A Novel Prototype for Localization of Misplaced Objects Using Internet of Things

Deepthi Grandhi¹, Krishna Prasad Satamraju²

¹Post Graduate Student, ²Assistant Professor, Department of ECE, Vasireddy Venkataidri Institute of Technology, Namburu, Guntur (dt), Andhra Pradesh, India

Abstract — In the recent years, tracking the misplaced objects within the home has become a good research area. This is very useful for the development of smart homes. Things such as wallets, keys etc. are often misplaced and it will be troublesome to find them. Such objects can be identified using these systems. There are many systems existed to perform this task. These systems exhibit location accuracy of about 10 – 15 cm. But there are no methods that give a meaningful description about exact location of the object. This paper attempts to develop a localization system which is used to locate the lost objects using Internet of Things architecture. The system uses Wi-Fi technology to connect to the Internet. The prototype developed is easy to integrate with latest smart phone technology. The solution developed is accurate and can be improved to use in the field of logistics and military applications.

Keywords — Internet of Things, Localization, Tracking, Wi-Fi.

I. INTRODUCTION

Ubiquitous computing helps in improving the standards of daily living of human beings and assists them to build smarter homes. The ubiquitous computing has the ability in managing objects at home and enables real-time searching of objects. Global Positioning System (GPS) is considered to be the choice for localization in the outdoor scenarios. But, GPS is poor in terms of accuracy and precision in the indoor environments [1], [2]. Many different wireless technologies have been experimented in this area of research such as Infrared, Bluetooth, WLAN (IEEE 802.11), ultrasonic, RFID, Zigbee etc. RFID technology proved to be the technology apt for the localization system [3] because of its less overhead. This RFID augmented with IoT can give the best solution [4] and in [5] a study related to smart home systems has been presented by Song et al.

The RFID system is comprised of two parts RFID tags that act as transponder and RFID readers that act as detectors. There are three types of RFID tags namely active tags, passive tags, and semi-passive tags. An active tag has its own power source (battery) and RFID system using such a tag is called Active RFID system. Passive tags need external power for their operation and systems that use these tags are called Passive RFID systems. Passive RFID tags cannot initiate communication. Ontology based solution for Smart Homes is proposed in [6]. Solutions based on ontology alone are best suited in laboratory experimentation. They are not suitable for general applications because of the complexity in the system design, cost, accuracy and usability.

II. LITERATURE REVIEW

There are many studies that have demonstrated the indoor localization systems. But, most of them faced different real-time difficulties and hence are still in prototype stage. GPS cannot be used for indoor localization because of its accuracy deviation is almost 3m and indoor localization demands more accuracy. There are six important characteristics that need to be satisfied by the localization system.

A. Accuracy The indoor environments differ in sizes and shapes of the rooms. Therefore accuracy of 1 meter is required and this is exploited in [7] and [8].

B. No Line-of-Sight There are many objects in between within a room and hence it is not possible to have line-of-sight. Therefore we need to device technologies that work in such environments.

C. Economy These systems need to be of low-cost as the cost always plays a role in the implementation and usage.

D. Flexibility Systems must be designed in such a way that these systems can be used in any environment with little or no modifications.

E. Non-intrusiveness The system should not disturb the normal objects used in daily life.

F. Usability It should be easy to develop the system. The systems developed will have different levels of accuracy and one should fall in usable accuracy range in order to implement it.

For over the years, the RFID technology is the spearhead for the research work in this domain. Most of the characteristics required for localization are present in this technology. Fields like aeronautics,
engineering and medicine are using this technology [9]. The solution proposed by Tesoriero et al. [10] gives a method that uses a virtual map with the actual room and identifies the physical location of the tracking object from its position on the virtual map. Almaitah et al. [11] proposed two methods for 3D localization of a passive RFID tag. The first method is Adaptive Power Multilateration (APM) that uses four RFID tags and localizes the tag based on the minimal interrogation power and multilateration. The second method is Adaptive Power with Antenna Array (APAA) that uses a single RFID tag equipped with both horizontal and vertical antennas. Both methods give an accuracy of 0.38m and 0.48m respectively.

Saad et al. [12] proposed another 2D solution that attaches reader to the tracking object. The passive RFID tags are placed along the object path as reference tags. Yuhong and Ya [13] provided another 2D solution that calculates the coordinates of the tracked passive RFID tag based on Angle of Arrival. Brenchan et al. [14] proposed another active RFID based 3D solution with extension to 3D. In [15], DiGiampaolo and Martinelli proposed a passive RFID tag based system that uses a Quantized Extended Kalman Filter for distance measurements. Han et al. [16] proposed a 3D localization solution based on active reference tags in 1m. This algorithm uses antennas and filter methods are applied to measure the distance between the tag and reader.

This paper proposes a prototype used for localization of easily lost objects based on Wi-Fi and uses Internet of Things architecture.

III. SYSTEM DESIGN

Fig. 1 shows the overall system view of the proposed system. The system contains a centralized server which is used as a database to store the data related to the localization. Technology we are using is Wi-Fi as it is the best suited technology when it comes to Internet of Things. D1, D2, D3 and D4 are devices connected to the server through wire or wireless. We are using wireless technology. The device uses IoT architecture in its design.

The system uses the Internet of Things architecture as shown in Fig. 2. As we can see, there are seven layers in this model. Layer – 1 is called the Things layer which normally comprises of sensors, microcontrollers and other devices which gather information from the physical environment. The second layer is the communication protocols layer that provides gateway to the data transfer. This is the backbone of the system. The protocols like TCP/IP, and other protocols can be used in this layer. The protocols supported by various hardware and other devices can be used here. This layer is the key in interfacing the objects with the external world. The next layers Data Ingestion and Data analysis provide with storage and management. This layer in general also referred to as cloud, where data is stored and allows access to this data at any instant of time from anywhere. Data security is also provided in this layer to protect the data from unauthorized access. Techniques like encryption and decryption are used in this layer. Data integrity and authenticity is maintained in this layer.

In the upper two layers, custom applications can be developed using Android Application development and other applications can also be designed to perform post data analysis from the data in the cloud. Many applications have been developed using this data in various fields depending upon the requirements. The process layer is used to take decisions based on the results obtained from the analysis of data. There are varieties of applications developed in this layer ranging from turning on/off a relay to motion control of space crafts. Applications built on services and process in the cloud are gaining huge response from various markets such as consumer electronics, medical, smart living and smart agriculture.

Fig. 3 shows the block diagram of the proposed prototype. The Wi-Fi module is attached to every object required to track. This Wi-Fi module is configured in station mode. This module using any access point will get connected to the internet to access the central server. The application server running on the server place will continuously listen to the incoming data and directs it into the database where data is stored permanently and various tools are available to analyze this data. The clients can access to the web server to access the data stored in the database. In order to access the web-server for data, proper authentication must be made. This will help to avoid unauthorized access to the data.
IV. RESULTS

The experimentation is done using a NodeMCU microcontroller that has an inherent Wi-Fi module. The device is compact and has many digital pins and analog pins for connecting different devices and sensors. It has 9 digital pins and 1 analog pin with built-in ADC (Analog-to-Digital Converter). ESP8266 is the Wi-Fi module that comes built-in with NodeMCU. The ESP8266 was manufactured by Expressif, China. It has built-in Tensilica 32-bit microcontroller that runs at 80MHz. It has 4 MB flash that can be used to flash program. It is cheaper and yet very powerful microcontroller.

To store the object information in the cloud, a stream is created at data.sparkfun.com/local_obj. This stream will store the information in the cloud periodically. During our experiments, we have considered two objects with IDs D1002 and D1012. We tried to change the location of objects within the house. We continuously post this data onto the cloud and this data stored in the cloud can be accessed by the legitimate user from anywhere around the world using the public key. Private key is required to modify or delete the data. In this way, some security is provided to the data.

V. APPLICATIONS

Although this localization technique is suitable for indoor objects, with some minor changes and additional equipment, we can generate additional applications.

1) Military Applications

One of the major requirements of the military application is position of the soldier in the war field. By making the soldiers equipped with this localization system, and tracking the movement/location of the soldier in the war filed from a centralized monitoring room, will help the military people to execute their plans and coordinate amongst themselves.

2) Equipment Tracking in Organizations

In larger organizations such as universities, or multinational companies identification of equipment/tools will be difficult task. By attaching these devices to the equipment we can have continuous monitoring of these.

3) Child Tracker

Another important application related to localization is child tracker. This device requires GPS and helps in tracking children when they are at home or in school bus or away from home.
VI. CONCLUSIONS

A novel prototype for localization of misplaced objects is developed and tested. The system is capable of identifying the objects with minimum error and high accuracy. The system can be used in various applications and even can be extended to military and logistic applications. With the technology getting better and better every day, it is required for people to grow up with the technologies and make it as integral part of our daily life for a better and smart tomorrow.

REFERENCES