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The Development Of Item Locating Device Utilizing Arduino And Radio Frequency Transmitter And Receiver Modules

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Abstract: Losing or misplacing personal belongings is an old-age problem that persists to this day. This is aggravated by the widespread usage of pricey gadgets and their related mobility, which causes wasted time in locating misplaced objects. Issues with item-locating trackers, in addition to healthcare professionals tasked with retrieving their patients' misplaced belongings who have cognitive impairments, are the misuse of item-locating trackers to aid dangerous purposes such as stalking due to the Bluetooth tracking technology. To find a feasible solution to these problems in a convenient and cost-efficient manner, this study made use of the quantitative experimental research design to develop an item locating device utilizing arduino and radio frequency transmitter and receiver modules. The device made use of radio frequency transceiver chips as its main components because they are readily available on the market and can be found in a variety of electronic products. The RF technology makes use of radio frequency signals to determine the distance between the user and the misplaced item, offering a wireless and convenient tracking method. This device intends to help people find their lost items conveniently by providing a beeping sound that will alert them to the location of the lost item, whether it is underneath other materials or not. For the item locating device to be improved, it is recommended to upgrade the antenna of the device, which will provide the device with a better connection and enable the device to reach further distances. The product promises convenience and affordability.

Keywords - Affordability, Convenience, Misplaced Objects, Trackers

1. INTRODUCTION

The way people live, work, and communicate has been significantly impacted by modern technology. Despite the abundance of high-tech devices created to minimize the loss of misplacement of personal items, such as keys, wallets, and bags. The consequences of misplacing such devices extend beyond material loss, affecting professional obligations and personal connectivity. Losing or misplacing personal belongings can be frustrating and stressful for anyone as it contributes to their irritation, anxiety, and interpersonal conflict. Frustration, unanticipated search times, and the inability to complete one's task on time come along with trying to find lost valuables (Weernink et al., 2018). This emotional distress can impact daily productivity and overall well-being; along with that, attempting to find these items consumes a lot of time. In the recently mentioned research, it was highlighted that the misplacement of belongings is no different in the world of healthcare and runs rampant among nursing homes that house residents with dementia.

In a study conducted by Bahadir-Yilmaz and Ata (2018), 33.3% of patients older than 65 had cognitive and functional impairments that could be related to dementia. Dementia leads to the deterioration of cognitive function, affecting memory, and causing problems such as misplacing personal belongings. Patients diagnosed with dementia are prone to losing their items so the burden of retrieving them falls into the hands of the caregivers assigned to assist them–which could be a difficult task balancing having to search for a missing item and comforting the frustrated patient.

Additionally, such devices are designed to help locate misplaced or lost items however, they are not always used for their intended purpose as there have been cases wherein they have been used for domestic abuse, stalking, and tracking others without their consent (Turk et al., 2023). There is a significant need for a portable tool for finding missing objects that are manufactured to be anti-stalking by not utilizing Bluetooth tracking technology as Bluetooth-based item trackers have sparked apprehension over their potential misuse in harmful stalking and privacy violations (Shafqat et al., 2023).

An Item Locating Device is a device that can be attached to an item to indicate the item's location by sending and receiving radio waves. The device assists the owner in finding misplaced items so long as the tracker is near or attached to the item. It does this by measuring the time it takes to go back to the transmitter to determine the distance the user and the misplaced item are from each other. Radio Frequency transceiver chips or RF transceiver chips will be the main parts to be used to conduct this study. These components will work together by having one module transmit a radio signal that will be received by the second module, making use of a buzzer to produce noise. RF transceiver chips are commonly used in tv remotes, car keys, wireless garage door openers, cordless telephones, wireless alarm systems, Wi-Fi transmitters, and Bluetooth radio devices. In addition, its use of wireless technology sets aside the use of wires to communicate which makes it more convenient to handle and operate.

RF technology has contributed to the development of communication applications and expertise in electronics. While objects like structures, furniture, cars, and people transmit, reflect, block, and disperse radio frequency signals, it is still possible to gather pertinent information from radio frequency signals such as one's location, movement, speed, and vital signs. Radio frequency sensing offers consumers inexpensive and unobtrusive services as opposed to conventional hardware sensors (Lubna et al., 2022). This main component is a technology that is used to communicate data wirelessly to and from different places, making it a feasible component in creating an item locating device.

This study holds significant benefits for Philippine School Doha, people of all ages, and future researchers. It aims to develop an item locating device with features of enhancing convenience, accessibility, and affordability. By addressing the frustration associated with misplaced items, the tracker intends to make users' lives more convenient, particularly aiding older individuals, those with cognitive impairment, and the healthcare professionals assigned to assist them in easily retrieving their belongings. Moreover, its cost-effective design ensures accessibility to a wide range of users, making it a budget-friendly option compared to existing tracking devices in the market. Not only does it provide assistance in item retrieval, but it also offers peace of mind through its valuables tracking capabilities, contributing to enhancing security for its users. Overall, the development of this tracker represents a significant step towards improving daily convenience, accessibility, and security for individuals of all ages.

2. STATEMENT OF THE PROBLEM

The main objective of this study is to make an Item Locating Device using Arduino and Radio Frequency Transceiver Modules. Specifically, it answers the following questions:

1. What is the maximum connection range of the Item Locating Device?
2. What is the loudness of the Item Locating Device when tracking the chip?
3. How effective is the Item Locating Device at detecting the chip beneath materials at various distances?

3. PURPOSES OF THE STUDY

The purpose of this study is to address the problem of losing items. The goal is to create a device that makes it easier to locate misplaced items, making them more convenient and accessible. This study aims to develop a solution that not only helps find lost items but also provides peace of mind with its tracking features, taking into account the effects of loss of personal belongings and the difficulties faced by caregivers assisting individuals with dementia. Using wireless technology, this device aims to provide a cost-effective solution while improving the safety and well-being of its users.

4. OBJECTIVES OF THE STUDY

The objective of this study is to make an Item Locating Device using Arduino and Radio Frequency Transceiver Modules that has a successful connection, adequate volume for better item detection, and ability to be detected under different materials at different distances. This study also assesses the enhanced accessibility and convenience in finding lost items.

This study also assesses the practicality and usability of the development system considering factors such as the reliability and energy efficiency of the device. Hence the study also points out the differentiation of the Voice-Commanded Automatic Vacuum Cleaner's abilities compared to other factory made automatic vacuum cleaners. Additionally, The objective of the Voice-Commanded Automatic Vacuum Cleaner is to improve the indoor air quality of our homes as there is always dust that is being generated due to the amount of time being spent inside the house.

5. RESEARCH HYPOTHESIS

H1: The development of an Item Locating Device utilizing Arduino and Radio Frequency Transmitter and Receiver Modules is possible.

6. RESEARCH METHODOLOGY

6.1. Research Design

This study utilized the experimental design of research. Experimental research design is defined as an application of tests that focus on constructing research that is high in causal (or internal) validity. In this study, radio frequency transceiver modules will be the independent variables, and the item locating device will be the dependent variable. Causal validity is high when we can find a direct correlation between the distances of the transmitter/tracker devices from each other and the time it takes for the tracker to locate it. Quantitative research yields results that can be used to characterize or note numerical changes in measurable qualities of a population of interest, generalize to other, similar circumstances, explain predictions, and explain connections between variables (Kraska, 2022). It is essential to use this method as it provides a high level of control over the variables that demonstrate an outcome and is advantageous in obtaining accurate, consistent, and precise results.

6.2 Research Locale

The research study was conducted at Philippine School Doha in Doha, State of Qatar, specifically in the Mesaimeer Area (Zone 56), Al Khulaifat Al Jadeeda Street (St. 1011), as the researchers are not only students of this school but also required facilities present in the school that will enable them to make their product.

6.3 Data Gathering Procedure

The procedure shows the step-by-step process of how to make an Item Locating Device out of Arduino and Radio Frequency Transceiver Modules and how its effectiveness was tested.

6.3.1 Ensuring protection and maintaining safety

Wear personal protective equipment such as safety goggles, safety gloves, or face masks while performing the procedure for the development of the Item Locating Device to avoid hazardous conditions.

Creating the Receiver

1. Connect an antenna wire to the antenna connection socket of the receiver module.
2. Connect the RF Wireless RX Module and Arduino Nano to the Mini breadboard.
3. Connect the GND pin of the RF Wireless RX Module to the GND pin of the Arduino.
4. Connect any DATA pin of the RF Wireless RX Module to the D11 pin of the Arduino.
5. Connect the VCC pin of the RF Wireless RX Module to the 5V pin of the Arduino.
6. Connect the negative wire of the passive buzzer to the GND pin of the Arduino.
7. Connect a resistor from the D13 pin of the Arduino Nano to the positive wire of the passive buzzer.
8. Connect the negative wire and positive wire of the 9v battery to the GND pin and the VIN pin of the Arduino respectively.
9. Make the case for the receiver.

Creating the Transmitter

1. Connect an antenna wire to the antenna connection socket of the transmitter module.
2. Connect the RF Wireless TX Module and Arduino Nano to the Mini breadboard.
3. Connect the GND pin of the RF Wireless TX Module to the GND pin of the Arduino.
4. Connect the VCC pin of the RF Wireless TX Module to the 5V pin of the Arduino.
5. Connect the DATA pin of the RF Wireless TX Module to the D12 pin of the Arduino.
6. Connect a wire from the right terminal of the push button to the 5V pin of the Arduino.
7. Connect a wire from the left terminal of the push button to the D7 pin of the Arduino.
8. Connect a resistor from the left terminal of the push button to the GND pin of the Arduino.
9. Connect the negative wire and positive wire of the 9v battery to the GND pin and the VIN pin of the Arduino respectively.
10. Make the case for the transmitter.

7. RESULTS

This part contains the results and interpretations of the data collected during the testing procedure in connection to the research topics.

7.1 The maximum connection range of the Item Locating Device

Table 1: Connection Range of Item Locating Device to the Object

Trials	Distance (in meters)	Detection	Photos
1	1 meter	Detected	
2	2 meters	Detected	

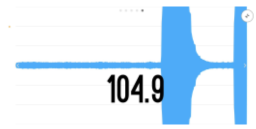
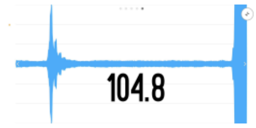
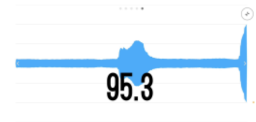
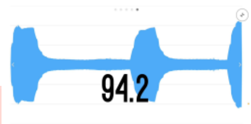
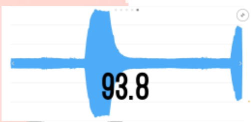
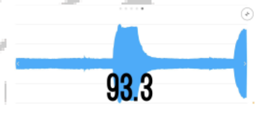
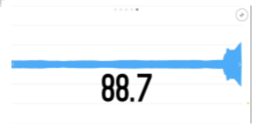
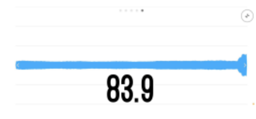
3	3 meters	Detected	
4	4 meters	Detected	
5	5 meters	Detected	
6	6 meters	Detected	
7	7 meters	Detected	
8	8 meters	Detected	

Table 1 shows if the receiver was able to receive the connection from the transmitter from different distances. The connection range of the item locating device to the object was tested using a tape measure, which measured the distance of the transmitter from the receiver. Table 1 has eight trials that measure the connection range of the two devices at the following distances: 1m, 2m, 3m, 4m, 5m, 6m, 7m, and 8m. Results show that the receiver successfully detected the connection from the transmitter in all trials which justifies the alternative hypothesis of the research that the development of an Item Locating Device utilizing arduino and radio frequency transmitter and receiver modules is possible.

The strength of the connection, however, decreases as the distance increases. This result emphasizes the importance of understanding the limitations imposed by environmental factors such as interference on signal transmission (Onwuka, 2018). These communication systems use radio frequency (RF) carrier signals, which deteriorate owing to attenuation and interference as they pass through the air interface. This pattern indicates that the tracker's effectiveness diminishes beyond a certain distance, likely due to signal degradation. Through these limitations, researchers can enhance the tracker's functionality or develop alternate approaches to overcome such limitations. This interpretation highlights the practical implications of the research findings and emphasizes the need for further investigation into enhancing the reliability and range of the tracker.

7.2 The loudness of the receiver of the Item Locating Device when tracking the chip

Table 2: Loudness of the Item Locating Device when tracking the chip

Trials	Distance (in meters)	Volume (in decibels)	Pictures
1	1m	104.9 dB	
2	2m	104.8 dB	
3	3m	95.3 dB	
4	4m	94.2 dB	
5	5m	93.8 dB	
6	6m	93.3 dB	
7	7m	88.7 dB	
8	8m	83.9 dB	

The testing of the item locating device's noise level using a decibel-measuring app revealed that the volume varied at different distances. Table 2 shows if the receiver was able to track the volume from different distances. Table 2 has eight trials that measure the loudness of the receiver when it is being detected by the transmitter at different distances ranging from one meter to eight meters. The volume at distances of one meter to two meters varied only by 0.1 decibels. There was a significant decrease in volume for Trial 3, with a distance of three meters, and maintained a relatively similar volume up to five meters. There was another significant decrease in volume between distances of six meters to seven meters. The average volume of the device from the eight trials conducted from distances of one meter to eight meters is 94.86 decibels.

The highest volume detected was 104.9 dB when the two devices had a small distance of one meter between them, and the lowest volume detected was 83.9 dB when the two devices had a large distance between them of eight meters. This suggests that the noise level is inversely proportional to the distance as it consistently decreases as the distance between the two devices increases. It indicates that there are complex connections between the environment and the seismic waves, affecting how the signals travel and are received. The noise level is inversely proportional to the distance between the two devices, but there will always be sound emitting from the receiver as long as it gets a signal from the transmitter.

The spectrum of a sound changes with distance from the sound source, even if the interference of other sound sources or barriers is excluded, because the attenuation rates of high- and low-frequency components differ (Li et al., 2020). The noise level varies depending on how far away you are. These findings suggest a complex connection between environmental conditions and sound wave travel and transmission (Bhavitha, 2022). However, despite its range, the gadget does not have a consistent signal quality, even in the presence of noise changes. This emphasizes how crucial it is to explore these issues, such as signal interference and inconsistent signal quality, in order to improve application in related fields.

7.3 Effectiveness of the Item Locating Device at detecting the chip beneath materials at different distances

Table 3: Ability of Item Locating Device to detect the signal beneath materials at different distances

Trial	Material	Distance (in centimeters)	Picture
1	Ceramic Bowl	326 cm	
2	Plastic Container	69 cm	
3	Steel Bowl	61 cm	
4	Aluminum Foil	0 cm	

The ability of the item locating device to detect signals beneath materials at different distances was tested using different materials such as ceramic, plastic, steel, and aluminum foil. Table 3 has 4 trials that measure the ability of the receiver to detect the connection from the transmitter under different materials. The effectiveness of the receiver in detecting the connection from the transmitter under different materials at different distances was measured using a ruler. The receiver was able to detect the connection from the transmitter successfully at 326cm or 3.26m under the ceramic material, 69cm or 0.69m under the plastic material, and 61cm or 0.61m under the steel material, and was unsuccessful in detecting a connection under the aluminum foil material.

Ceramic and plastic, being insulators, have relatively low electric conductivity, which allows RF signals to pass through them. Steel is a conductor and would typically reflect the RF signals. However, its composition, such as thickness, should be taken into consideration as to how it resulted in a successful connection. The receiver was unable to detect any connection from the transmitter at all under the aluminum foil material. This is because aluminum foil effectively blocks radio frequency waves due to its high electrical conductivity and thickness relative to the wavelength of RF waves. When radio frequency waves encounter aluminum foil, the metal's conductivity allows it to form surface currents that generate electromagnetic fields, which in turn reflect the incoming waves away from the foil. Additionally, the thickness of aluminum foil prevents RF waves from penetrating through it. This combination of reflective properties and thickness creates a barrier that effectively blocks RF waves from passing through the foil (Chen et al., 2019).

8. DISCUSSION

The study on item locating devices provides insights into addressing the issue of lost items especially for individuals with cognitive impairments such as dementia. It reveals that the device's effectiveness decreases as the distance from the lost item increases, emphasizing how environmental factors like signal interference can affect its performance. Additionally the study found that higher levels of noise are beneficial in helping users locate items by emitting noise cues. However the inconsistent signal quality points to the need for solutions to minimize interference and ensure performance of the device for convenience and security.

By overcoming the challenges identified in the study there is potential for developing an item locating device that enhances accessibility and convenience in finding lost items. These findings provide insights for enhancing the device's features to assist individuals with cognitive impairments who often experience distress when losing personal belongings. The study sets a foundation for creating an efficient item locating device offering practical benefits to those in need of help finding misplaced items while promoting overall well being and peace of mind.

Based on the results, the development of an Item Locating Device with the use of Arduino and Radio Frequency Transmitter and Receiver Modules is possible. The receiver of the Item Locating Device is able to detect a connection from the transmitter in most trials considering the range and presence of physical barriers. The maximum effective range recorded by the researchers is sufficient for short-range tracking. The loudness of the receiver is adequate in allowing for easier item detection. The researchers made use of 2 insulators and 2 conductors as the physical barriers; namely: ceramic, plastic, steel, and aluminum foil. The connection detection proved successful for only the ceramic, plastic, and steel and received no connection at all through the aluminum foil. This implies that physical barriers have considerable effect on the connection range between the receiver and transmitter. The battery life can be improved upon. The battery used for the device, The Duracell MN1604 9V battery, can only operate at full power for around 5 hours before decreasing in effectiveness significantly. The casing can also be miniaturized to make consumer usage easier. Making the device case more compact will also make it feasible to be attached to a keyring and keychain, improving the device's portability and form factor. The use of Arduino Nano makes the device more sensitive to user input, making it much more user-friendly. The modular nature of the Arduino Nano also makes it easier to program for functionality (Babu & Vardhini, 2020).

The results of the testing shows promise as it proves the viability of the device in practical scenarios such as looking for a misplaced bag from up to at most 8 meters if both devices are in open-air. The results show that it is indeed possible to minimize the cost of tracking devices and it may prove to be an object of study in the future to minimize it further, thus increasing its availability for low-income consumers. However, further research can be done on what materials the devices can and cannot detect through. Data on the device’s range underwater and concrete walls would serve to broaden the scope of the device’s use to include those that work around water and enclosed areas with multiple layers of obstacles.

Lost and misplaced items are a common cause of inefficiencies in health care and a source of frustration for staff and care recipients alike (Weernink et al., 2018). Not only does it affect individuals with cognitive impairments, but also their caregivers. Devices equipped with RF technology can be a solution for finding lost items. These devices can be attached to personal items such as keys, wallets, or even their accessories. This gives comfort to both the individual and their caregivers.

Using RF technology comes with advantages. It is crucial to understand the dangers it poses. These gadgets could be exploited for purposes like stalking or violating someone's privacy. The idea of monitoring an individual's whereabouts through RF signals can be risky for those with challenges. Therefore, it is vital to establish safety protocols to mitigate these risks and promote the use of RF technology.

In addition to helping individuals with impairments and their caregivers, it is essential to include stalking measures in RF technology to prevent misuse and protect the safety and privacy of vulnerable users. By incorporating features like tamper design, these devices can deter stalkers and defend against unauthorized tracking or monitoring. Finding a balance between functionality and security does not enhance the effectiveness of these tools in aiding people. Also builds confidence in their usage. This trust is crucial for maintaining the well-being and independence of those who depend on it.

Even though there are obstacles, it is crucial not to overlook the advantages of RF technology for people with impairments and those who care for them. By finding a balance between leveraging the aspects of this technology and addressing any potential risks, we can maximize its potential to enhance the quality of life for individuals who need help managing their belongings while protecting their privacy and security.

RF transceiver modules are practical and cost-effective options for creating an item locating device because of their capacity to wirelessly send and receive data. These modules are small, adaptable, and easily accessible, making them a convenient selection for incorporating wireless communication capabilities into the tracker. Additionally, they offer a balance between performance and cost, providing a cost-effective solution for enabling accurate positioning and tracking functionality. In addition to their technical attributes, RF transceiver modules are readily available on the market, which contributes to their cost-effectiveness. RFID tags function well under various conditions, providing consistent readings and acceptable read ranges. Overall, the feasibility and cost-efficiency of radio frequency transceiver modules in developing item locating devices stem from their wireless communication capabilities, compact design, availability, and reliable performance, making them a preferred component for developing effective tracking solutions.

In conclusion, the development of an Item Locating Device utilizing a radio frequency transmitter and receiver modules is possible. The researchers have inferred from the results that modifications can be made to improve different aspects, such as the connection between the receiver and transmitter, the loudness of the receiver device when being detected, and the connection between the two devices under different materials. The researchers recommend addressing the problem of maintaining and maximizing the connection between the transmitter and receiver even with a longer distance and physical barriers by using better and stronger antennas for both modules. The antenna is one of the most important components of a wireless communication system, with a significant impact on total energy consumption. Current mobile antennas may be inefficient in both converting radio energy to radiating waves and focusing on those waves (Viikari et al., 2019). The antenna can also be lengthened to the resonance frequency of 433 mHz to further increase the strength of the signal (Jones et al., 2024).

Lastly, making use of better materials for the casing of the device is recommended. As seen from the results, plastic displayed the most successful connection among the different materials. Hence, the researchers recommend using biodegradable plastic, as it has similar properties to traditional plastics but is more beneficial due to its minimized impact on the environment (Moshood T. et al., 2022).

This study is beneficial to Philippine School Doha as it aids students, faculty, and staff when the inevitable misplacing of belongings occurs. This study is also beneficial to different sectors, with a focus on the healthcare sector, as it provides assistance to the caregivers of patients with cognitive impairment who are prone to misplacing their belongings. Aiding people with these kinds of problems upholds the school's mission of being pro-people. Moreover, the recommendation of the researchers to future researchers in using biodegradable and recyclable materials for the casing of the device upholds the school's mission of being pro-environment. This study also upholds another one of the school's missions, which is to be pro-country, as this is dedicated to the Filipino community here in Qatar and in the Philippines.

9. CONCLUSION

The study emphasizes the potential of RF technology in developing a low-cost device for locating items that will benefit people with cognitive impairments and their caregivers. Although the study found that the device can help find lost items from a distance, there are areas for improvement, such as increasing signal strength, making the device compact, and extend the life of the battery. This tool offers the opportunity to solve problems related to lost items and establish a peace of mind for users all while prioritizing safety and environmental considerations through exploration and improvement.

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