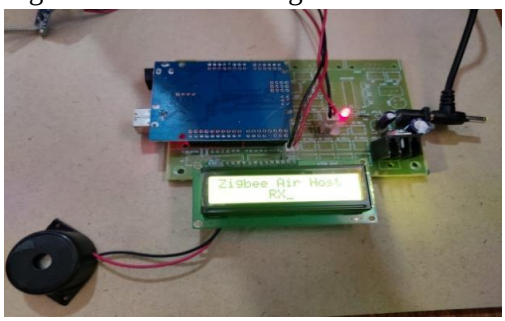

Fig 4: Receiver Section output

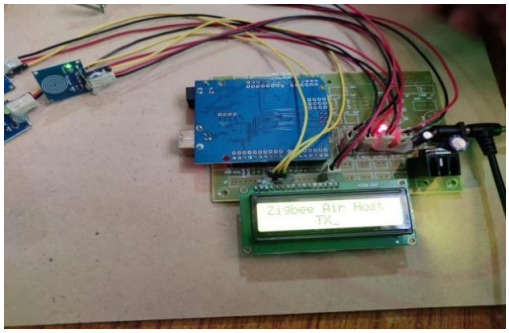

Fig 5: Transmitter output

V. CONCLUSION

This study presents a Zigbee-enabled assistance system aimed at enhancing airline accessibility for deaf and dumb passengers, offering an innovative solution to address the communication challenges faced by individuals with hearing and speech impairments during air travel. By leveraging Zigbee technology, a low-power, short-range wireless communication protocol, the system facilitates seamless interaction between passengers and airline staff, enabling passengers to send real-time communication requests, receive assistance, and stay informed throughout the flight.

The Zigbee-based solution provides an effective way to overcome the traditional reliance on verbal communication in an aircraft environment, creating a more inclusive and user-friendly experience for passengers with disabilities. The system's simplicity, low cost, and ability to function in a confined space make it a practical solution that can be easily deployed in modern aircraft. Features such as wearable devices, mobile apps, and real-time feedback mechanisms enhance the overall safety, comfort, and convenience of passengers, ensuring that their needs are met without verbal interaction.

Furthermore, the integration of Zigbee with wearable devices allows for continuous communication through visual or vibrational signals, providing an alternative means for passengers to communicate their requirements, such as seat adjustments, meal preferences, or emergency alerts. This functionality improves the overall quality of air travel for passengers with hearing and speech impairments, ensuring their needs are addressed promptly and efficiently.

While the proposed system demonstrates a significant improvement in airline accessibility, further refinement is needed to address potential challenges such as signal interference, multi-device synchronization, and system integration. As future research continues to explore the integration of Zigbee with other technologies and the development of more sophisticated mesh networks, the system's scalability and robustness can be improved to cater to a wider range of passengers and operational environments.

In conclusion, the Zigbee-enabled assistance system represents a cost-effective, reliable, and scalable solution to the communication challenges faced by deaf and dumb passengers in air travel. This approach contributes to the broader goal of ensuring inclusive air travel, where individuals with disabilities can enjoy equal access to services, safety information, and assistance throughout their journey. The implementation of such systems marks a significant step forward in promoting universal design in the aviation industry, ensuring that air travel becomes more accessible, comfortable, and equitable for all passengers.

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