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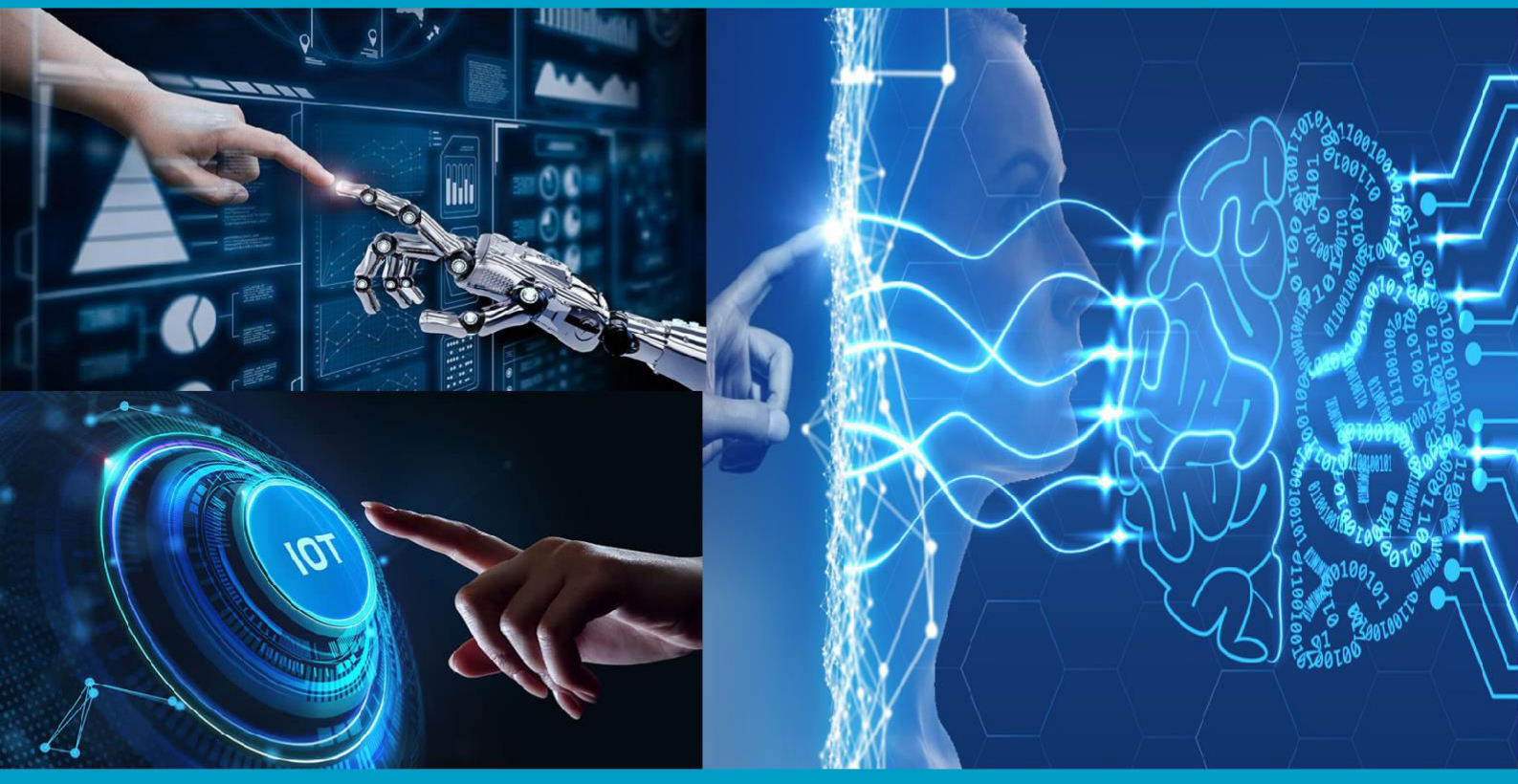

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Enhancement of WSN System Based on Multi-Hop with RSSI Variation and Identifying Breaks in The Line of Sight (LoS)

DARSHNA, NISAR

Department of Electrical Engg., CBS Group of Institutions, Jhajjar, India

A.P., Electrical Dept., CBS Group of Institutions, Jhajjar, India

ABSTRACT: In this study, we provide a DFP system that uses RSSI measurements to pinpoint the origin of an attack and track its spread throughout a network by correlating alarms from various nodes. We also demonstrate how far an intrusion is likely to have spread throughout the network using this approach. First and foremost, we wanted to evaluate the system's strengths while avoiding its weaknesses, and we wanted to make sure that the final product performed as well as it could given the constraints imposed by the sensor networking platforms. Both of these ends were intended to be reached. In order to get things done, this step was taken. Methodological requirements included validating interference from concurrent systems and identifying sources of RSSI variation. Confirming the absence of influence from other systems was another need of the probe. Finding the causes of the RSSI fluctuations was essential for proving that they originated from preexisting systems. To back up this claim, we performed research into the ways in which WLAN interference impacts the performance of WSNs. To improve the overall effectiveness of the system. After analyzing the impact of a person on the RSSI data gathered at a node, researchers developed a method for locating breaks in the line of sight (LoS). They were therefore able to ascertain the individual impact on the statistics. The algorithms were shown effective in their ability to alert users of illegal LoS access after being put through their paces. Because of the omnidirectional antenna's incorrect emission pattern and nearby objects' reflections of radio signals, a number of false alarms were picked up as the investigation progressed. Our research to now has shown many promising avenues for further investigation. In order to attract more users, we must first put to the test various experimental ways of user monitoring. We'll be able to find more users thanks to this. Additionally, there is the issue of experimenting with alternative localization methods to improve accuracy.

KEYWORDS: DFP system, device-free localisation, WSN, RSSI, line of sight (LoS)

I. INTRODUCTION

The information that is carried by an object being monitored is essential to the operation of each of these systems. A piece of apparatus that will be examined in further detail. In addition, the monitored device is required by a few of these approaches in order to complete a portion of the required computational work for the localisation process. This is an essential step in the process. This will enable the system to provide the user with access to its location as well as other services that are dependent on the user's approximate position [5, 6]. GPS has a number of flaws, despite the fact that it has become the industry standard for tracking and navigation technologies. Inside, its functionality is non-existent or extremely restricted, and users are required to carry their terminals at all times.

These days, device-free localisation (DFL) and the indoor tracking of people have a wide range of potential applications. Some examples of these applications include, but are not limited to, analysing shoppers' reactions to the placement of products and advertisements in shopping malls; locating intruders in critical buildings or infrastructures; and localising people in remote areas. Wireless sensor networks, often known as WSNs, are a technology that may be used for this purpose. The presence of humans and their movement within the monitored area generates changes in the received signal strength indicator (RSSI), and these variations may be used to extract useful information about the environment. Because they can detect radio waves on their own, the nodes that make up a wireless network can be thought of as RF sensors. This is because there is no need for any other kinds of sensors to be used.

The received signal strength indicator, also known as RSSI, is often used in situations in which one has to ascertain the position of nodes, compute the distances that separate them, and assess the quality of a connection that exists between the nodes. Recent research has shown that it may be possible to leverage the variations in RSSI levels that occur in indoor spaces with deployed nodes to detect human movement in such situations. In addition, the RSSI time histories of the many links make it possible to reconstruct the path that a person took while travelling inside the monitored zone. Measurements of RSSI, together with distributed processing, are going to be used for interior surveillance as part of this project.

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| Volume 10, Issue 6, June 2023 |

Categories of WSNs system and subsystems

This is dictated by the location of the installation, which might be underwater, inland, coastal, or any other location. There are several different categories of WSNs, including:

- Domestic WSNs
- WSN Underground
- Submerged WSNs
- WSN Video
- WSN Smartphone

WSNs on Earth

The target region is reduced to a fixed plane, and sensor nodes are then scattered in an ad hoc fashion and at random across the space. The strong interface, grid interface, and 2D layout are all included in the pre-programmed or developed modes. These layouts are regarded to be 3D models. This WSN has a battery that only stores a limited amount of power; however, a solar cell has been attached to the battery so that it may be used as an additional source of power. This method of providing electricity is carried out by WSN via the use of a low frequency system, which minimises delays and maximises routes.

WSN System used for under ground

When it comes to economic considerations and meticulous planning in terms of deployment, maintenance, and equipment, subterranean wireless sensor networks are more costly than terrestrial WSNs. This is because underground WSNs need more space. Within the WSN network are a number of sensor nodes that are responsible for monitoring the top-secret weather conditions in the field. For the purpose of transmitting data from the sensor node to the base station, some receivers have been installed at elevated positions.

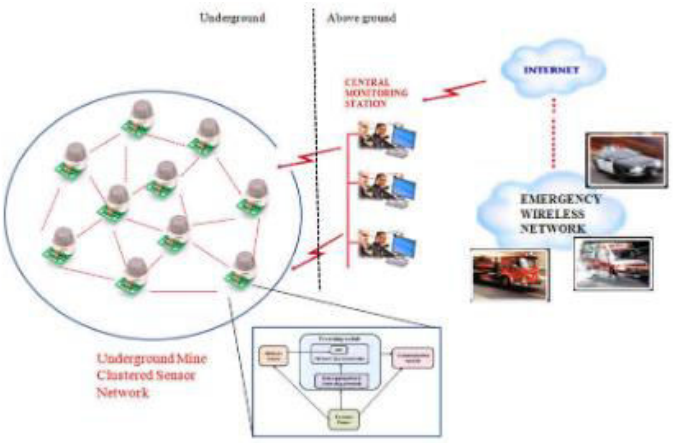

Figure 1: WSN System used for under ground

WSN Underground

It will be difficult to rebuild the wireless subsurface sensor network that was previously established on the playing field. When it comes to resale, battery node sensors with low battery capacity are difficult to find. In addition, the subterranean environment creates difficulties for wireless communications owing to the significant degree of signal loss and degradation that occurs there.

II. RESEARCH METHODOLOGY

ZigBee

ZigBee is an improved protocol for wireless local area networks (LR-WPANs) that is based on IEEE 802.15.4. These networks are becoming more popular. (ZigBee Alliance, 2010) The ZigBee protocol was developed by the ZigBee Alliance with the intention of enhancing the already established IEEE 802.15.4 standard by adding network, security, and application software. According to Eriksson et al. (2008), ZigBee was developed specifically for use in automation sensor networks. The technique allows for a maximum of 216 devices to run simultaneously in a mesh network, which has a total capacity of 65536 devices. ZigBee devices may be broken down into three distinct categories: coordinators, routers, and end devices. When utilising ZigBee, it is necessary to have a coordinator who is responsible for setting up the network, storing information, and connecting various networks. The environment is perceived and acted upon by

the sensors and actuators that make up a ZigBee end device, which in turn only communicates data with other end devices that are operating as routers or coordinators in the network.

LoWPAN

A low-power wireless personal area network protocol that is based on Internet Protocol version 6 (6LoWPAN) is known as IPv6. Utilising IP addresses to accomplish its mission of providing internet access over low-power radio transmissions is the primary focus of the protocol. In order to handle mesh route forwarding and the compression, fragmentation, and reassembly of IPv6 headers, an adaptation layer has been designed as part of the 6LoWPAN communication stack. Using IP addresses, 6LoWPANs may be linked to other networks (such as WLANs, Ethernet networks, and so on) via the use of border routers. These routers are responsible for relaying IP-based communications across the different kinds of media.

Access Token Method

The nodes that make up a WSN communicate with one another through a common channel. If this medium were poorly maintained, however, the communication that occurs between the nodes would be inefficient. There was a risk of data packets colliding with one another, and transmission of data packets in a timely manner could not be guaranteed. A large portion of the channel's time would also be taken up by unnecessary rebroadcasts due to poor management of the channel. One such point of view is that the communication pairs that make up a network do not necessarily have to use the whole bandwidth of the shared medium. The channel split is located at this point.

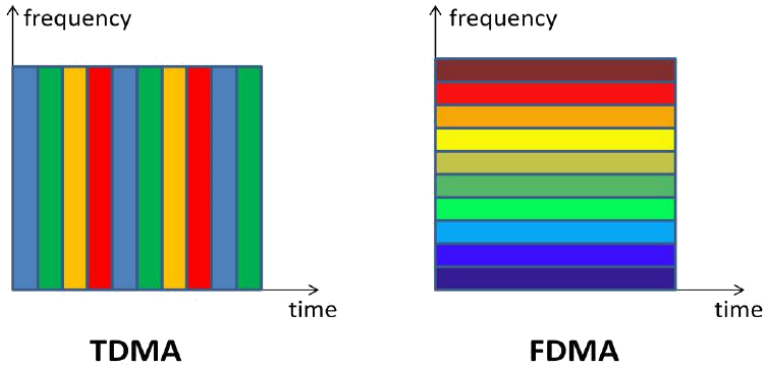

Figure 2: Allocation of channel as Time division and frequency division

The phrase "multiple access" refers to both a system that enables numerous users to share a single radio channel as well as the management strategies that are used in order to make the most of the channel's limited resources. Multiple access techniques may be broken down into two primary categories: contention-free and contention-based. Transmissions that make use of conflict-free protocols are not susceptible to being interrupted by other transmissions, and their success is ensured. To ensure that there is no interference during transmission, one might employ channel allocation that is time-based, frequency-based, or mixed. The technology known as frequency division multiple access (FDMA) gives each user access to the full bandwidth all at once. Time division multiple access (TDMA), on the other hand, gives each user access to a concurrently reduced but still significant fraction of the available bandwidth. Because contention protocols are designed so that successful transmission is not guaranteed by design, these protocols need to include a process for resolving conflicts in order to guarantee transmission in the long run. Contention-based protocols have the benefit of not spending the limited resources of the radio channel on users who are not actively participating in the communication.

Time division multiple access

Each super frame is broken down into smaller pieces of time that individual nodes on the network are free to utilise anyway they see fit. At the predetermined time, each and every available bit of bandwidth is sent across to that one node. Every node makes an appearance at precisely the same time in every frame, and the cycles continue to occur at predetermined intervals. The network must be synchronised in order for TDMA to be used properly; this ensures that all nodes know when it is their time to transmit and when to watch out for packets from other nodes in the network. The nodes are able to save power by turning off their radios when they are not required since they are aware of when communications are likely to take place. The time delays it generates in communications and the inefficiency with

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| Volume 10, Issue 6, June 2023 |

which it utilises the available bandwidth are the two primary downsides of time division multiple access, often known as TDMA.

FDMA Method

The fact that each node in the network is given a unique channel on which to operate is one of the drawbacks of the FDMA protocol. As a consequence, the bandwidth available to each user is always the same. However, there are only a limited number of channels that can be accessed using this method (Eriksson et al., 2008), which contributes to the technique's limited scalability. Figure 2.1 illustrates how the TDMA and FDMA protocols keep the time and frequency domains distinct from one another.

In a method that is comparable to that of the TDMA protocol, the FDMA protocol divides the spectrum into a greater number of channels that are more narrowly focused on frequency rather than time. Because the user in FDMA always has the channel occupied, even when there are no transmissions taking place, the efficiency of the channel is decreased. This is one of the benefits that come with using the system. However, one of the drawbacks of FDMA is that it assigns a separate channel for each node to operate on. This is one of the disadvantages of the method. Because of this, the bandwidth available to each user is maintained at a constant level at all times, irrespective of the time of day or the conditions. However, there are only a limited number of channels that can be accessed, which contributes to the limited scalability of the method (Eriksson et al., 2008). This is only one of the factors that contributes to the limited scalability of the method. The TDMA and FDMA protocols are shown in Figure 2.1 illustrating how they maintain the separation of the time domain and frequency domain from one another.

III. RESULT

Simulation conduction

The whole experiment has been carried out indoors, from start to finish. The presence of noise and interference in the RSSI data is often to blame for errors in the localisation process. As a consequence of this, we have put the following precautions into place to ensure that the environment will be conducive:

- Each of the nodes that have been installed is kept at the same elevation above the ground.
- The IITH motes get their power via USB in order to ensure that all of the nodes have the same amount of battery life.
- There is no possibility of interference occurring between any of the nodes that have been installed and the base node.

Due to the fact that the antenna of the base node is not isotropic, we have restricted the deployment of sensor nodes to just the direction of that node's antenna. We have taken safety measures to guarantee that the experimental location does not include or is in the vicinity of any other equipment that operates at 2.4 GHz. The experiment was carried out with the help of six IITH mote. In the controlled environment of the laboratory, four of the mote particles serve as transmitters, while the other two take on the function of receivers. In order to evaluate the accuracy of the localisation, we first compare the distances between the base node and each of the other nodes, using the median RSS values as our measuring stick. We will show that our PC DfP technique may successfully locate a subject in a residential environment via the use of experimental assessment and testing. The classroom located in the institute's log house is being used as a staging area for the deployment. The space is packed with various pieces of furniture, which creates a dense network of potential multi-path sources. The moment a packet is taken, it is immediately sent to the receivers, which are responsible for delivering it to the host PC.

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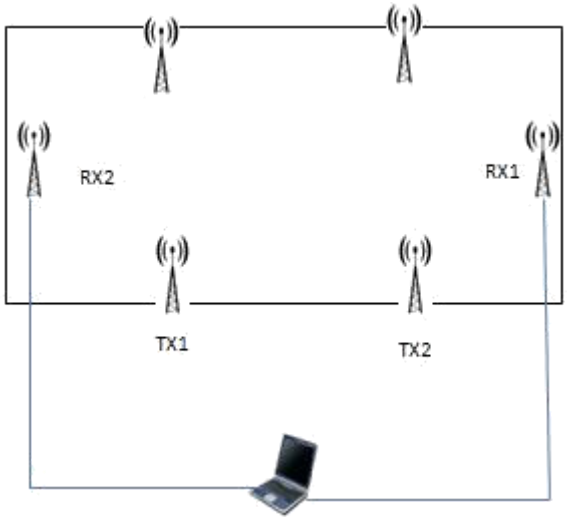

Figure 3: Transfected Receiver

Hardware Details

The IITH mote is designed for use in wireless sensor networks, monitoring software, and the rapid creation of application software. It has a very low power consumption and yet still offers dependable wireless communication. The use of widely adopted protocols, such as IEEE 802.15.4, ensures that the IITH motes and other devices will be able to communicate with one another. As a result of its use of industry standards, integration of humidity, temperature, and light sensors, and availability of direct connections with peripherals, IITH mote is capable of supporting a broad range of mesh network applications. The IITH motes are shipped with compatibility with the Tiny-OS operating system, which allows them to take advantage of emerging wireless protocols and the open-source software revolution. The IITH mote is a member of a family of modules that were developed to be universally compatible with the majority of different sensor boards.

Major Characteristics:

500 kbps, 5 GHz An Atmel transceiver that is compatible with other devices that comply with the IEEE 802.15.4 standard and is able to communicate via the IEEE 802.15.4 protocol.

The Atmel ATmega1281 has the following memory capacities: 512k of serial flash memory, 128k of programmable flash memory, and 8k of random-access memory.

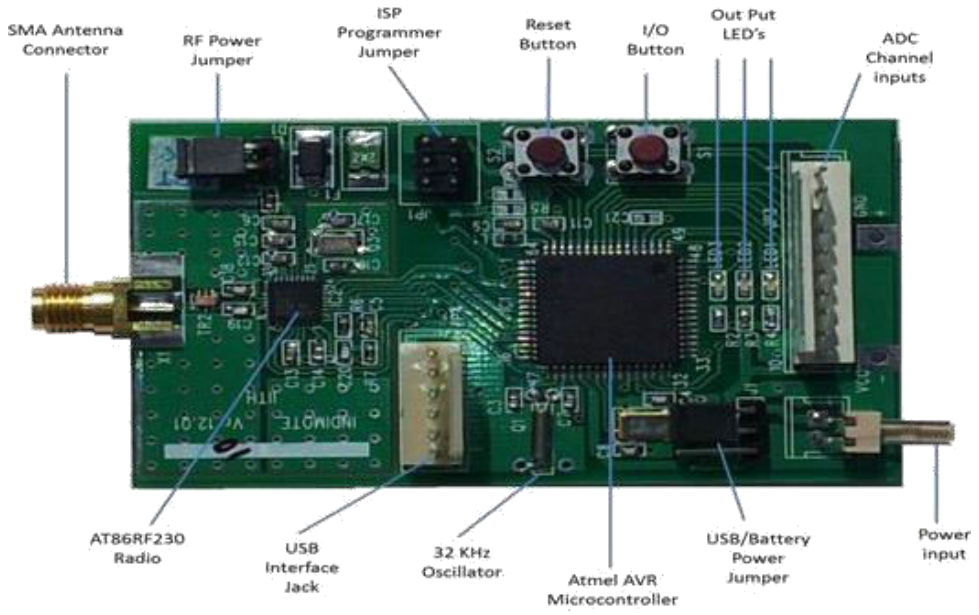

Figure 4: Basic A2D converter

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| Volume 10, Issue 6, June 2023 |

The range of this integrated analog-to-digital converter and supply voltage supervisor antenna is up to 100 metres (300 feet) outdoors and up to 30 metres (100 feet) inside. The antenna includes an inside mount.

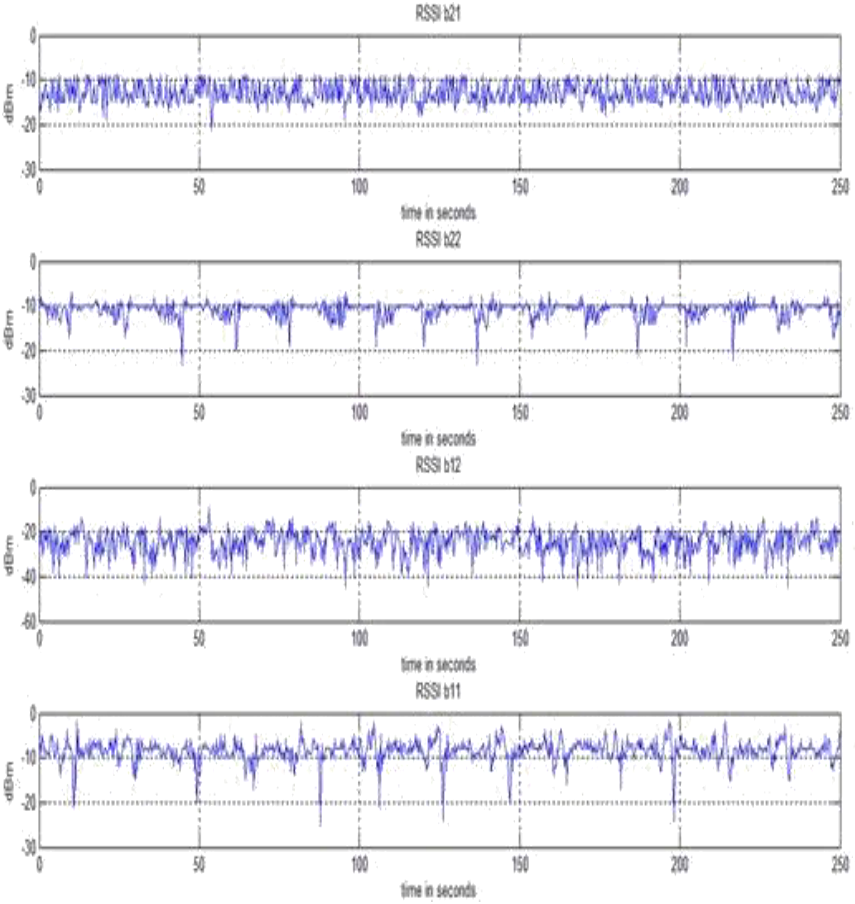
Related Work

system architecture and organization:

In a DFP system, in addition to the DFP server, there are four transmitters, two receivers, and the DFP server as illustrated in Section 3.1. The DFP server, which is a personal computer, is the one in charge of doing the computations on the RSSI streams and initiating the replies that are suitable. By using the transmission and receiving of RSSI packets, the design of this equipment makes passive localisation completely free of charge. The steps involved in determining the position of a user are as follows: a. receiving packets; b. saving them in a database; c. obtaining values from the database and applying algorithms to them in order to determine the user's location. For the purpose of data transmission, IITH motes are used both as transmitters and receivers. a.Transmitting and Receiving Messages and Packets Recording the RSSI of all radio links should take place whenever there are no people in the deployed area. In the second phase, the receiver will record the fluctuations in received signal strength indication (RSSI) over the whole of the radio connection while the user is present. These readings will then be compared to the readings obtained in the first phase of the process. The third step entails compiling a summary of the correlation that was found between the rate of change in RSSI (for each radio connection) and the location of the users. The MYSQL database is used to store the values that are gathered by the sensor nodes.

Algorithm:

On the server side of things, the algorithm is what is run while monitoring is being done. In order to calculate the cost matrix, the Euclidean shortest path algorithm is used, and the Dynamic Time Warping technique is utilised in order to calculate the best possible route. Section 3.3.2 Identifies the Presence of an Intruder Detection is determined in the moving average detection technique (also known as "moving average based detection") by comparing two moving averages of incoming signal intensity indications with possibly varied window widths. This comparison takes place in order to identify whether or not detection has occurred.



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| Volume 10, Issue 6, June 2023 |

As f travels through these four distinct regions, we are able to observe the differences that exist among the six streams. According to the illustration, a realistic threshold value would be 1:98 in order to achieve a detection probability of one hundred percent. Even though reducing the threshold could potentially improve the chances of detection, doing so would also increase the risk of producing false positives.

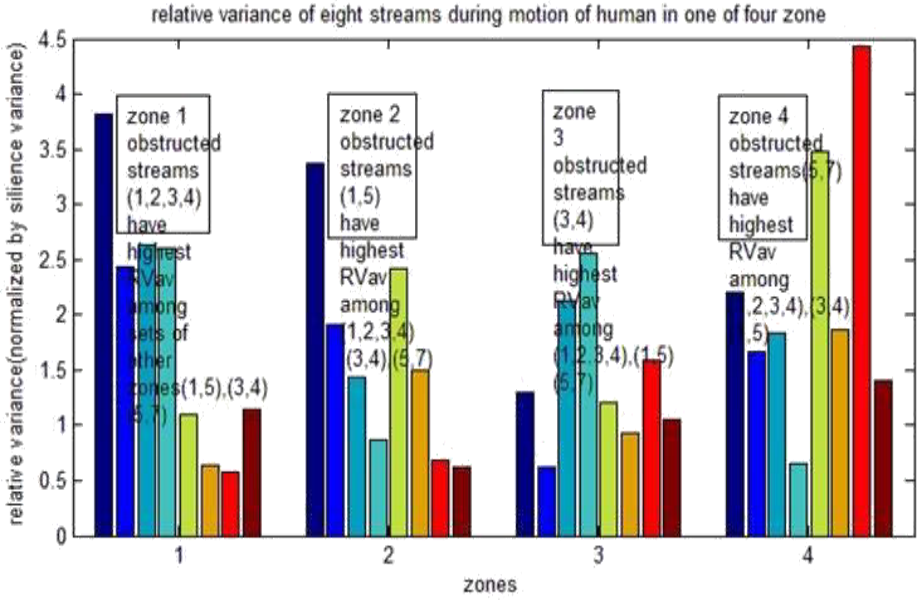
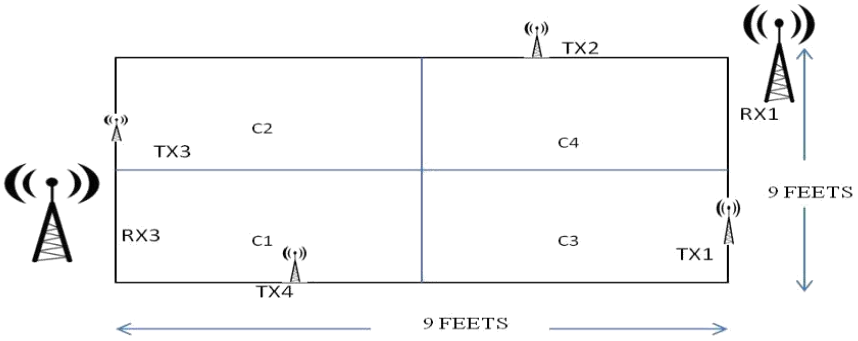


Figure 5: Relative variance presenting in this figure as zone vs variance



System parameter

parameter	Default value	meaning
K	4	Number of cells
L	8	No of radio links
Ntrn	1000	No of training data per cell

Figure 6: system parameter

Performance Assessment

The term "average error distance" is used to describe this particular number. Localization The term "accuracy" is being used in the context of this conversation to refer to the proportion of times that an estimate turns out to be correct. A localisation system's performance should be optimised by maximising the chance of producing an accurate location estimate and minimising the average error between the estimate and the actual position in order to get the best possible results. The four-cell-based method outlined in table 1 is the one that our system uses to carry out the tasks of localisation and detection. In this case, we discovered that the localisation error increased from 70 percent to 100

percent as the average mistake travelled from 0 inches to 90 inches. This was the case when the mistake progressed from 0 inches to 90 inches. In a similar manner, the margin of error ranged from 0 inches all the way up to 90 inches.

Table 1: Avg. Error and Localization accuracy table

AVERAGE ERROR	NO OF TEST COUNT	NO OF CORRECT DETECTION	NO OF FAULSE DETECTION	LOCALIZATION ACCURACY
OBJ IS zero inch FROM CENTRE OF CELL	10	7	3	70%
OBJ IS 54 inch FROM CENTRE OF CELL	12	10	2	83.3%
OBJ IS 72 inch FROM CENTRE OF CELL	10	9	1	90%
OBJ IS 90 inch FROM CENTRE OF CELL	5	5	0	100%

IV. CONCLUSION

In this work, we offer a DFP system that utilizes RSSI measurements to pinpoint the origin of an attack and follow its spread throughout a network by correlating alerts sent in by separate nodes. Evaluating the system's benefits while avoiding its drawbacks, as well as ensuring the highest potential performance of the final product within the constraints imposed by the sensor networking platforms, were the primary objectives. To get where we needed to go, this was done. Key steps in the process included verifying interference from coexisting systems and tracing its roots to different sources of RSSI variance. Identifying the causes of RSSI change was also necessary for validating interference from many systems operating in close proximity to one another. We looked at how interference from WLANs affects the performance of WSNs to give support for this assertion. With the goal of improving the system as a whole. Researchers devised a technique for detecting LoS disruptions after analyzing the impact of a human on RSSI data obtained at a node. After being put through their paces, the algorithms were capable of alerting users to unauthorized LoS access. Several false alarms were picked up throughout the examination due to the omnidirectional antenna's sloppy emission pattern and radio signals being reflected off of nearby objects. The findings of our study suggest many interesting avenues for further research. We need to start by putting to the test untested ways of user monitoring if we want to find additional users. The problem of trying out different localization methods to improve precision is another consideration.

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