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Home Automation and Security over the Internet

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ABSTRACT

Security and automation of one's home are major concerns for the general public. Convenience and security are both enhanced by installing a home security system. When it comes to making a home more energy efficient, nothing beats having a home automation system installed. In this article, we'll talk about how to build a home automation and security system that works over the internet. The PIR motion sensor in this system will catch would-be intruders red-handed. To transmit a notification to the house owner in the event of an intruder, the microcontroller feeds the GSM module. The LDR light sensor, on the other hand, is used to turn on the lights at night and dim them during the day. By monitoring and controlling the sensors and lights at home remotely, a web-based system may conserve energy. There is an answer proposed in this work. Working inside or outside of the workplace, a worker who finds himself in an unsafe position can use the emergency button (or pull a magnetic cable) on his smart safety belt to halt any cars within a 15-meter radius while simultaneously alerting any coworkers within a 250-meter radius through an indication. The results of the initial design phase have been presented in this technical document. To now, we've managed to create a range mechanism that is both dependable and accurate, with an error of no more than 0.3 meters. An established RF TOF approach serves as the foundation for this range system.

INTRODUCTION

In today's fast-paced technological development environment, a wide range of solutions are available for securing one's property. A microcontroller-based home security system is one of the technologies [1]. Doors and windows of a home may be monitored by this device. To alert the police, an alarm system will sound when someone tries to break into a home.

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Existing systems for security, according to [2], are passive and expensive. Web-based home security systems may detect intruders, fires, and smoke at home. With this invention, they hope that users will be able to keep tabs on their house and take action if anything untoward happens. One may securely control their house from a distance with this technology.

As an illustration, the GSM-based wireless home security system shown in [3] consumes a negligible amount of power. GSM modem, magnet, and relay for door security are included in the wireless home network. Home owners will be notified through GSM module when an intruder enters their property. Sending an SMS or making a phone call might alert a user to suspicious activity through GSM technology.

The majority of individuals now own a smart phone. As a result, home security system technology is shifting to be Android-based. Home appliances may be controlled by just pressing a button on a smart phone running the Android operating system. With internet connectivity, they may operate their home appliances from any location. When a home invasion or attempted home invasion is detected, the system can alert the owners who are located at a distant area [4].

PIR motion detector and light detector are included in the home security system in this study. By sending an SMS and sounding a buzzer when motion is detected by the PIR sensor, the system alerts its users of any prospective intruders.

Here's a real-world example of a potentially dangerous environment: Think about a worker who was hurt when he unexpectedly fell from a pallet while working around heavy gear in a warehouse. The driver of a big vehicle or the crane operator may be difficult to reach in such a hostile environment. Heavy machinery operators may not be able to notice someone who has been harmed via the drive chamber of the machine. In this situation, a severe accident may be prevented if the affected employee's fear signal was correctly transmitted to all cars and fellow warehouse workers. Robust wireless communication mechanisms [1] can be used to facilitate this type of communication. In addition to communication, ground-based applications are also needed.

You may use several different strategies to construct your own ranger system. These methods incorporate GPS-based location tracking [2]. The indoor performance of GPS-based ranging devices is poor, despite the fact that these systems are widely used. Optical ranging equipment may also be used to measure the distance between a transmitter and its target.Because of obstructions between the optical transmitter and the target object, the optical ranging system has difficulty determining distances. To avoid all obstacles in a warehouse, you'll have to find creative ways to go around them.

1. RESEARCH METHOD

This project necessitates the use of both software and hardware. For this project's authentication module, three different modules were used, including the GSM module.

Module for the verification of identity

Figure 1 depicts the system's authentication flow diagram. First-time users can use the system's default password, 12345, to log in to the system. In order to prevent illegal access, users are then prompted to update their password. They'll have to login again to confirm their identity once they've changed their password.

In order to begin configuring sensors and lights, the system would first ask the user to input the system's IP address, as seen in Figure 2. This strategy has added an additional layer of security to the system. As a result, only those who entered the right IP address for their home's network may access the settings page.

In order to design the user interface, Adobe Dreamweaver was used. XAMPP's Apache and MySQL function as web servers and database systems, respectively. MySQL was used to store the login information, which included username and password. This method restricts each household to only one user account. User may begin configuring motion sensors and lighting in the house after successfully logging in to the system.

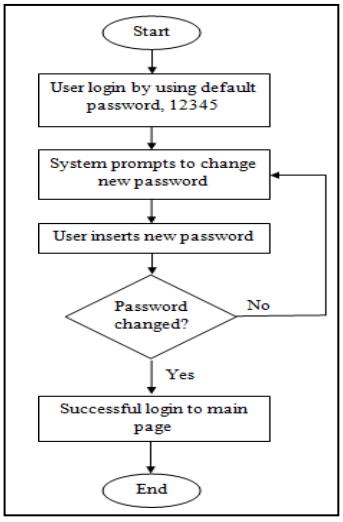

Figure 1. Authentication module flow diagram

In this study, the RF Time-of-Field (TOF) approach is used for range purposes. System for smart safety belts was designed. In the event of an emergency, the worker can use this system's panic button. When the worker presses the panic button, all the cars in the critical zone are compelled to come to a halt. Within a 15-meter radius of the system where the panic button has been pressed, the critical zone is specified. Section II dealt with system design. System application algorithms were explained in Section III. Section IV displays the results of tests conducted in both an indoor and an outdoor setting. Section V is the final chapter.

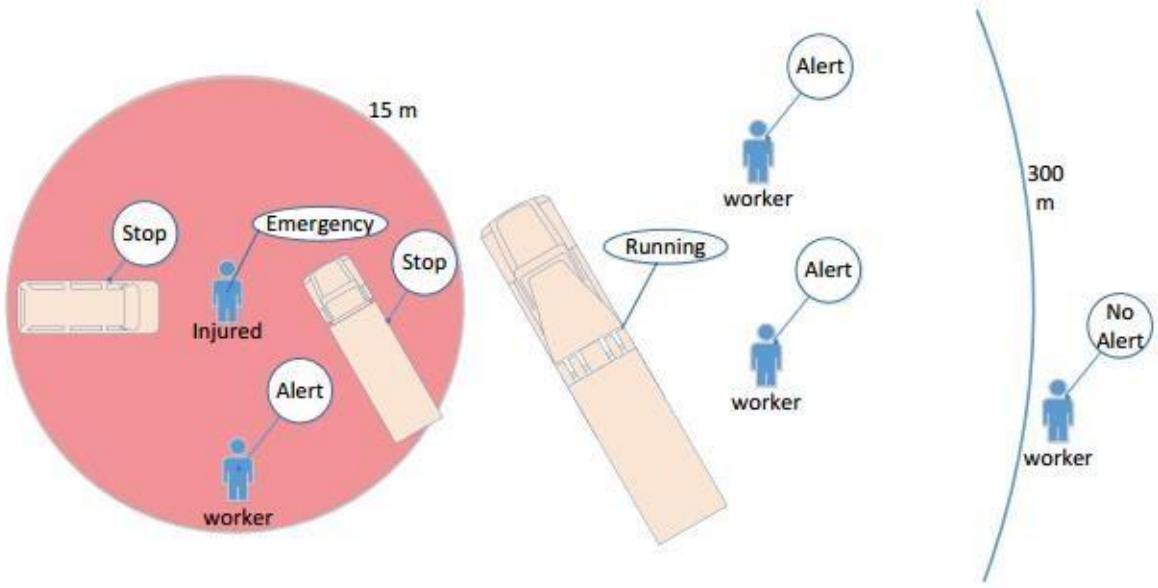

Figure 1. An example of how this could be used

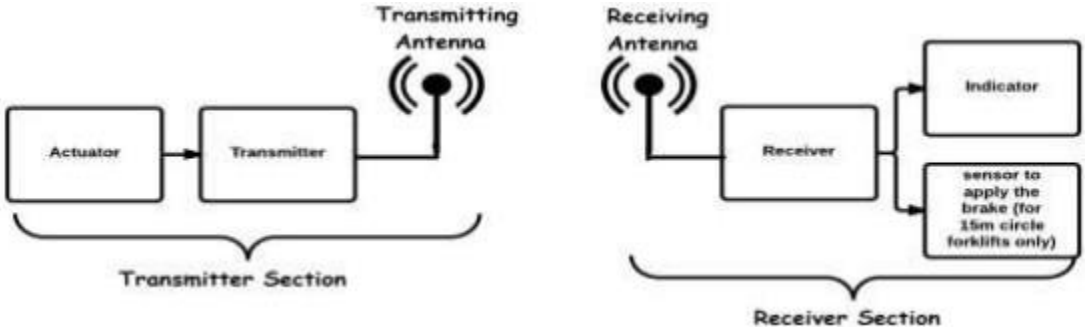

Figure 2. Diagram of a system's blocks

1. THE DESIGN OF THE SYSTEM

A. Environment

Figure 1 depicts a possible setting for the proposed system. The wounded worker is seen in the red circle at the top of the image captions. There is a 15-meter red circle that represents the important zone. There are two cars in the crucial zone that can connect with the UWB transceiver-based system and

one vehicle that is outside the critical zone but within 300 meters of it. There should be no traffic in the critical region to prevent a collision. An alarm for an injured worker may be sent to a car outside the critical region, but it will not be stopped.

Module for home security

As shown in Figure 3, the project's total home security system will be installed. The main controller of the system is an Arduino Uno board with an Ethernet shield attached to it. The Arduino IDE software was used to write the control program for the Atmega328 microcontroller on the Arduino Uno board using the Arduino programming language, which is based on C++. Using the Arduino Ethernet shield, the Arduino Uno may be accessed and controlled from a distance.

The Arduino Uno board serves as a hub for several peripherals, including a PIR motion sensor, LDR sensor, and buzzer. [1] The LDR sensors detect light, whereas the motion sensors sense motion inside the house.

An alarm buzzer, whose sole purpose is to create sound, is intended to deter intruders as well as warn the surrounding community. The Arduino Uno also has a GSM module attached, allowing it to send and receive SMS messages from smart phones.

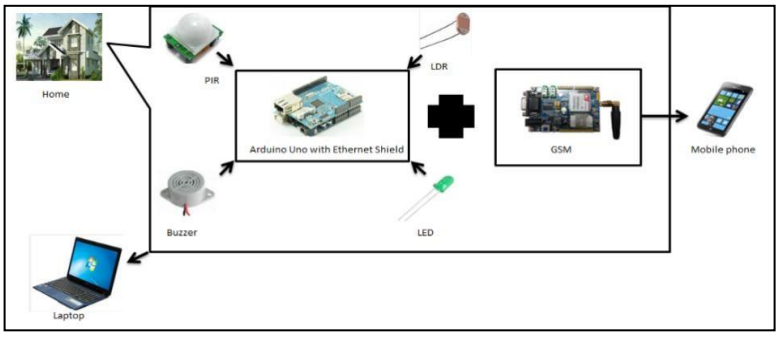

Figure 3. A comprehensive solution for home security and automation

Module for Notification

In order to notify consumers when motion is detected in their houses, this system requires a notification module. Due to its wide range of communication capabilities, the GSM module is selected as an ideal medium for sending SMS messages, even if the recipients are a long distance away from home. The proposed system is pre-configured to function in both transmitting and receiving modes. An acknowledgement is received from the GSM module after Arduino has repeatedly sent AT commands to the latter. After that, it sits and waits for a signal from the PIR motion sensors. Alerts are delivered to a mobile phone and a light is triggered whenever the

GSM module spots any movement within the residence. Step-by-step instructions are shown in Figure 4.

B. Ranging mechanism

The use of Ultra Wide Band (UWB) for a ranging mechanism is on the rise [12]. Sub nanosecond pulses, which are more robust than narrow band signals, are the primary justification for using UWB for range applications [13]. There are two major parts to the system: the transmitter and the receiver, as depicted in Figure 2. An actuator in the transmitter section connects two RF transmitters and one acoustic signal generator. Employees in danger will initiate a distress call by pressing a button or pulling a cable. Receiver-side RF and acoustic sensors are mounted on belts or automobiles to receive the signals. Once the signals have been received, they are processed by the receiver. It is up to the receiver controller section to decide whether or not to stop the vehicle once the driver has been warned of an injured worker due to a weak RF signal. Using RFT OF as a basis, the system uses a distance measurement method to determine distance.

C. Time of Flight

It is necessary to employ the Time of Flight (TOF) approach in order to do this. The received signal strength indicator (RSSI) is a less precise technique of determining distance than this one. Calculating a range using the TOF technique is demonstrated in the following figure:

Figure 3. Time of Flight time domain representation

The graphic above depicts the time-domain message transmission between the master and slave nodes. The time it takes for a packet to go from the master node to its destination and back again is known as Total Transition (TT). Return Delay (RD) is the amount of time it takes for a packet to be processed by the slave. There are several ways to express the TOF.

$$T.O.F = \frac{tTT - tRD}{2}$$

$$distance = T.O.F * speed\ of\ light$$

Here tx is the time of x. It is possible to measure distance between transmitter and receiver by utilizing TOF and RF signal speed (the speed of light).

2. ALGORITHM

Workers wear this device as a tag, and an anchor is attached to every vehicle in the warehouse. It's impossible for the unpaired anchor and tag to exchange information at first.

Unpaired tags send a Blink message that includes their own address, following which they wait for a Ranging Initiation response from an anchor to begin the exploration phase. If it doesn't, it rests for a second before blinking once more. The unpaired anchor gets the tag blink signals. To begin the Ranging phase, the anchor sends a Ranging Initiation message to the first tag it gets a Blink message from, which couples the two devices together.

Anchors switch on their receivers and wait for poll messages endlessly after they reach the Ranging phase. An encrypted Poll message is sent by the tag. The tag receives a poll message and subsequently a response message. The tag then decrypts and provides its timing information back in encrypted form.

The anchor determines the tag's range at the conclusion of this exchange. At a range of less than 15 meters, the gadget engages the vehicle's braking system and brings it to a halt. Figure 4 depicts the scenario's graphical depiction.

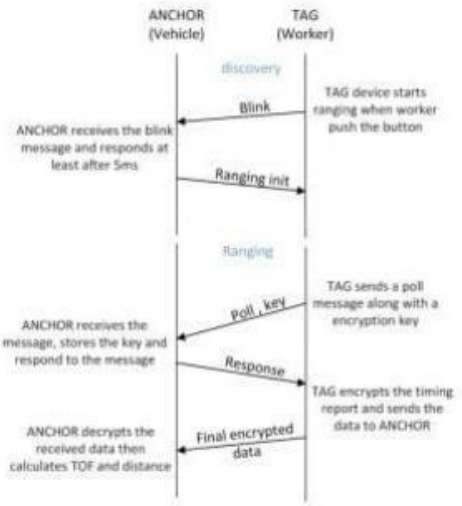

Figure 4. Message exchange during the discovery and ranging phases

The algorithms for smart safety belt tags and vehicle anchor tags are presented separately. So each algorithm has its own component.

A. Algorithm for Tag device

There should be a constant check for an emergency button on the tag device. The search will begin as soon as the button is pressed. A polling mechanism is initiated after receiving a start-range message and acknowledgment. This device will wait

for other devices to react with their response message when ranging is complete. Every 5 or 10 ms, an alert is issued.

If a worker sends an alert message, the jacket's LED, Vibrator motor, and buzzer will sound for one second. Then, it will recheck to see whether the emergency has been resolved. The tag device algorithm is as follows:

A. Affecting a Service Button pressed or an Alert received is checked as part of the routine. – You'll want to follow Step A, if the button has been hit. Step B, if an alert has been received

Procedure A:

1) The UWB transceiver must be activated.
2) Alert all peer nodes by sending an alert message to them all.
3) It's been a while since I've heard back In either case, move on to step 3; otherwise, stop here.
4) Calculate distance between the tag and all anchor devices using the time of flight (TOF) distance.
5) Is there a response to the alert? If so, move to the next step, if not, continue to the following step (step 3).

2. RESULTS AND ANALYSIS

In Figure 5, an Arduino Uno, Ethernet Shield, GSM module, and sensors were put on a home prototype and tested. The system was tested to verify it functioned.

Figure 5. Perspective of the house model from the side

A buzzer and warning light are activated when a PIR sensor detects movement within the house, as shown in Figure 6. In addition, the GSM module sends notifications to customers' mobile phones when motion is detected in their house, allowing them to take prompt action as seen in Figure 7.

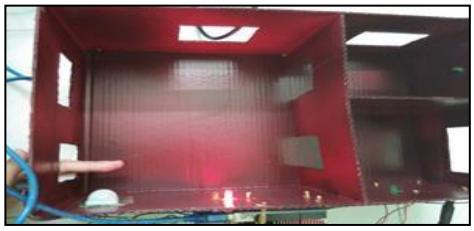

Figure 6. When we sense motion, a warning light will come on.

3. CONCLUSION

Finally, a web-based home security system can improve the security of your house. In addition, the auto-light system and the ability to choose which light should be switched on made it more comfortable for consumers. Gradual reductions in use are possible. This initiative also made it possible for users to use the system at any time, from any location, as long as they had internet connectivity.

In order to prevent the buzzer from being accidentally activated by a pet walking by, an additional motion detector should be added to this home security system. This is due to the fact that the PIR sensor is unable to distinguish between human and animal movement. Section-by-section breakdowns of these tests' findings are provided below.

A. Indoor testing:

The battery-operated device has been put through its paces in an office setting. Measuring distances ranging from 1 to 15 meters were done with the newly created device. Tests included running the system through walls and using a variety of devices in the environment. The findings show a 99.27% accuracy at a distance of 15 meters. Figure 5 shows a visual representation of the test findings.

B. Outdoor testing:

As a result, the item has also been tested outside. A parking spot was used to collect the data for this dataset. Using a distance of 15 meters, the results show 99.33% accuracy. Figure 6 shows a visual representation of the test findings.

An inaccuracy of no more than 0.3 meters has been found during all of the tests carried out in both indoor and outdoor settings utilizing the suggested technology.

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