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Autonomous Indoor Mapping Using Raspberry Pi

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***Abstract*: The main objective is to assist a person to know the location of another person in the campus by using Passive Radio Frequency Identification (RFID) tags. The RFID tag stores the data about the person. The RFID sensor acts as the power source for the RFID tags. GPS is not suitable for positioning inside the building. Generally, there is a problem in locating the individual in the campus at the time of urgency. To eliminate the problem, indoor mapping is done to know the exact location of the individual. Here RFID tags give the exact location of an individual inside the campus. It can also give data about the personals present in a specific cabin or a room. Raspberry pi is used as the controller circuit for this project.**

***Keywords*: Raspberry Pi, RFID Tags, Indoor Positioning.**

1. Introduction

In daily life people face many kinds of trouble, in large campus like universities and industries there arises a trouble of locating an individual at the time of need. To assist that indoor mapping and positioning becomes useful. For outdoor mapping, Global Positioning System (GPS) is the most reliable, well known and widely used technology in today's world. It is capable of producing guaranteed results in outdoor environment. But in indoors it would be completely useless as it would not be able to work properly inside the buildings. There are many different kinds of positioning technologies such as Global Positioning System (GPS), cellular phone tracking system, Wi-Fi positioning system and RFID Positioning System. All these technologies have different coverage, applications, accessories and limitations. As GPS is a system developed for outdoor mapping, but for indoor mapping it is not possible due to some construction problems faced by the satellite which controls the GPS signals. Thus signal does not reach inside a building or a campus due to the architecture. Bluetooth devices can b used for indoor mapping but it faces many problems for distance, as Bluetooth has range up to 1m to 10m. Wi-Fi has good range as compared to Bluetooth, but not that good which can be used for positioning and mapping and Wi-Fi devices installation cost more and it makes the circuit more complicated. Wi-Fi also needs full speed network and also routers installation. When it covers a large area, it requires deployment of expensive Wi-Fi tags for tracking items. Since such tags are relatively expensive, they need to be removed from tracked places for reuse on places to be tracked. If the places to be tracked change frequently, the operation cost of transferring tags for Wi-Fi positioning applications will be very high. For this problem we are developing indoor mapping using RFID tags which is very easy to handle and install and very cost efficient. Deriving an accurate propagation model for each Wi-Fi access point in a real world indoor environment is extremely complex and therefore usually results in a relatively poor positioning accuracy. Designing a cost effective indoor positioning system remains an open challenge at present. This paper presents a real time and low cost indoor RFID positioning system. To offer a low cost indoor positioning solution for locating large number of items, passive tags are chosen rather than active ones. Typically, a RFID system consists of a reader, tags and a computer that holds and processes the tags information. In general, RFID tags can be classified into active, passive and semi-passive tags. Active tags embed an internal battery which continuously powers themselves and their RF communication circuitry. Readers can thus transmit very low-level signals, and the tag can reply with high-level signals. Tags without battery are called passive tags. Generally, it backscatters the received carrier signal from a reader. Passive tags have a smaller size and are cheaper than active tags, but have very limited functionalities. The third type is semi – passive tags. These tags communicate with the readers in the same way as passive tags but they embed an internal battery that constantly powers their internal circuitry. Low cost systems usually use passive tags instead of active tags. The accuracy of the GPS would become low as it would not be able to intercept properly with the satellites. Therefore, Indoor Positioning Systems (IPS) is used in the place of GPS. Some of the IPS used is RFID's Bluetooth beacon, Wi-Fi modules etc. Here we use RFID tags as it is more conventional and economical than its counter parts. The programming is done using Python 3. This project helps in detecting and locating the person in the large campus and shows where the person is along with the floor map. This helps a person to easily locate where a person is at that instant. It can be used in large campus like Universities and Industries.

2. Overview

The RFID sensors can sense the RFID tags within a given range. The data of the person is stored in each tag. Therefore, when the tag gets sensed by the RFID sensor the information the name of the tag holders gets displayed. PIR sensor is employed in order to display in which floor the person is standing.

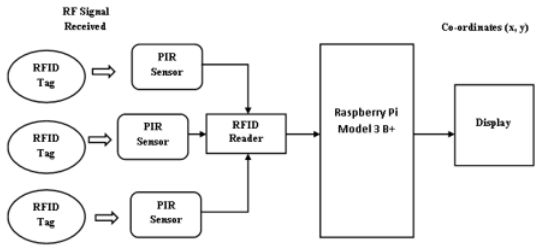

Fig. 1. Block diagram of proposed system

3. Hardware description

A. *Raspberry Pi*

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals or cases. However, some accessories have been included in several official and unofficial bundles. The Raspberry Pi model used in this project is Raspberry Pi model B+. The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting an updated 64-bit quad core processor running at 1.4GHz with built-in metal heat sink, dual-band 2.4GHz and 5GHz wireless LAN, faster (300 mbps) Ethernet, and Power Over Ethernet (PoE) capability via a separate PoE HAT. It controls the signals obtained from the RFID sensors and processes the data and it either displays the location of a person or people in a room. The Raspberry Pi itself is a mini computer. It has ports for keyboard and mouse too. It can either be connected to wired display or wireless display using VNC viewer.

B. *RFID Sensor*

Radio Frequency Identification (RFID) sensors, integrating the features of Wireless Information and Power Transfer (WIPT), object identification and energy efficient sensing capabilities, have been considered a new paradigm of sensing and communication for the futuristic information systems. RFID sensors tags featuring contactless sensing, wireless information transfer, wireless powered, light weight, non-line-of-sight transmission, flexible and are a critical enabling technology for future Internet of Things (IoT) applications such as manufacturing, logistics, healthcare, agriculture and food. They have attracted numerous research efforts due to their innovative potential in various application fields. However, there has been a gap between the in-lab investigations and the practical IoT application scenarios, which has motivated this survey of this research to identify the promising enabling techniques and the underlying challenges. This study aims to provide an exhaustive review on the state-of-art RFID sensor technologies from the system implementation perspective by focusing on the fundamental RF energy harvesting theories, the recent technical progresses and commercial solutions, innovative applications and some RFID sensor based IoT solutions, identify the underlying technological challenges at the time being, and give the future research trends and promising application fields in the rich sensing applications of the forth coming IoT era. RFID sensor uses electromagnetic field to automatically identify and track tags attached to objects. When the RFID tag comes within the range of the RFID sensor, the tag gets sensed by the sensor. Once the tag is sensed by the sensor and the sensor reads the data that is stored in the tag. Signaling between the reader and the tag is done in several different incompatible ways, depending on the frequency band used by the tag. Tags operating on LF and HF bands are, in terms of radio wavelength, very close to the reader antenna because they are only a small percentage of a wavelength away. If a person is to be located inside a campus, the id that is sensed by sensor gets compared and the id of the person that is to be located is found and the location of the person is displayed along with the floor map.

C. *RFID Tag*

An RFID tag is a small electronic device that is also referred to as a transponder. The tag consists of a simple silicon microchip and antenna. The tag can be attached to an object, typically an item, box. Information is collected by chip and can be transmitted wirelessly. RFID tag can be active (With batteries), passive (without batteries) and semi-passive (hybrid). Tag has an identification code that can be transmitted towards reader. There are five types of RFID tags available. RFID tag is of two types, Active and Passive. In active tags, the tags are provided with the separate source. In passive tags, it does not contain a separate power source. It uses the electromagnetic signal that is provided by the RFID sensor as the power source. The electromagnetic signal produces a voltage in the passive RFID tag and thus it operates without a power source of its own. Each tag is embedded with the name and id of the user. Once the sensor reads the tag, the data is also read by the sensor and the data is provided to the Raspberry Pi.

D. *PIR Sensor*

A passive infrared sensor (PIR) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. PIR sensors are commonly used in security alarms and automatic lighting applications. In this project the PIR sensor is used to detect the floor where the person is located. PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in

appliances and gadgets used in homes or businesses. They are often referred to as PIR, Passive Infrared, "Pyroelectric", or "IR motion" sensors. PIRs are basically made of a Pyroelectric sensor, which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low. Along with the Pyroelectric sensor is a bunch of supporting circuitry, resistors and capacitors. It seems that most small hobbyist sensors use the BISS0001 ("Micro Power PIR Motion Detector IC"), undoubtedly a very inexpensive chip. This chip takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor.

4. Evaluation

The data of every employee in an organization is stored in each RFID Tag and the tag containing the information about the person is given to the respective person. The RFID Tags used here are of passive type because it does not require a separate power source. The PIR Sensor acts as a motion sensor. The PIR Sensor is used to distinguish between the floors in the building. The PIR Sensor first senses the movement of the person in certain floor. Then the RFID Reader senses the RFID tags and the id that is needed by the user gets sorted by the program code in the Raspberry Pi. The programming is done by using Python GUI. Once the required tag of the person gets identified, the location of the person is displayed in the floor map. To locate an individual inside a large campus is always a tedious thing. This project helps people to locate them easily. The programming is done by using Python GUI. Firstly, the data is uploaded in the program. Then to locate the individual, the id of the person is entered in the search box. Then the location of the person is displayed along with the floor map. The further development would be automating it to do the attendance in classrooms.

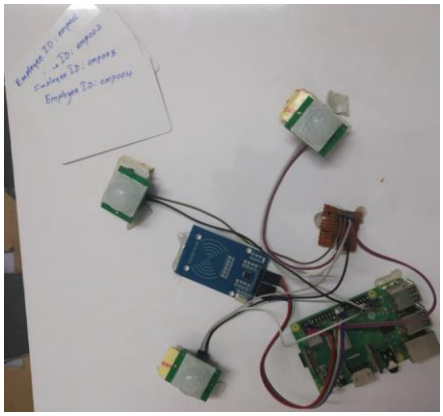

Fig. 2. Hardware setup

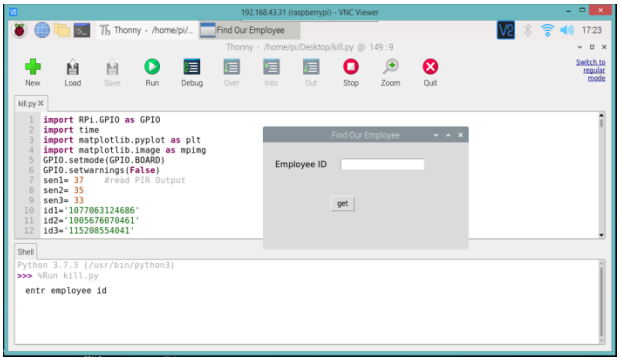

Fig. 3. Simulation input

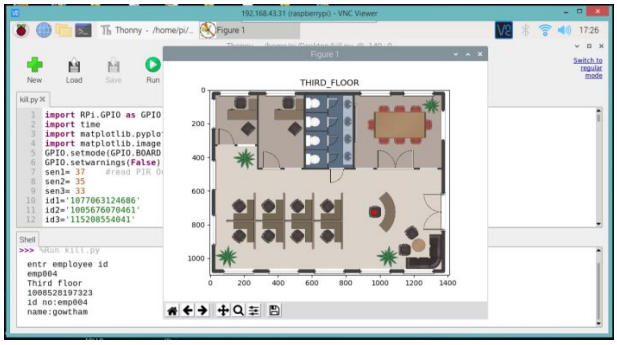

Fig. 4. Simulation output 1

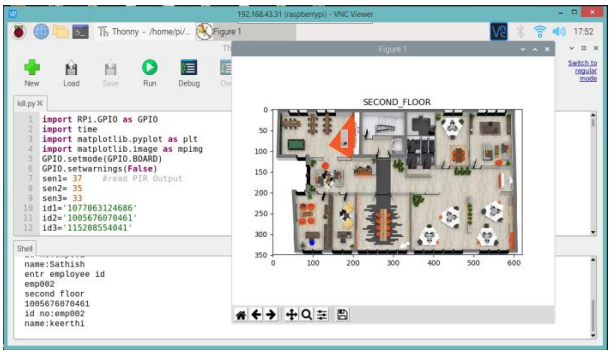

Fig. 5. Simulation output 2

5. Conclusion

This paper presented an overview on autonomous indoor mapping using Raspberry Pi.

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