Survey of Smart Technologies for Application in Home Elderly Care

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This project addresses the increasing demands of an aging population and the need to adapt social structures to accommodate elderly individuals better in specialized care settings. As the number of elderly individuals grows, there is a pressing need for practical solutions to enhance their quality of life and ensure their well-being. The methodology employed in this project includes a comprehensive survey of care environments' characteristics and a thorough analysis of available intelligent technologies. These technologies encompass various communication options such as RFID, Bluetooth Low Energy (BLE), LoRaWAN, ZigBee, and Ultra Wideband, as well as a range of sensors designed to monitor sleep, physical activity, and nutrition among the elderly. Implementing these intelligent technologies aims to facilitate the early identification of potential health risks and provide continuous monitoring of the elderly's overall quality of life and health. Preliminary tests have indicated the necessity for further investigation into additional resources to enhance the effectiveness and coverage of these sensors.
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The aging population has led to an increasing demand for solutions that address the specific needs of elderly individuals, particularly in specialized care environments such as nursing homes. In this context, integrating innovative technologies is crucial for enhancing the quality of life and ensuring the safety of these individuals.

A primary concern in these environments is the safety of residents. Sensory technologies can address this issue by improving safety and preventing accidents. Sensors can detect movements, falls, and other events that may jeopardize the health and well-being of the elderly. Preventative measures can be taken with such data, such as alerting caregivers or family members responsible for the resident's safety. Additionally, sensory technologies can offer other benefits, including monitoring sleep quality, physical activity, and nutrition, thereby contributing to improved health and quality of life for the elderly.

In the project's initial phase, conducted in 2022, various indoor location and monitoring communication technologies were evaluated, including RFID, Bluetooth Low Energy (BLE), LoRaWAN, ZigBee, and Ultra Wideband. Each technology exhibited distinct advantages and disadvantages regarding range, cost, power consumption, and compatibility with other devices. After a thorough comparison, the most suitable technologies were selected for specific applications within the project.To monitor the sleep of elderly individuals, several sensor options available on the market were considered in the first phase of the project, including motion sensors, pressure sensors, and ultrasonic sensors.

A well-evaluated solution for the project was using ultrasonic sensors capable of detecting the chest and abdomen movement during breathing. This allows caregivers to monitor the frequency and quality of patients' breathing. Additionally, the data collected can be analyzed to identify possible anomalies or patterns that could indicate respiratory problems, enabling preventive actions to provide more effective care for the elderly, thus increasing quality of life and reducing health risks [1-3].

Among the communication technologies assessed, preliminary evaluations highlighted that BLE (Bluetooth Low Energy) technology, while promising in aspects such as low energy consumption and high compatibility with other devices, faced significant challenges. Subsequently, tests and experiments were carried out with RFID (Radio-Frequency Identification) technology, chosen for its feasibility of implementing Arduino

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and the MFRC522 module, widely used for contactless communication. This project proposes to continue evaluating and implementing the selected technological solutions for monitoring in a nursing home setting.

Materials and Methods

The method adopted for this project involved evaluating two main options: beacons (BLE) and RFID. Initially, beacons were considered due to their ability to provide indoor location tracking, enabling real-time monitoring of elderly individuals' movements and locations. Their low energy consumption would allow for their installation in various locations within the home, facilitating caregiver oversight. However, after encountering issues with BLE devices, such as communication problems and high import costs, RFID technology was selected for further testing and experimentation. The MFRC522 RFID reader module, based on the NXP chip, was chosen due to its affordability, ease of implementation, and widespread availability. This module operates at a frequency of 13.56 MHz and supports contactless communication, allowing it to read and write on cards adhering to the Mifare standard.

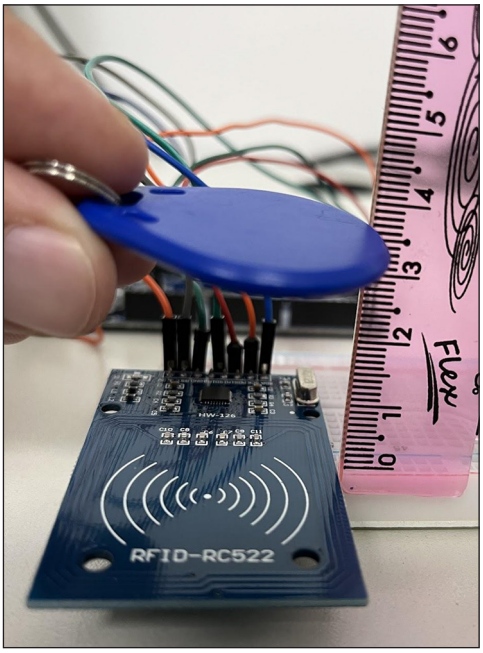
A code was developed for Arduino using the Arduino IDE software to test the viability of RFID technology. The experiments included jumpers, a breadboard for connecting components, an Arduino Mega 2560 microcontroller, and a computer. A simple code was created to test the RFID module's functionality and determine the distance at which the sensor can detect RFID tags, assessing the feasibility of this technology for the project.

The system was designed to collect data by positioning the RFID reader at various locations, such as doors, and attaching RFID tags to patients' clothing. This setup aimed to monitor specific metrics, such as the number of trips and the average time each person spent in the bathrooms. The code checks for nearby RFID tags, and when detected, it reads their serial numbers and displays them on the serial port. This setup evaluated the average distance at which the RFID module can read the tags. The tags were gradually removed from the reader, and detection and instances of reading failures were noted. Measurements were taken with a ruler to determine the effective range of the RFID module.

Results and Discussion

Figure 1 shows the measurements taken with a ruler. The results showed that the maximum range of the RFID reader, with repeatability tested 20 times, was approximately 48 mm. This range is insufficient for meeting the application's specific needs, as a typical door has dimensions of approximately 210 cm x 80 cm. Therefore, the sensor's range is inadequate for detecting a tag on a patient's clothing from such a distance. The tests demonstrated the need for additional investigations to improve BLE and RFID technologies, focusing on enhancing the ability to provide indoor patient location for monitoring bathroom visits and assessing the cost-benefit of implementation. Other communication technology options are still being considered for the project's implementation

Figure 1. Tests for measuring the sensor's average detection distance.



of intelligent solutions in the nursing home. Technologies such as LoRaWAN and ZigBee are under evaluation, and other technologies that still need to be addressed could be studied and evaluated.

Conclusion

This study investigated intelligent technologies to improve the care and safety of older adults in specialized homes. Innovative technologies can offer numerous benefits to nursing homes, enhancing patients' safety, comfort, and overall well-being. Various communication technologies and sensor options, including motion, pressure, and ultrasonic sensors, were meticulously evaluated. However, the tests revealed a need for further investigation to enhance the selected solutions, particularly concerning the range and effectiveness of these sensors.

Moreover, trained professionals must use these technologies appropriately to ensure that elderly individuals receive comprehensive and high-quality care at home. Despite the challenges, using intelligent technologies presents a promising option for improving the quality of life for the elderly and providing more effective care. Therefore, continued exploration and refinement of available technologies are essential to advancing the well-being and safety of older individuals in specialized care settings.

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