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Device based Multi-User Tracking System using Internet of Things

Bhagwan Sahay Meena
Department of Computer Science
Assam University, Silchar
Email ID _ bsmeena.g1@gmail.com

Abstract - In Light Dependent Resistor (LDR) sensor-based user is localized based on the event and the intensity of the room light when a user enters inside a room and switch ON the lights, the intensity goes high, an entry is notified. An exit is notified when a user switches OFF the light and exit the room. Moreover, the model remains prone to more error in multi user localization because multiple users may enter inside same room at same time and the lights of many rooms remain ON which makes more difficult to localize a user. In order to overcome this ambiguity of light sensors, two passive infrared (PIR) sensor with radio frequency identification (RFID) tag-based model has been proposed, where every user has a tag. In this system, 10 PIR sensors and 5 RFID readers were attached to house room (10.0 m * 6.0m). An entry is notified if the following pattern form, the outer PIR detects a motion and waits for few seconds, next the RFID reader reads the tag given to the user and finally the inner PIR detects a motion within the given time delay. An exit of a user is notified only if the pattern from inner PIR to outer PIR is followed with the given time delay. The RFID tag is used to identify which user has entered a room at a particular time and also ensures unauthorized entry. The LDR based system gives accuracy nearby 20% but the multi-person tracking in a binary infrared sensor network-based system gives accuracy near about 90%. In this paper, the proposed PIR sensor along with RFID based indoor navigation system gives accuracy near about 94%.

Keywords —Internet of Things, Bluetooth Low Energy, Light Dependent Register, Radio Frequency Identification, Passive Infrared Sensor, Localization.

1. INTRODUCTION

The Wireless Sensor Networks have become a part of life, while this domain attracts a lot of research and development in a period of past few years. The inception of the Internet of Things (IoT) has contributed to the growth of the implementation of wireless networks to a great extent which includes scalable wireless applications, implementing new and sophisticated devices on nodes to carry out various objectives.

1.1 Wireless Sensor Networks

Wireless Sensor Network (WSN) is a combination of battery powered wireless equipment along with physical property detectors depending on the area of implementation. Being a flexible domain of study, it has attracted a lot of attention with the advancement of technology. The WSN nodes are deployed in the environment primarily two fashions-static and dynamic [1]. The primary matter of concern in a WSN is the availability of limited energy. It is required that the nodes do not consume more power during runtime, can sustain for a longer time.

1.2 Internet of Things

The Internet of Things (IoT) is a ground-breaking approach that is gaining popularity by the day in the scenario of wireless telecommunications. The idea behind this concept is to establish a pervasive presence among various. IoT devices like as RFID, ZIG-Bee, Bluetooth low energy (BLE), Smart phones and sensors [2]. These IoT devices are having unique identifiers which allow them to established a connection with other devices to achieve a specific common goal. The main motive behind IoT is to make the internet more immersive, enabling internet access by a wide variety of devices. A large amount of data is generated by different devices and many applications can be developed by this generated data [3]. The IoT creates a doorway for several applications like as surveillance [4], smart cities [5], home automation [6] and healthcare [7]-object localization [8] etc.

1.3 Localization

Tracking of users can also be carried out on a large scale using Global Positioning System in a scenario with a considerable number of people [9] or by active tracking applications like as smart devices used by the user [10].

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While outdoor tracking of the user is possible by the given methods. Moreover, Indoor localization of the user has been made possible by using RFID and PIR sensors [11]. Localization is one of the major areas of interests in WSN applications. Many localization algorithms have been developed so far. In WSN, there are two types of localization techniques, first is range-based localization [12]– [17]. There are two phases in range-based localization: ranging and position computing. In the first phase, the Received signal strength indicator (RSSI), Angle of Arrival (AoA), Time difference of arrival (TDoA), and Time of arrival (ToA) have been used to estimate the relative distance between two sensor nodes. In the second phase, based on available information (relative distance) and anchor nodes position, the relative coordinates of blind nodes calculated by trilateration, maximum likelihood, and triangulation techniques. The second technique is range free localization [18]– [23]. In range-based localization, the connectivity information (hop count) and topology among sensor nodes have been used to locate the entire network. The DV-Hop, Modified DV-Hop, Pattern matching localization techniques used for range-free localization.

1.4 Localization using Internet of Things

Localization using IoT can also be very useful for locating and guiding someone in an indoor environment like as inside a building, shopping mall, or inside a museum, etc where GPS based localization fails. Different mathematical methods are used in IoT based localization for localizing a device such as trilateration [24], multilateration [25], Time ToA, TDoA, AoA [26], etc. IoT based localization is classified into two groups: Device- based localization and Device-free localization.

1) Device-based localization: Device-based localization techniques are used to solve the problem of localization in a very easy and economical way. It provides target data that carries a specific device, such as a smartphone or tag.

(a) Smartphone-based localization: Many approaches had discussed in [27] to solve the problem of localization that is based on smart phone. As we know that communication can be made among smart phones via Wi-Fi or Bluetooth. Therefore, location of a smart phone can be determine using ToA, with two smart phones or trilateration, with three smart phones.

(b) Wifi-based localization: Wi-Fi based positioning system uses the intensity of the received signal [28]. In RSSI based technique the signal strength is measured from one device to several other different access point and by using RSSI value, distance is calculated from each access point using trilateration methods. The main disadvantage of RSSI based localization is it does not provide very good accuracy [29].

(c) Bluetooth-based localization: Most of the existing Bluetooth based localization techniques are relying on RSSI based inputs as they are less complex. Indoor localization using BLE- can be done in three ways - many BLE's per room [30], one BLE per room [31] and few BLE's per building [32]. The major disadvantage of BLE based localization is accuracy. Even though, they are used for localization because of their low cost and energy consumption.

(d) Camera-based localization: In camera-based localization, cameras placed at many places. These cameras capture the object's image. The captured image will send to the server where the features of the captured image will be extracted and compared with the already pre-stored images. In this way the object would be identified. In this method no additional infrastructure is needed [33]. Another approach for localization is by using an optical camera and orientation sensor [34].

(e) Acoustic based localization: Acoustic signal-based localization use speakers and microphones. The velocity of the acoustic signal is known and time of arrival of a signal is determined by using ToA/TDoA with at least three sensors [35]. Finally, the distance will be calculated by multiplying the signal velocity with time of arrival of a signal.

(f) Tag-based localization: There are three components in tag-based localization such as tag, reader and processing system [36]. The tag is read by the reader and store the read values and processing system uses an algorithm to calculate the position of the device carrying the tag [37].

2) Device-free localization:
Device-free localizing technique tracking any objects without carrying any special devices. The radio waves, sound propagation speed, magnetic spot and radiation variation are used for device-free localization.

(g) Magnetic sensor-based localization: Most of the modern objects leaves some magnetic imprints, and this technique uses the sensors to detect these imprints and locate the target [38].

(h) Ultrasonic localization: It is based on sound propagation speed. It measures the propagation times accurately that is why it obtain reliable distance estimation [39].

(i) Radio frequency identification: RFID is relying on radio waves to identify objects. This technology used in large stores and shopping malls. The RFID based technology gives more error in compared to ultrasonic sound technology [38].

(j) Infrared tag-based localization: This technology is works on the radiation variation of infrared lights that caused by objects [39]-[40].

The paper is divided into the following sections: Section 2 provides a brief problem description regarding the implementation. Section 3 describes the Hardware description. Section 4 describes proposed model of implementation giving a detailed explanation of the algorithms executing in different parts of the system, while section 5 describes the result and discussion, section 6 concludes the paper, section 7 list the applications and section 8 shows the scope of future work.

2. PROBLEM DEFINATION

Implementation of a single user localization system using two PIR sensors and binary pattern matching does perform fairly well in the scenario. The system fails if there are multiple people present in the environment. This makes it impossible to track the users individually as all of them may enter different rooms at different point of time. Thus, tracking of users in a multi-user environment requires tagging the user with any form of ID to effectively track a user. An organized system is required so that the users can be located in a large organization efficiently.

3. HARDWARE DESCRIPTION AND IMPLEMENTATION

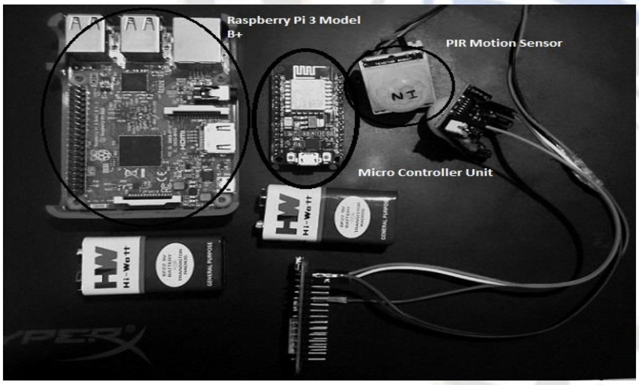

Figure 1. Hardware: Raspberry Pi, PIR Sensors, MCU

A. Hardware Setup The following hardware as shown in Fig:1 are being used in the proposed model listed below in table 1 and the table 2 shows the specifications of Raspberry Pi. Similarly, in table III the required software for this implementation has been listed.

TABLE 1

PARAMETERS

PIR Sensors	Range 0-3 m
NodeMCU ESP8266	ESP8266 Storage 4MB, Range 0-300m, 802.11n, Rx Power=56 mA, Tx Power = 120 mA, 65 mbps, PA +25 dbm, 2.4 GHz, Pocket length 1024 bytes
Wifi	2.4 GHz,150 feet (Indoor range),300 feet (Outdoor range)
Room Size	10X10 - 20X20 feet
RFID	Range 0-2m

TABLE 2

RASPBERRY PI SPECIFICATIONS

Processor count	4
CPU	1.2GHz 64-bit quad-core ARMv8 CPU
RAM	1GB
Graphics Card	PCI-E
Wireless Type	802.11n wireless LAN, 10/100Mbps lane speed
Bluetooth	Bluetooth 4.1, Bluetooth Low Energy
Hardware Platform	Linux
Operating System	Ubuntu Mate, Raspbian OS, Windows 10 IOT etc.

TABLE 3

REQUIRED SOFTWARES

Description	Description
XXAMP	Apache Server database, PHP 7.0, SQL
Matlab R15u	Simulation and Results
Arduino IDE	IDE for programming NodeMCU

- Passive Infrared (PIR) Sensor- It detects motion by the change in radiation emitted by moving objects. It provides an output 1, if a motion is detected else 0.

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- Radio Frequency Identification (RFID). It uses radio waves in order to identify the object/person according to RFID tag.
- Node Micro Controller Unit (NodeMCU): It store the binary value that has been received by the PIR sensors and RFID readers. The stored values at Node MCU transferred to the server (raspberry pi).
- Raspberry Pi: It is a mini computer that support multiple programming to perform required task. It can communicate with devices in wired and wireless mode. The PIRs and RFID readers can directly interface with the Raspberry Pi.

4 PROPOSED MODEL

The scenario is designed taking into consideration its application in Personnel localization in an organization and a system is designed in order to effectively carry out location tracking in an area with a large number of people. The paper concentrates on the implementation of organizational multi-user tracking using the internet of things devices. The following assumption(s) are being made for implementation of the network:

- The organization consists of a Wireless network with a router capable of access point isolation.
- Every member of the organization is equipped with an RFID based tag.

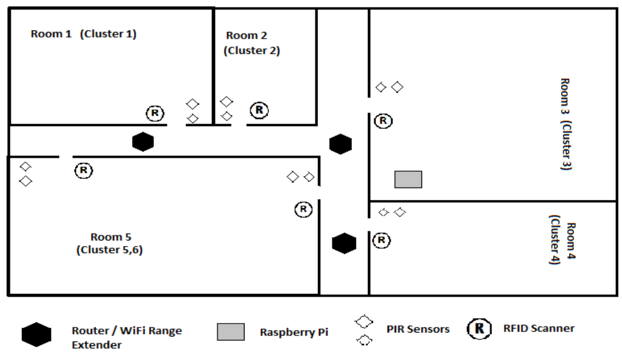

Figure 2. Implementation Schematics

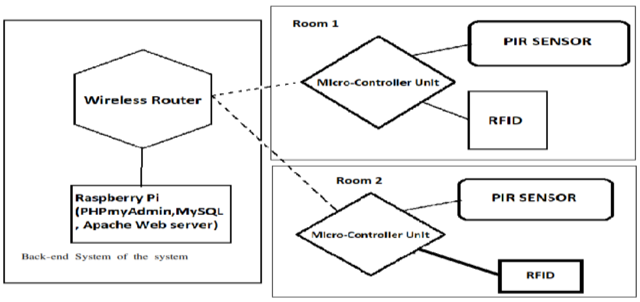

Figure 3. System architecture of the proposed model

Figure 2 Represents the architecture of the proposed model. Here Room1, Room2....Room5 are denoted as R1, R2....R5 and each room in the scenario is assigned a unique number and is denoted as a cluster with unique ID (as per room id). Each room contains two PIR sensors and one RFID reader. The RFID subsystem uses two sub-components namely the RFID tag and the RFID reader. Each RFID tag has a unique identifier which allows the tag to be identified in the system. In this implementation mid-range RFID scanners are used so that seamless scanning is done with minimal to no user interaction. As per the proposed scenario (ref Fig:2) Raspberry Pi and Wi-Fi router are used to communicate between nodeMCU and Raspberry Pi.

The Microcontroller units and the Raspberry Pi are connected to the wireless network so as to provide a seamless connection in a long range in case of the large area of implementation with seamless connection in a long range in case of the large area of implementation with longer range. Though it is an option to create a custom Hosted Network from the Raspberry Pi to connect the PIRs, such hosted networks from the devices have a very less range and hence cannot be effectively used to extend the Sensor Network over a large area. The existing network is being used in order to mitigate the extensibility issue in the network also, since the Raspberry is used for all the core processing in the network, creating a hosted network from the Pi creates additional networking overhead to the device and thus the core processing power is reduced to some extent, for this a dedicated networking system is preferred which can be an existing Wi-Fi network or a custom network for this specific setup.

Figure3 Shows the communication model of the proposed system. The PIR sensors and the RFID reader's scanned value stored at Node MCU for room1, through a wired link. The NodeMCU send the stored values to the server (Raspberry pi) through the wireless router. Similarly, the same communication model would be applied to every room of the proposed scenario. Since the PIR sensors and RFID are transferring binary data to the system. The process of binary pattern matching is used where each node of a room is responsible for a single bit of information. Assuming that each room is populated with two PIR nodes along with one RFID and contributing a combination of three bits with the scenario as given below for entry events:

- 000 (-, -, -): Nodes are inactive.
- 001 (-, -, +): The outer node is active. This might possibly lead to an entry scenario or a false trigger (person knock the door and run away)

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- 011 (-, +, +): The first node/outer node is active and RFID is also triggered. This might possibly lead to an entry scenario or a false positive (Person tends to enter but turns back).
- 111 (+, +, +): True entry.
- False-Positive: A false positive is a data in which the system registers an event even when the event has not occurred like a person enters inside the room and turns back half-way (the same note for an exit scenario), it is a false event denoted.

While exiting, only the PIR sensors binary information are adequate to trace the user's exit events 00 (-, -): Nodes are inactive. 10 (+, -): The inner node is active. This might possibly lead to an exit scenario or a false trigger (person tend to leave but turns back) 11(+, +). The inner node and the outer node are triggered. The exit event is notified.

When a user enters or exits a room the following cases are considered:

*Case 1: **Entry***

1) When a user enters inside a room, RFID is triggered according to its RFID tag as well as motion detected at outer PIR sensor, it will be recorded into database.

2) After the outer PIR sensor and RFID are triggered, If motion detected at inner PIR within 3 seconds, then a pattern is formed as Outer PIR → RFID→ inner PIR (,-,-) to (+,+,+), the event is recorded into the database else it will be treated as an error. The counter value is incremented by 1 to identify the number of users inside the room.

3) If the outer PIR sensor and RFID are triggered, and If motion is not detected at inner PIR within 3 seconds (knock the Door and run away), then it will be recorded an error.

4) If a user enters without RFID tag, motion is detected at outer sensor and if the motion is also detected at inner PIR, then the user is localized using the following pattern is formed outer PIR → inner PIR within 3 seconds then an entry is recorded. The user is localized to be unauthorized.

*Case 2: **Exit***

1) If a user motion is first detected at inner PIR sensor and that followed by outer PIR sensor within 3 seconds, then an exit event is recorded into the database and a pattern is formed from inner PIR to outer PIR (+,+) to (-,-) and the counter value id decremented by 1 to identify the number of users leaving the room.

2) Otherwise the event is considered to be error.

time_stamp	device_ID	cluster_ID	device_DATA	RFID
2018-04-06 01:14:31	room1_PIR_0	1	activated	838188095950
2018-04-06 01:14:16	room1_PIR_0	1	activated	838188095950
2018-04-06 01:14:12	room1_PIR_0	2	activated	838188095950
2018-04-06 01:14:06	room1_PIR_0	1	activated	838188095950
2018-04-06 01:13:51	room1_PIR_0	1	activated	838188095950
2018-04-06 01:13:41	room1_PIR_0	3	activated	838188095950
2018-04-06 01:13:25	room1_PIR_0	1	activated	838188095950
2018-04-05 23:12:20	room1_PIR_0	1	activated	838188095950
2018-04-05 23:12:20	room1_PIR_0	1	activated	838188095950
2018-04-05 23:12:19	room1_PIR_1	1	activated	0
2018-04-05 23:12:19	room1_PIR_1	1	activated	0
2018-04-05 23:12:14	room1_PIR_0	3	activated	838188095950
2018-04-05 23:12:14	room1_PIR_0	1	activated	838188095950
2018-04-05 23:12:13	room1_PIR_1	5	activated	0
2018-04-05 23:12:13	room1_PIR_1	1	activated	0
2018-04-05 23:11:27	room1_PIR_0	5	activated	838188095950
2018-04-05 23:11:27	room1_PIR_0	1	activated	838188095950

Figure 4. Raw Server-side Database Snapshot.

Data: outer PIR trigger flag, Room ID, node ID, sensor Status, RFID tag value

Result: Transmission of outer PIR status and RFID value, trigger time to server

Initialization: Connect to the Network and get IP address;

initialize variables to nodeID and RoomID;

while Node is Connected to the network **do**

subroutine 1(b)

send POST data to the server address (Raspberry Pi);

Go back to the beginning of the loop;

end

end

Algorithm 1(a): Real time multi user indoor localization

Figure4 represents the raw data received from the PIR sensor nodes and RFID devices. All the nodes give the data at different time-stamp. The cluster id column is beneficial for setting up sensors for rooms with multiple entry/exit points. The field timestamp indicates at time the entry recorded. The deviceID indicates from which device the data is received. The clusterID indicates the room id. The deviceDATA indicates the status of the device whether it is activated or sleep. The RFID indicates the serial number of the RFID tag. For this implementation, algorithm 1 is the driving algorithm for indoor localization and the raspberry pi calls the subroutine algorithm 1(b). Algorithm 1(b) is a subroutine call to identify the user's entry /exit events.

Data: Motion sensor data, pattern =000, flag= true/false, RFID tag id, Room ID.

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Result: Entry or Exit Flag with user ID and location initialization;

Initialization: For I=0 to N, Where N=5; // five rooms as per the proposed scenario

while true **do**

  if (outer-sensor) is triggered **then**

    set pattern= (+, -);

    scan RFID ();

    set pattern= (+, +);

    wait for **inner-sensor** trigger for 3 seconds;

    if inner-sensor is triggered **then**

      set pattern= (+, +, +);

      signal entry (name, location);

    else

      set pattern= (-, -);

    endif

  else then

    if inner-sensor is triggered **then**

      set flag= (-, +);

      scan RFID ();

      wait for **outer-sensor** trigger for 3 seconds;

    if outer-sensor is triggered **then**

      set pattern= (+, +);

      signal exit (name, location);

    else

      set pattern= (-, -);

    endif

  endif

endif

Return pattern;

Room[I];

If you want to exit the program then

set flag=false;

End While

Algorithm 1(b): Filter the raw data to get actual entry/exit events.

Algorithm 1(b) is used to filter the raw data to get actual entry/exit events. The PIRs are installed in a way so as to implement Binary Pattern Matching for detecting entry and exit, i.e. entry/exit is notified by the pattern in which three bits are considered for entry and two bits are considered for exit.

MySQL database is installed in the Raspberry Pi and Apache is installed in order to allow the server-side scripting to handle the MySQL database. The algorithm is implemented by every alternate node of the cluster, the Raspberry Pi, which hosts a PHP script to handle the POST request from the nodes executes a query every time a request is received and updates it to the table of the database as shown in Figure 4

5. RESULTS AND DISCUSSION

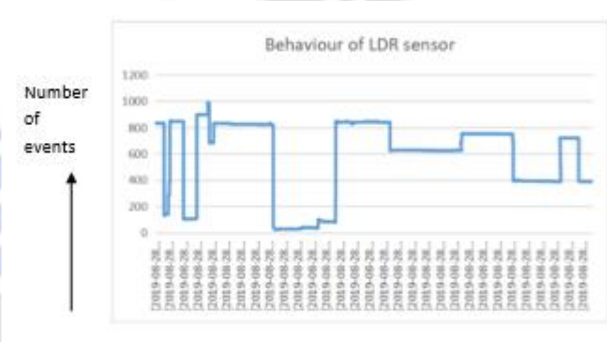

Figure 5. Behaviour of LDR sensor.

Figure 5 Shows the behaviour of LDR sensor during day and night time. When a user enters a room and switches ON the lights, the intensity of light goes high. When a user switches OFF the lights the intensity goes low. In LDR sensor based indoor localization, the threshold value is set 400 light intensity because during day time sunlight intensity and room light intensity exists. An entry is notified when the user enters the room and switch ON the light. During the night time, an exit is notified when the user switches OFF the light and exit the room.

As per the Figure 6, Figure 7 and Figure 8 the entry/exit events using LDR sensor have been simulated for 3 rooms and data are recorded into the database separately. The entry/exit events inside any of three rooms may increase or decrease depending on user behaviour during day or night time. The raw data collected from LDR sensor contains more than 80% error. In order to reduce the error of raw data, the raw data have been filtered using a method by setting a threshold value. The user is localized inside a particular room which means the user has turn OFF/ON the

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lights. The following results shows the erroneous data have been discarded efficiently.

Figure 9, figure 10, figure 11 the entry events have been simulated inside three rooms as per the data recorded of RFID, inner PIR, and outer PIR attached in each room. Depending on user behaviour, the entry events inside each room may increase or decrease. The raw data of RFID, inner PIR, and outer PIR sensor contain more error but it has been filtered using the proposed algorithm3 and the actual results came out and the erroneous raw data discarded efficiently. Here, two PIR sensors are used in order to count the number of users entering a room and exiting a room.

Similarly, as per the Figure 12, figure 13, figure 14 the exit events have been simulated inside three rooms as per the data of inner PIR and outer PIR. Depending on the user behaviour the exit event may increase or decrease. The inner PIR and outer PIR sensor contains more error but it has been filtered using the proposed algorithm3 and erroneous raw data discarded efficiently. The RFID tag is used for unauthorized detection of users.

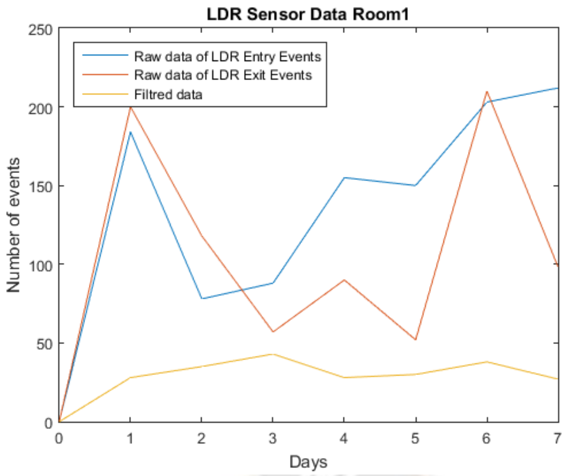

Figure 6. Entry and Exit events of LDR Sensor in room1

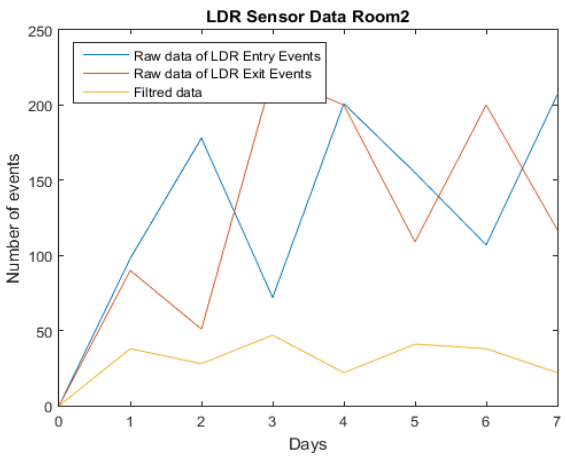

Figure 7. Entry and Exit events of LDR Sensor in room2

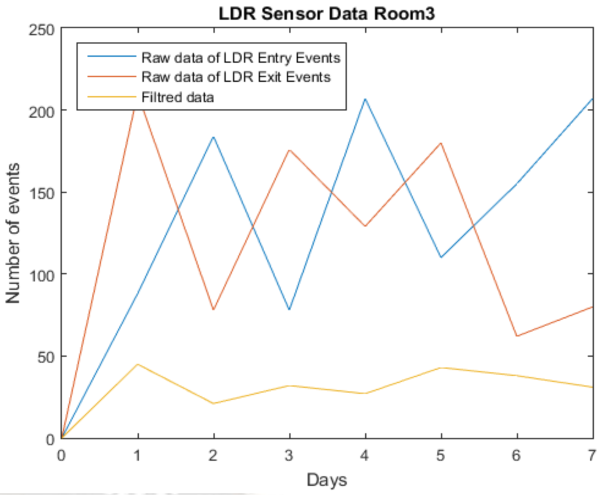

Fig 1. Entry and Exit events of LDR Sensor in room3

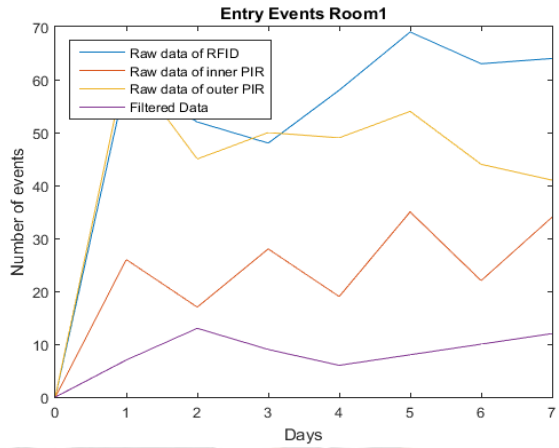

Figure 9. Entry events on PIR and RFID Sensor in Room1

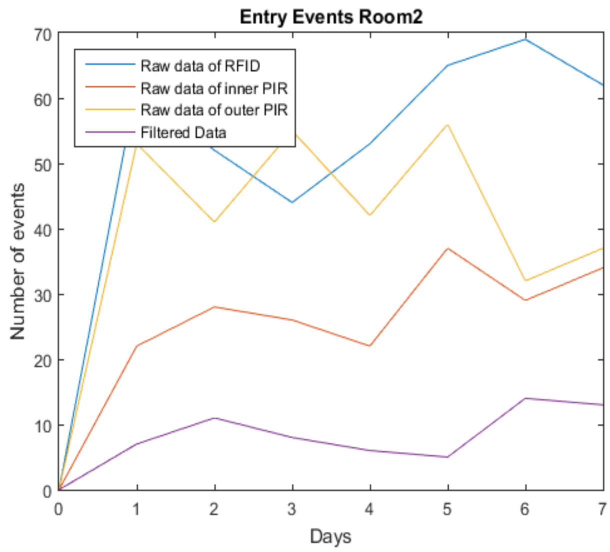

Figure 10. Entry events on PIR and RFID Sensor in Room2

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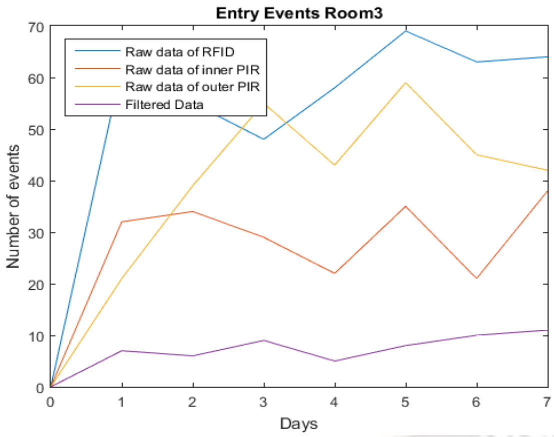

Figure 11. Entry events on PIR and RFID Sensor in Room3

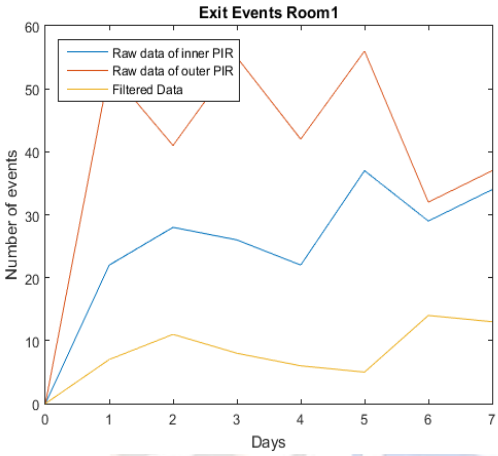

Figure 12. Exit events on PIR Sensor in Room1

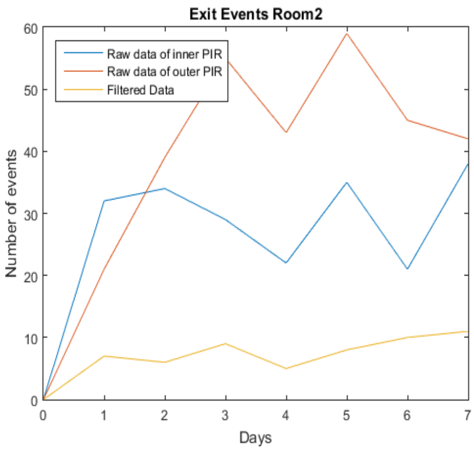

Figure 13. Exit events on PIR Sensor in Room2

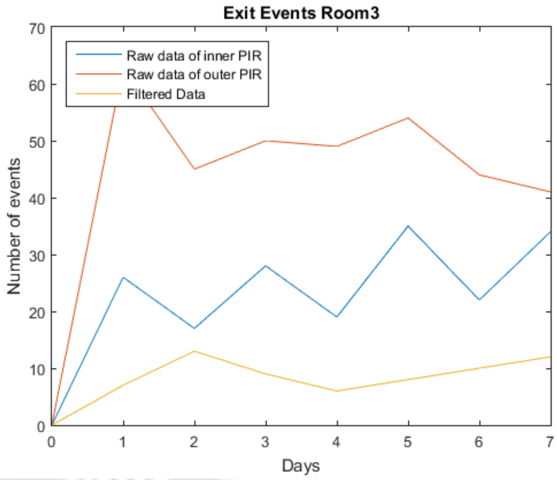

Figure 14. Exit events on PIR Sensor in Room3

A. Comparison with existing approach

As per Fig.15, fig.16, fig.17 a comparison between the LDR and PIR sensor-based techniques is done by comparing the filtered data generated, discarding the error detected inside each room for both the approaches. The above results show that PIR sensor along with RFID based localization provides better accuracy than the LDR based localization. The accuracy of the system is measured as per the given equation:

accuracy = (Filtered_data/total_no_of_events) ∗100   (1)

Using Equation (1) the of the PIR sensor-based navigation system accuracy is calculated 94%, In Tao et al. have proposed a multiperson tracking with binary infrared sensor system, which gives accuracy near about 90% [41].

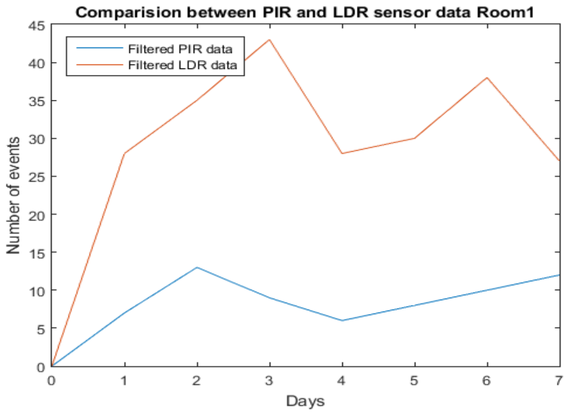

Figure15. Comparison of filtered data of both PIR and LDR Sensor Data Room1

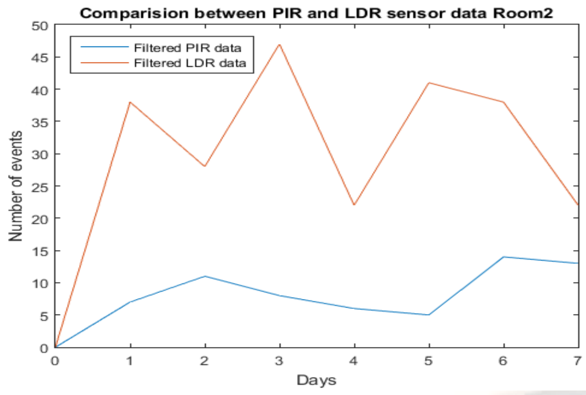

Figure16. Comparison of filtered data of both PIR and LDR Sensor Data Room2

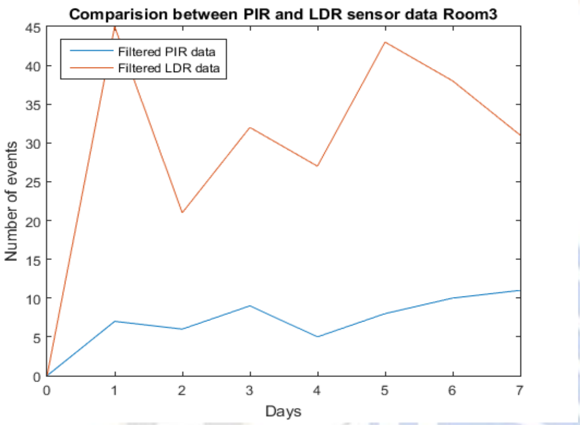

Figure17. Comparison of filtered data of both PIR and LDR Sensor Data Room3

6. CONCLUSION

In Tao et al. have studied the multiperson tracking based on binary infrared sensor network [41]. It used location of personal desk, moving direction of people for soft tracking of a person. The binary PIR sensor base system gives a binary response in each epoch, if a person is present/ absent. In [10] Alkiviadis et al. have studied the LDR sensor-based localization. In LDR sensor-based localization user is localized inside a room only when the intensity of the light is high/low, the user switches ON/OFF the lights. If lights remain on and multi user get enter inside a room then it is impossible to identify the person's location. To overcome this problem, The PIR sensor along with RFID based techniques has been proposed where the entry and exit events contain less error than the LDR sensor-based technique.

In PIR sensor and RFID based method, entry of a user is notified from the event triggered from outer PIR to RFID to inner PIR in a given specific time delay. Similarly, the exit of a user is notified from the event triggered from inner PIR to outer PIR in a given specific time delay. The RFID and outer PIR contain more error compared to inner PIR but the actual event is generated using the proposed algorithm by discarding the error events. For verification of the system, the system has been tested over a period of time, a manual logbook of entry/exit events have been recorded with a timestamp. The accuracy of the proposed system, PIR sensors along with RFID based navigation system is 94%. In Tao et al. have proposed a multiperson tracking with binary infrared sensor system, which gives accuracy near about 90% [41]. This system gives the information about the user as per the event detected at RFID and PIR.

Limitation- If an authorized person/object (living/non-living) enters, this system tells somebody is there but exactly who is there, it can't determine as like video-based system. This is the limitation of this system. But, if we compare the video-based system with the proposed system, in term of cost then the proposed system is very less cheap.

7 APPLICATIONS

The following are the applications of the proposed system: An unauthorized user can be localized at any moment of time such as in a highly restricted areas- inside a building, shopping mall, inside a museum, border area, Banks, Museums, Defence, Dockyards, Airports etc.

8 SCOPE FOR FUTURE WORKS

The implementation is undertaken to keep in mind its implementation in large scale organizations where tracking of users becomes necessary at a point of time. Although, it cannot replace existing Biometric or Video based localization. It can be used in the places where implementation of biometric devices is not feasible or there is a concern for breach of privacy due to the presence of monitoring cameras in the room.

Reference

[1]. Meena B.S, Analysis of different coverage and connectivity techniques, International Journal of Recent Technology and Engineering, Volume 8, Issue 2S3, 2019, Page No: 1636-1650, 2019.

[2]. Meena B.S, Hemachandran,K. An Experimental approach for understanding internet of things for corporate model and various platform. International Journal of Innovative Technology and Exploring Engineering, Volume 8, Issue 7S, pp. 228-240,2019.

[3]. P. Bellavista, G. Cardone, A. Corradi, and L.Foschini,"Convergence of MANET and WSN in IoT urban scenarios,"IEEE Sensors Journal, vol.13, no. 10,pp.3558-3567, Oct. 2013.

[4]. A. P. Plageras, K. E. Psannis, Y. Ishibashi and B. G. Kim," IoT-based surveillance system for ubiquitous healthcare," IECON 2016 - 42nd Annual Conference of

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the IEEE Industrial Electronics Society, Florence, 2016, pp. 6226-6230. doi: 10.1109/IECON.2016.7793281

[5]. A. Zanella, N. Bui, A. Castellani, L. Vangelista and M. Zorzi," Internet of Things for Smart Cities," in IEEE Internet of Things Journal, vol. 1, no. 1, pp. 22-32, Feb. 2014.doi: 10.1109/JIoT.2014.2306328

[6]. Meena B.S, laskar, R.U, Hemachandran K." Indoor localization-based office automation system using IoT devices" Intelligent Computing in Engineering,199-212, Springer,2020.

[7]. R. K. Kodali, G. Swamy and B. Lakshmi," An implementation of IoT for healthcare," 2015 IEEE Recent Advances in Intelligent Com-putational Systems (RAICS), Trivandrum, 2015, pp. 411-416. doi10.1109/RAICS.2015.7488451

[8]. Meena B.S, Deb S, Hemachandran K," Impact of heterogeneous IoT devices for indoor localization using RSSI Intelligent Computing in Engineering,199-212, Springer,2020.

[9]. Jun Zeng, Minbo Li, , Yuanfeng Cai, A Tracking System Supporting Large-Scale Users Based on GPS and G-Sensor , International Journal of Distributed Sensor Networks, https://doi.org/10.1155/2015/862184 May 27, 2015

[10]. Tsitsigkos, Alkiviadis and Entezami, Fariborz and Ramrekha, Tipu A and Politis, Christos and Panaousis, Emmanouil, A case study of internet of things using wireless sensor networks and smartphones, wireless multimedia and network research group,,Kingston University ,London, United Kingdom,April 2012

[11]. Meena B.S, Hemachandran K. Device based real time single user indoor localization using IoT devices. Recent Advances in Computer Science and Communications, Volume 15, Issue 9, pp- 1213-1222,2021.

[12]. P. Bahl and V. N. Padmanabhan," RADAR: an in-building RF-based user location and tracking system," Proceedings IEEE INFOCOM 2000. Conference on Computer Communications. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies (Cat. No.00CH37064), Tel Aviv, Israel, 2000, pp. 775-784 vol.2. doi: 10.1109/INFCOM.2000.832252

[13]. Xiuzhen Cheng, A. Thaeler, Guoliang Xue and Dechang Chen," TPS: a time-based positioning scheme for outdoor wireless sensor networks", Hong Kong, 2004, pp. 2685-2696 vol.4. doi: 10.1109/INFCOM.2004.1354687

[14]. Karalar T C, Rabaey J. An RF ToF based ranging implementation for sensor networks. In: IEEE international conference on communications, June 2006, vol 7, pp 3347–3352,

[15]. Kułakowski P, Vales-Alonso J, Egea-Lopez E, Ludwin W, Garcıa-Haro J, Angle-of-arrival localization based on antenna arrays for wireless sensor networks. Computers & Electrical Engineering 36 (6), 1181-1186,2010.

[16]. Kumar P, Reddy L (2009) Distance measurement and error estimation scheme for RSSI based localization in Wireless Sensor Networks. In: Fifth IEEE conference on wireless communication and sensor networks (WCSN), Dec 2009.

[17]. D. Niculescu and Badri Nath," Ad hoc positioning system (APS) using AOA, Twenty-second Annual Joint Conference of the IEEE Computer and Communications Societies (IEEE Cat. No.03CH37428), San Francisco, CA, 2003, pp. 1734-1743 vol.3.doi: 10.1109/INFCOM.2003.1209196

[18]. Bulusu N, Heidemann, GPS-less low-cost outdoor localization for very small devices. IEEE Pers Communication Magazine 7(5):28–34, 2000

[19]. L. Doherty, K. S. J. pister and L. El Ghaoui," Convex position estimation in wireless sensor networks," Proceedings IEEE INFOCOM 2001. Conference on Computer Communications. Twentieth Annual Joint Conference of the IEEE Computer and Communications Society (Cat. No.01CH37213), Anchorage, AK, USA, 2001, pp. 1655-1663 vol.3.doi: 10.1109/INFCOM.2001.916662

[20]. Tian H, Huang C,Brian M, Blum, John A. Range-free localization schemes for large scale sensor networks. In Proceedings of the 9th annual international conference on Mobile computing and networking (MobiCom '03). ACM, New York, NY, USA, pp 81-95,2003. DOI=http://dx.doi.org/10.1145/938985.938995

[21]. Nagpal R, Shrobe H, Bachrach J, Organizing a global coordinate system from local information on an ad hoc sensor network. In: Second International Workshop, information processing in sensor networks, IPSN 2003, Palo Alto, CA, USA, April 22–23, 2003.

[22]. Niculescu D, Nath B, DV based positioning in ad hoc networks. Telecommunication System, (2003) 22(1–4):267–280

[23]. Yi Shang, Wheeler Ruml, Ying Zhang, and Markus P.J.Fromherz. Localization from mere connectivity, In Proceedings of the 4th ACM international symposium on Mobile ad hoc networking and computing (MobiHoc 03). ACM, New York, NY, USA,2003, 201-212.

[24]. N. Kodippili and D. Dias, Integration of fingerprinting and trilateration techniques for improved indoor localization," in 2010 Seventh International Conference on Wireless and Optical Communications Networks (WOCN), pp. 1-6, IEEE, 2010.

[25]. A. Mathias, M. Leonardi, and G. Galati, An effcient multilateration algorithm," in 2008 Tyrrhenian International Workshop on Digital Communications-Enhanced Surveillance of Air- craft and Vehicles, pp. 1-6, IEEE, 2008.

[26]. F. Khelifi, A. Bradai, A. Benslimane, P. Rawat, and M. Atri, A survey of localization systems in internet of things," Mobile Networks and Applications, vol.24, no. 3, pp. 761-785, 2019.

[27]. A. J. Ruiz-Ruiz, O. Canovas, and P. E. Lopez-de Teruel, A multisensor architecture providing location-based

services for smartphones," Mobile Networks and Applications, vol. 18, no. 3, pp. 310-325, 2013.

[28]. Y. Chen, L. Shu, A. M. Ortiz, N. Crespi, and L. Lv, Locating in crowdsourcing-based dataspace: wireless indoor localization without special devices," Mobile Networks and Applications, vol. 19, no. 4, pp. 534-542, 2014.

[29]. Li, William Wei-Liang; Iltis, Ronald A.; Win, Moe Z., A smartphone localization algorithm using rssi and inertial sensor measurement fusion," in 2013 IEEE Global Communications Conference (GLOBECOM), pp. 33353340, IEEE, 2013.

[30]. F. Mazan and A. Kovarova, A study of devising neural network based indoor localization using beacons: First results," Computing and Information Systems Journal. University of the West of Scotland, vol. 19, no. 1, pp. 15-20, 2015.

[31]. S. Bobek, O. Grodzki, and G. J. Nalepa, Indoor microlocation with ble beacons and incremental rule learning," in 2015 IEEE 2nd International Conference on Cybernetics (CYBCONF), pp. 91-96, IEEE, 2015.

[32]. X. Li, J. Wang, and C. Liu, A bluetooth/pdr integration algorithm for an indoor positioning system," Sensors, vol. 15, no. 10, pp. 24862-24885, 2015.

[33]. Y. Li, Z. Ghassemlooy, X. Tang, B. Lin, and Y. Zhang, A vlc smartphone camera based indoor positioning system," IEEE Photonics Technology Letters, vol. 30, no. 13, pp. 1171-1174, 2018.

[34]. W. Chen, W. Wang, Q. Li, Q. Chang, and H. Hou, A crowd-sourcing indoor localization algorithm via optical camera on a smartphone assisted by wingerprint rssi," Sensors, vol. 16, no. 3, p. 410, 2016.

[35]. S. I. Lopes, J. M. Vieira, J. Reis, D. Albuquerque, and N. B. Carvalho, Accurate smartphone indoor positioning using a wsn infrastructure and non-invasive audio for tdoa estimation," Pervasive and Mobile Computing, vol. 20, pp. 2-46, 2015.

[36]. C. Zhang, M. J. Kuhn, B. C. Merkl, A. E. Fathy, and M. R. Mahfouz,Realtime noncoherent uwb positioning radar with millimeter range accuracy: Theory and experiment," IEEE Transactions on Microwave Theory and Techniques, vol. 58, no. 1, pp. 9-20, 2009.

[37]. D. Yang, H. Li, Z. Zhang, and G. D. Peterson, Impressive sensing based sub-mm accuracy uwb positioning systems: A space-time approach,"Digital Signal Processing, vol. 23, no. 1, pp. 340-354, 2013.

[38]. Ruan W,Sheng QZ,Yao L, Rutu M : Device free human localization and tracking through human object interaction. In: world of wireless, mobile and multimedia network, IEEE 17th international symposium on A .IEEE,p 1-9.2016

[39]. Priyanathan NB, Chakraborty A, Balakrishna H: The cricket location support system, In: Proceeding of the 6 th annual international conference on mobile computing and networking.ACM,p 32-43.2000

[40]. Yang B, Wei Q, Zhang M, multiple human location in a distributed binary Pyroelectric infrared sensor network. 2017. Infrared Phys Tech

[41]. Tao s, Kudo M, Pei BN, Nonaka H, Toyama J: Multi person locating and their soft tracking in a binary infrared sensor network. IEEE Transactions on human-Machine System, 45 (5): 550-561.2015