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Autonomous Indoor Mapping Using Raspberry Pi

Jagadesh T.[1], Praveen R.[2], Neu Pramod M.[3], Sridhar S.R.[4]

[1]*Assistant Professor, Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, India.*

[2-4]*Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, India.*

Abstract

Passive Radio Frequency Identification (RFID) tags are used to let a person know the location of another person on campus. The RFID tag stores personal data. The RFID sensor for the RFID tags serves as the power source. GPS is not appropriate for installation within the house. In general, there is a problem at the time of urgency in locating the person on the campus. Indoor mapping is performed to minimize the difficulty, to know the precise position of the entity. Here the RFID tags give an individual's exact location inside the campus. It can also provide personal data in a particular cabin or room. In this project, Raspberry pi acts as the controller circuit.

Index Terms: *Raspberry Pi, Indoor Positioning, RFID Tags.*

1. Introduction

People face many kinds of trouble in everyday life; there is a difficulty in locating an individual at the time of need in large campuses such as universities and industries. To support that, it is useful to map and locate indoors. Global Positioning System (GPS) is the most accurate, commonly deployed, and well-known tool in today's world for outdoor mapping. This is capable of delivering assured outdoor environmental performance.

But it would be completely useless indoors, as it would not be able to work properly within the buildings. There are many different types of positioning technologies, such as the Global Positioning System (GPS), the cell phone tracking system, the Wi-Fi positioning system and the RFID positioning system. Each of these devices has numerous masks, implementations, modifications, and limitations. GPS is a device built for outdoor mapping, but due to some construction problems faced by the satellite which regulates the GPS signals, it is not possible to map indoors.

Regardless of the architecture, the signal doesn't penetrate within a house or school. Bluetooth devices can be used for indoor mapping, but because Bluetooth has a range of up to 1 m to 10 m it faces many distance problems. Wi-Fi has a good range compared to Bluetooth, but not the good that can be used for positioning and mapping, and the installation of Wi-Fi devices costs more, making the circuit more difficult. Wi-Fi also includes high speed network as well as installation of routers. As it reaches a wide region it needs costly Wi-Fi tags to be installed to identify objects. As these tags are fairly costly, they need to be withdrawn from monitored locations for reuse at tracking sites. We are developing indoor mapping for this problem using RFID tags which are very easy to handle and install, and very cost-effective.

The derivation of an accurate propagation model in a real world indoor environment for each Wi-Fi access point is extremely complex and thus usually results in relatively poor positioning accuracy. Currently the design of a cost-effective indoor positioning system remains an open challenge. This paper presents an indoor RFID positioning system that is in real time and low cost. Passive tags are chosen rather than active ones to offer a low cost indoor positioning solution for locating large numbers of items. A RFID device usually consists of a reader, tags, and a machine which holds and processes information about the tags.

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RFID tags are typically classifiable into active, passive and semi-passive categories. Responsive tags embed an internal battery that continually control itself and its RF contact circuitry. This allows readers to transmit very low-level signals, and the tag can respond with high-level signals. Battery-free Tags are called passive tags. In general it backscatters a reader's received carrier signal. Passive tags have a smaller scale and are simpler than active tags, but have very few features and functions. The third form is semi tags-passive. These tags communicate with the readers in the same way as passive tags, but they incorporate an internal battery which constantly enhances their internal circuitry. Low cost systems tend to use passive tags rather than active tags.

The GPS accuracy would be poor, because it would not be able to detect the satellites properly. Indoor Positioning Systems (IPS) is therefore used in place of GPS. Some of the IPS used are Bluetooth beacons from RFID, Wi-Fi modules etc. We use RFID tags here because it is more conventional and cost-effective than its counter parts. Programming is conducted using Python 3. This project helps identify and locate the person on the big campus, and shows where the person is along with the map of the building.

This helps a person identify quickly where he or she is at that moment. It can be used on large campuses such as Universities and Industry.

2. Overview

Within a given range the RFID sensors will sense the RFID tags. The person's details are stored in each tag. Consequently, when the tag is detected by the RFID sensor the tag holder’s information is shown. The PIR sensor is used to indicate on which floor the individual stands.

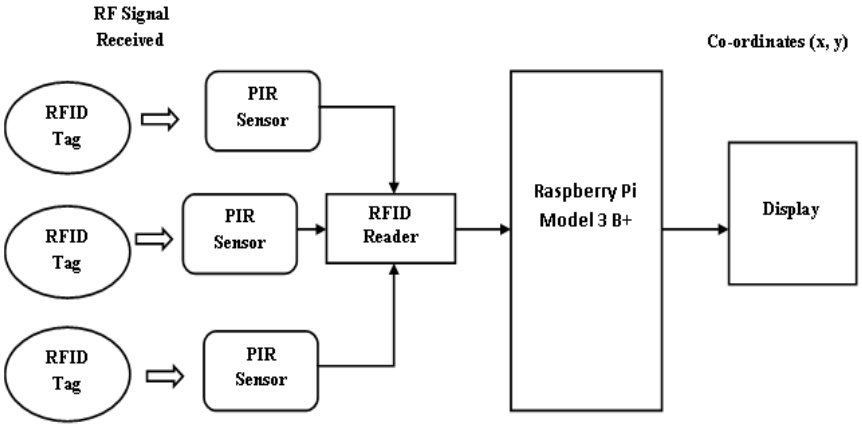

Fig.1 Block Diagram of Proposed system

To locate the accurate position of the person, multiple sensors are used. When multiple sensors are present in a single room, the accurate location is given by recording, which sensors sense the RFID tag and calculating the distance between the sensor and tag and accurate location can be done by plotting the point in the room map.

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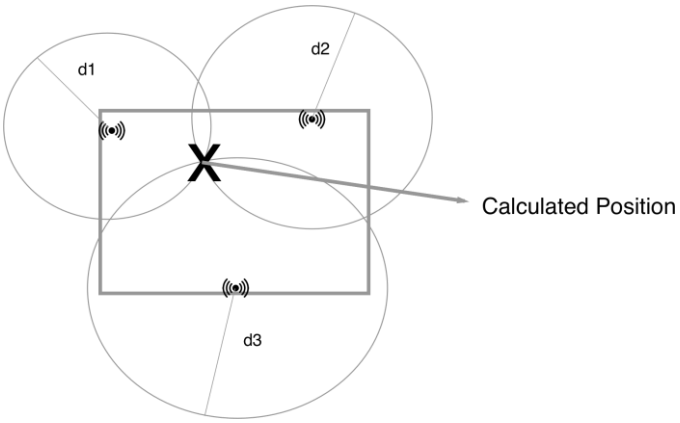

Fig.2 Locating using Multiple RFID Sensors

3. Hardware Description

A. Raspberry Pi

The Raspberry Pi is a series of tiny single-board computers built in the UK. The original model was much more popular than anticipated, selling uses such as robotics outside of its target market. It contains neither peripherals nor containers. However, some official and unofficial packages included several accessories. The type Raspberry Pi used in this project is code Raspberry Pi B+. The Raspberry Pi 3 Model B+ is the newest device in the Raspberry Pi 3 series, featuring a 1.4GHz modified 64-bit quad core processor with built-in heat sink, 2.4GHz dual-band and 5GHz wireless LAN, faster Ethernet (300 mbps) and Power Over Ethernet (PoE) functionality through a separate PoE HAT. It regulates the signals obtained from the RFID sensors and it analyses the data, and either shows a person's or people's position in a space. Raspberry Pi is a mini-computer in itself. It has keyboard and mouse ports too. Using VNC viewer it can be either linked to wired monitor or wireless monitor.

B. RFID Sensor

Radio Frequency Identification (RFID) sensors, incorporating Wireless Knowledge and Power Transfer (WIPT) technologies, target recognition and energy-efficient sensing capabilities, is considered to be a modern sensing and communication model for the potential information systems. RFID sensor tags feature contactless sensing, wireless information transfer, wireless powered, light weight, non-line-of - sight transmission, flexibility and are a critical enabling technology for future Internet of Things (IoT) applications such as manufacturing, logistics, healthcare, agriculture and food. Because of their groundbreaking ability they have drawn multiple work efforts in different fields of study. However, there has been a distance between the in-lab investigations and the realistic IoT implementation situations, which has inspired this review of this study to recognize the successful supporting approaches and the underlying challenges. This thesis intends to include a comprehensive analysis of state-of-the-art RFID sensor technology from the viewpoint of device deployment by concentrating on the basic theories of RF energy harvesting, recent scientific developments and practical solutions, groundbreaking applications and some RFID sensor-based IoT solutions, defining the underlying technological challenges at the moment, And give the future research trends and promising fields of application in the rich sensing applications of the IoT era to come. RFID sensor uses electromagnetic field to automatically identify tags attached to objects and track them. When the RFID tag reaches within the RFID sensor's range, the sensor senses the object. When the sensor detects the tag and the sensor reads the data which is contained in the packet. Signaling between the reader and the tag is performed in numerous conflicting forms, based on the frequency band the tag requires. Tags that run on LF and HF bands are very similar to the reader antenna in terms of radio frequency, since they are just a tiny percentage apart from a spectrum. If a person is to be located inside a campus, the sensor-sensitive Id will be compared and the person's Id will be found and the person's location will be displayed along with the map of the floor.

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C. RFID Tag

An RFID tag is a thin, electronic device often known as a transponder. The tag comprises of an antenna and a small silicon microchip. The tag may be appended to an entity, normally an element, package. Knowledge is chip-gathered and can be distributed wirelessly. RFID tag can be active (With batteries), passive (without batteries) and semi-passive (hybrid).Tag has an authentication code that can be conveyed through user. The RFID tags are available in five forms. RFID tag is Active and Inactive, with two forms. The tags are given separate source in active tags. In passive names, it does not include a different power source. It utilizes the electromagnetic signal given as the power source by the RFID sensor. The electromagnetic signal generates a voltage in the passive RFID suffix, and thus works without its own power source. Each tag is encoded with the user's name and Id. If the sensor reads the code, the sensor also reads the data, and the Raspberry Pi is supplied with the data.

D. PIR Sensor

A passive infrared sensor (PIR) is an electronic sensor that detects infrared (IR) light radiating in its field of view from objects. They are more widely found in motion-detectors dependent on PIR. Usually PIR sensors are used in safety detectors and automated lighting applications. The PIR sensor is used in this project to determine the floor the user is placed in. PIR sensors enable you to feel motion, which is almost often used to determine whether a person has travelled inside or beyond the range of sensors. They're lightweight, affordable, low-powered, simple to use and does not wear out. They are most usually used in devices and gadgets which are used in homes or companies. Often they are referred to as sensors PIR, Passive Infrared, "Pyroelectric" or "IR wave". PIRs are essentially constructed of a Pyroelectric system capable of measuring amounts of radiation from the infrared. Both emit any low-level radiation, and the more radiation is released, the hotter stuff. In reality, the sensor in a motion detector is divided in two halves. The explanation for that is that we are trying to identify non-average IR rates of motion (change). They wire up the two halves so that they balance each other out. If one half receives the IR radiation more or less than the other, the performance may shift high or small. A lot of connectors, resistors, and capacitors are provided together with the Pyroelectric sensor. The BISS0001 ("Micro Power PIR Motion Detector IC"), probably a very inexpensive device, seems to be used by most tiny hobbyistic sensors. This chip takes the sensor's signal and does some minimal processing on it to generate a simulated pulse from the analog sensor.

4. Evaluation

In each RFID File, the details of each employee in a company are processed and the file containing the individual's information is given to the corresponding user. The RFID tags used here are of passive form since a different power source is not needed. The PIR sensor serves as indicator of motion. The PIR sensor is used to differentiate the building floors from each other. First the PIR sensor detects the person's movement in any air. The RFID Reader then detects the RFID tags, and the Id the user requires is filtered by the Raspberry Pi software file. The programming is accomplished by using Python Interface. After the person's appropriate tag is found, the person's position is seen on the floor chart. Locating a single person within a wide campus is often a boring task. This initiative lets citizens quickly recognize them. The programming is accomplished using Python GUI. In the system, first, the data is imported. Then the person's Id is placed in the search box to find the user. The person's location is then seen along with the floor map. The further advancement will be to simplify the attendance at the classes.

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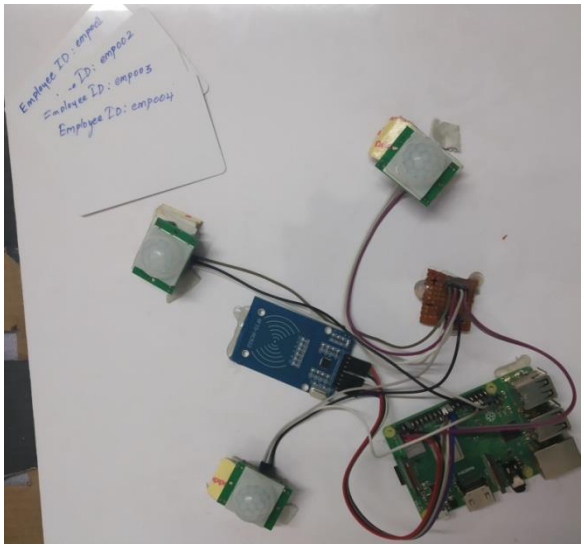

Fig.3 Hardware setup

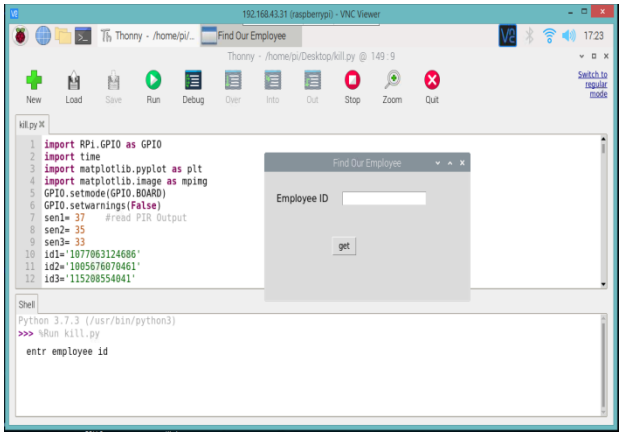

Fig.4 Simulation input

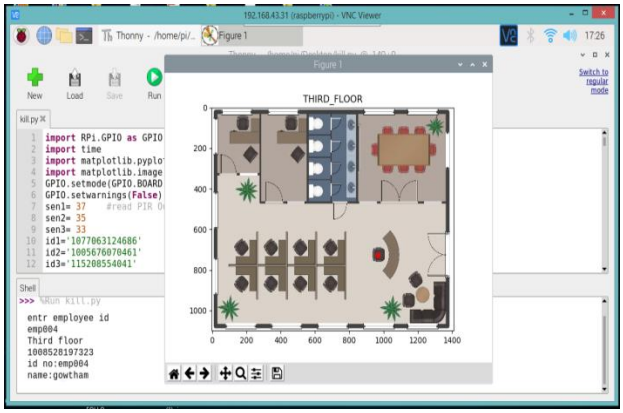

Fig.5 Simulation output 1

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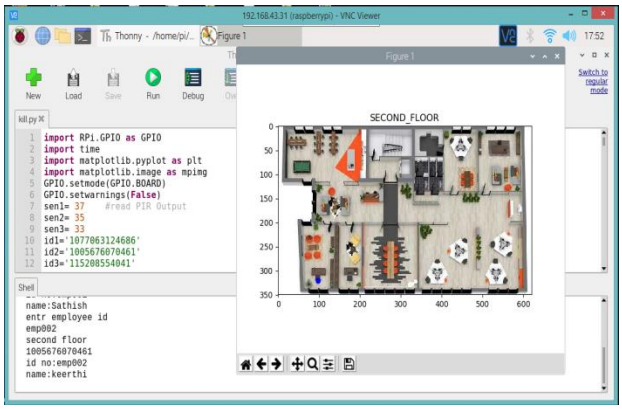

Fig.6 Simulation output 2

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