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Research Paper

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A Novel Approach for RFID Based Object Detection and Locating System

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***Abstract*—** It is the human tendency to mess up with finding the miss placed day-to-day objects such as car keys, spectacles, mobile chargers, etc. A survey shows that nearly 68% of working people find it difficult to find these necessary objects. This causes unnecessary wastage of time especially during getting ready for office. In this paper, we propose a low-cost RF-based object-locating system that uses compact RF-based object locators that can be attached to daily-use objects such as keys, spectacles, and chargers. The android-based application is developed to track the proximity of such RF trackers using BLE protocol. The application detects the signal strength to check the proximity of the target object. The proposed methodology uses both one-way and two-way trackers to provide proximity as well as proximity with a remote alarming system respectively to trigger an alarm for easy finding of the object from the developed android application. The proposed system can help in tracking and locating the objects using low energy and efficient Bluetooth transmission protocol. The system also implements GPS-based tracking of the objects on the map which can give the exact geographical coordinates along with the objects' position on the map. w.r.t. to the android application. The results show that the system works with 100% and 92% for indoor and GPS tracking respectively.

Keywords— Bluetooth, BLE, RF, Tracking,Objects, android, GPS, Map.

I. INTRODUCTION

Given the variety of use cases for IoT applications and the benefits to businesses, object localization in indoor space is of utmost relevance. Systems that track objects or people are a major application field. These systems are common problems in contemporary technology. The use of item finding and tracking systems to give solutions for daily operations has several benefits, including finding coworkers at a workplace, seeing a child's movements around a theme park, or monitoring the transit of luggage through an airport. The most common methods for tracking people involve the deployment of surveillance cameras. The CCTV images must be centralized monitored by a human operator using these systems. Fatigue frequently causes a loss of concentration. Typically, trackers with a Global Positioning System (GPS) implementation are used to monitor vehicles and other objects (GPS). These systems show a vehicle's location over a predetermined period of time. However, as GPS requires lines of sight operation with a minimum of three satellites, it permits outside navigation. Radio Frequency Identification is a different method of establishing tracking systems (RFID). RFID tracks objects using either passive or active tags. In stores and libraries, where tags are attached to products and are checked as they leave the store by passing through receivers near the entrance, passive RFID tracking is fairly widespread. When a wider range is required, active RFID is frequently employed in warehouses and places like airports. RFID tracking requires very little power and does not require line-of-sight communication. The sensors are significantly more expensive and call for complex configuration and software installations, in contrast to RFID tags, which are inexpensive, compact, and ideal for tracking objects. Radio waves from other sources and objects can readily block RFID signals. Another approach to object tracking is based on GSM communication technology. Through relay stations, GSM equipment talks with the GSM network. Triangulation allows for position determination by using the times and angles of arrival of signals from at least three stations.

Without the use of GPS, real-time object tracking or person tracking is currently impossible. However, the physical barriers in interior situations prevent GPS signals from passing through. The indoor positioning system (IPS) therefore takes to track the object or position, put it in the indoor application. These days, the topic of indoor positioning is getting more and more intriguing. Outdoor positioning has become a standard function in many goods as satellite-based navigation technology has advanced. Businesses now use maps for monitoring and navigation frequently and there is rising interest in how to do the

same indoors. The use of Bluetooth Low Energy beacons, Wi-Fi Access Points, and other strategies have all been suggested as part of the extensive ongoing research in this field. Many different strategies have been put out in this area of ongoing study, including the use of Bluetooth Low Energy beacons, Wi-Fi access points, and magnetic fingerprinting. Infrared sensing and sensor fusion technology are two more examples.

The idea of smart object tracking utilising RF technology is the subject of this study. The suggested system includes the creation of an RF-based item tracking system that makes use of low energy protocols to quickly determine an object's location and proximity. The built android application is used to track the RF beacons, which are small and simple to include in items like sunglasses, a keychain, a laptop charger, and other items. The method also uses portable trackers that may be attached to the everyday things to be tracked to provide exact location tracking.

II. RELATED WORK

Before we start with the paper a brief literature review is carried out to determine the currently existing approaches and arrive at the problem definition. The literature studied isdiscussed in this chapter.

Song Chai et al proposed an Indoor Positioning Algorithm Using RSSI-powered Bluetooth Low Energy [1]. The study has utilized the 4.0 generation of bluetooth based on the investigation of Received Signal Strength Index (RSSI). This study proposes a locating technique for indoor applications utilizing Bluetooth Low Energy RSSI. The RSSI value is pre-processed in this method by removing outliers and calculating the RSSI moving average. In order to determine the mobile device's present location, a triangulation process is used.

An Indoor Tracking System Based on Bluetooth Technology was proposed by Samuel King Opoku [2]. Line-of-sight operations, constrained coverage, and low-level programming languages are requirements of the technologies utilized in this article to access Bluetooth signal strength. It proposes a different way for monitoring the motion of indoor objects that is based on Bluetooth connection, motion-theoretical concepts, and the least square statistical method. Java is used to create and implement algorithms.

The influence of Bluetooth Low Energy devices in advertising/beaconing mode on fingerprint-based indoor location systems was examined in an analysis of the accuracy of Bluetooth Low Energy for indoor positioning applications suggested by R. Faragher and R. Harle [3]. Early testing revealed that when three BLE advertising channels are used, the limited bandwidth of BLE signals relative to Wi-Fi is the root of a substantial measurement mistake. A multipath mitigation strategy is suggested and put to the test. It is found that 10Hz beaconing and a 1-second multipath mitigation processing window size offer the best positioning performance.

Research on Wireless Indoor Positioning Systems and Techniques. [4] offers an overview of the wireless in-door positioning options now available and makes an effort to categorize various techniques and systems. The author investigates the common location estimate techniques of triangulation, scene analysis, and proximity. Due to its widespread use in modern systems and solutions, we also go into great length about location fingerprinting. The next step is to look at a set of criteria used to assess location systems. We then survey a variety of current systems using this methodology. A thorough assessment of performance is provided, covering accuracy, precision, complexity, scalability, robustness, and cost.

A high accuracy localization and tracking method using only inexpensive Bluetooth low-energy (BLE) beacons is described in Model-Based Localization and Tracking Using Bluetooth Low-Energy Beacons, which was proposed by F. Serhan Dani [5]. Here, a moving sensor's position is tracked by fusing noisy and extremely unreliable BLE observations streaming from many places. This method's creation of an observation model that is specifically suited for fingerprinting of received signal strength indicator (RSSI) is innovative; it is based on the optimal transport model of Wasserstein distance.

The methods used to determine a user's position in an indoor positioning system (IPS) have a considerable impact on the accuracy of the outcomes, according to L. Bai et al [6], who proposed the indoor positioning system employing Bluetooth beacon technology [6]. An efficient algorithm mitigates and, in the best situation, eliminates elements that have a detrimental impact on the placement outcome. Identifying the algorithms currently in use for indoor location with BLE Beacons is the aim of this study, which will also analyze one of these algorithms in a practical experiment with reference to various error factors.

III. METHODOLOGY

The fig.1 shows the conceptual diagram of the object detection system. As shown in the illustrative diagram the system consists of development of Beacons system which can be placed on objects to be located. The developed hardware part consist of a wireless RF beacon which uses low energy protocols to continuously transmit an RF signal consisting of unique identifier. The mobile app developed will pick up the unique identifier to scan the devices in the proximity of the android phone. The device is in the proximity it will be determined and displayed on the android app developed for object tracking. If the device is in the proximity the app is developed in such a way that it can also show the probable proximity of the location. This provides an innovative approach for indoor tracking of lost objects using RF based object location system. The system can also be used to trigger an alarm or vibration in the RF based locator to enhance the visibility. The system also

includes the feature of exact location tracking which will track the location of the objects to be tracked on the map with their exact geographical coordinates (latitude and longitude).

IV. SYSTEM DESIGN

The fig.3, presents the overall architecture diagram of the proposed RFID detection system. The proposed system consists of three modules as presented in this section.

- **The Wireless beacon Module:** This module consists of interfacing of the requisite hardware for the purpose of object tracking. This module consist of the development of the wireless RF beacons modules which will be compact and will be transmitting a unique ID.

Fig 1: The conceptual diagram of the paper

Development of required hardware to

- Transmit the location data using beacon hardware.
- Assignment of unique identifier which will be unique for each such beacon.
- Interfacing the hardware and reading the location data.
- Required Software development and coding the beacons to transmit the data to the android application to be developed.

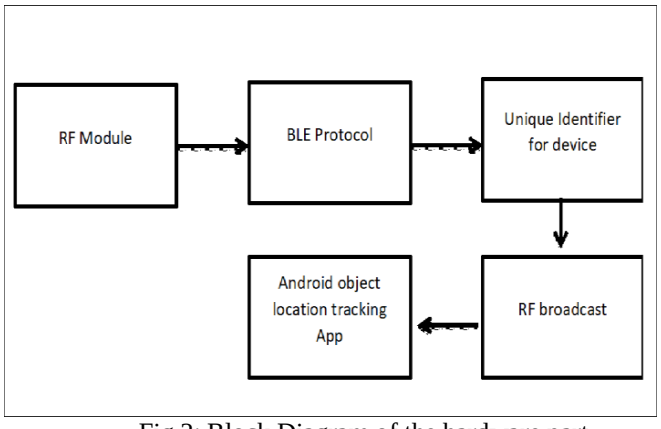


Fig.2: Block Diagram of the hardware part

- **The object Track android application:** This module consist of development of android application which can read the wireless signals transmitted by the beacons and display the location of proximity of the beacon to track the object. This module consist of:
  - Development of android application which can track the beacon location to provide the presence of object in the house or proximity of the android device
- **The Alarm system and vibration system module**: In this module the alarm system is developed on few objects which can be used to raise an alarm and vibrate form the object tracker to improve the visibility of the system.

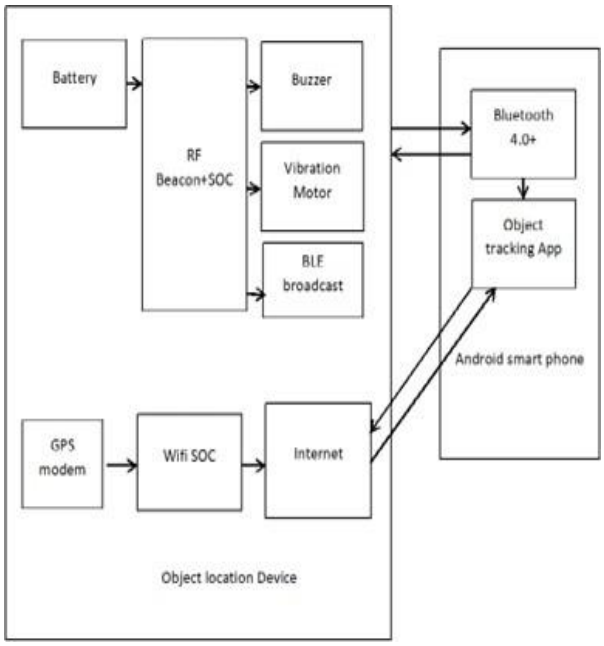


Fig.3: Architecture diagram

V. RESULTS AND DISCUSSION

The table 1 presents the efficiency of the proposed system for the both indoor and outdoor detection. The proposed system detects the objects with 100% efficiency in close proximity (up to 3 meters)

Table 1: Efficiency of the proposed model

Parameter	Dataset	Readings actually Recorded	Efficiency
GPS-(outdoor)	50	45	90
Indoor	50	40	100

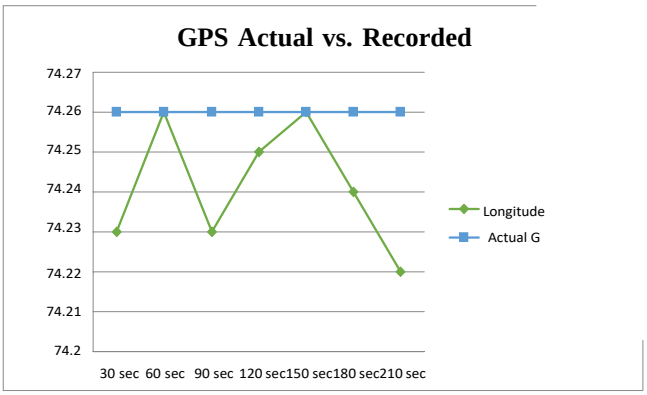
From the above table we can conclude that the efficiency of indoor object detection system accurate for the proximities of 3 meters. Since the system uses light weight MQTT protocol, the web service hit percentage was almost equal to complete.

The table 2 presents the accuracy of system for 8 minutes monitoring taking 50 sets ofreadings.

Table 2: System monitoring for 10 sec interval

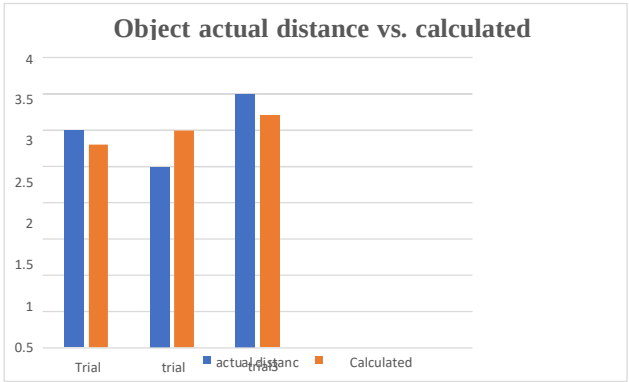
No of Readings	Time interval	Readings recorded by server	Readings expected	Efficiency
50	10 seconds	46	50	92%

From the above table we can conclude that the readings are being triggered to server reach at 92 percent. There was loss of 4 readings to 3 readings every 50 readings recorded. However, this loss is due to the network problem. Therefore, the system is expected to work at least 92 percent. Graph 1 shows the actual GPS and recorded readings of the system.



Graph 1: Aactual GPS vs recorded readings of the system

Graph 2 shows the comparison of actual GPS distance to the system recorded distance.



Graph 2: actual GPS distance vs system readings.

VI. CONCLUSION AND FUTURE SCOPE

The proposed RFID based tracking system can be used to find the lost objects nearby or in the home using RF beacon technology which is not possible by GPS due to the unavailability of the signal strength. Additionally, the paper also implements GPS based tracking system which can be used to track the objects with exact geographical coordinates on map if the GPS data is available. From the implementation the paper is expected to:

1. Provide an innovative and compact object tracking system which can be used to find the day-to-dayobjects in home.
2. Deliver a low energy system which consumes minimum energy so that the battery can last long.
3. Provide an android application which can display the lost objects if it is in the proximity of the android device and show the location as well as tell if the object is near or far.
4. To provide exact location tracking on the map using GPS based tracking system.

FUTURE WORK

The proposed RFID tag based object locating system can be integrated on super market robots to get the product to be sold to customers in the queue.

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