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Development of an IOT based Visitor Detection System

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ABSTRACT: In this paper, we propose system based on impulse radio ultra-wideband (IR-UWB) radar sensors for counting multiple people passing through a passage or a wide door. The proposed counting system utilizes two IR-UWB radar sensors equipped with antennas which have narrow beam width to form two invisible electronic layers in the path. The two electronic layers are used for sensing and direction recognition of multiple people passing by. Algorithmically, sensing and direction recognition of a person passing through a path are performed considering both information of a received signal in each radar and mutual information between two radar signals. The proposed counting system is implemented with two radar modules designed using commercial radar ICs and a Raspberry Pi 2 module. We installed the designed modules in the subway station to verify the performance. Based on the installed modules, data were acquired for one week and the counting performance was verified for various time intervals such as 2 minutes, 1 hour, and 1 day. Except for a few cases, we could get counting results with errors less than10%.

I. INTRODUCTION

Recently, technologies of various fields are combined with the concept of Internet of things (IoT) [1], and it is possible to be aware various situations in real time. One of the key elements in IoT is sensor technology for context awareness. Nowadays, many sensor technologies that can be combined with IoT are being studied. Impulse radio ultra-wideband (IR- UWB) radar sensor is also one of the things in this trend. The IR-UWB radar sensor is attracting attention as an intelligent sensor that can be easily used as an embedded type sensor with a simple hardware configuration [2] and can be used in various applications.

An IR-UWB radar uses an impulse signal that occupies wide bandwidth [3]. It is a technology that transmits an impulse signal and recognizes various situations by processing multiple signals that are received after being reflected from multiple human and objects. It can be used for a distance measurement based indoor positioning system [4]–[6], and as an intrusion detection sensor for security[7]

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actively studied for measuring vital signs in distance [8]–[10], and is being explored for the purpose of detecting people at disaster sites [11]–[13]. Even, the IR-UWB radar sensor is used to distinguish human activities, detect breast cancer, and recognize gestures [14]–[18].

Unlike these fields, there have been attempts to use IR- UWB radar sensors for people counting [19]–[21]. Similar to these studies, in this paper, we will refer to the development of a people counting sensor for counting the number of people passing through a passageway or wide door simultaneously. Information on the number of people passing through a certain passage can be used as key information in configuring smart city. More specifically, it can be used to know the flow of population of each main district of the city, and to know the population density of each main region based on the flow information. In addition, it is also applicable to the control and management of congestion in subway stations based on the information of population.

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In this paper, we propose a people counting algorithm using IR-UWB radar sensors, and moreover, refer to embedded implementation and installation examples. More specifically, using two IR-UWB radars equipped with antennas which have narrow beam width, two invisible thin layers are formed to count and recognize directions for a large number of passers by. For implementation, antennas and radar modules are designed and algorithm proposed in this paper is implemented using ARM Cortex-M4 and Raspberry Pi 2 modules [22], [23]. In order to verify the performance, the designed modules were installed in the subway station and the data for one week was acquired and the performance was verifiedthrough the data.

The contents of the paper are as follows. First, we refer to related works about people counting. After that, we describe two IR-UWB radar sensors based system configuration and basic radar signal processing for people counting, and then, introduce the people counting algorithm in detail. Finally, we talk about designed antenna, radar sensors, and Raspberry Pi 2 based designed counting module to implement the proposed algorithm, and describe performance verification in one of the subway stations in Seoul,Korea.

II. RELATED WORK

People counting can be classified into two categories de- pending on the purpose of use. The first category is a counting that counts the number of people in a certain area. In this regard, there are mainly vision based studies [24]–[27], and people counting researches using radio frequency (RF) signals such as Wi-Fi, Zigbee, UWB have been done in [21], [28]– [32]. The main issues related to people counting in a given are focus on what is the characteristic of human and how to detect it ,or ,in order to deal with the number of people who are more massive, research is focused on finding out what indexes tend to change with the number of people and measuring the number of people based on the indexes.The second category is the people counting, which counts the number of people passing through a door or passage. The people counting that we want to deal with in this paper is the second category, people counting, for counting people passing through a door or passage. Unlike the people counting that counts the number of people in a certain area, the counting of people passing through a door or passage should also take into account the binary direction along with the detection of the moving person. In other words, to count the number of people moving in each direction, we must detect the moving person and determine the direction of the moving person.In this regard, many researches based on vision sensors have been performed [33]–[38]. The technical contents of people counting using computer vision show mainly ways to set virtual line on the scene and to count the number of people passing through it. It detects people by using physical features of each person's head, shoulders, and omega patterns, and tracks each detected person to find the direction of movement.However, technically, counting the number of people using vision has the disadvantage that there is a performance variation depending on the appearance of person passing by (the person carrying the baggage or the person carrying the bag).In addition, the critical disadvantage of vision based people counting is privacy problem. IoT emphasizes accessibility to things based on Internet, and vision sensor can make those who is monitored feel uncomfortable. Even if the videos are not saved, there is always a risk of hacking [39]. In terms of the performance, the performance of the vision sensor depends on the illuminance and a relatively large amount of calculation is required due to the 2-dimensional image processing [40],[41]. As a result, image processing requires a certain amount of hardware resources. In order to overcome the disadvantages of people counting based on the vision, people counting based on other tech- no logies appeared. In [42], a population counting study was conducted based on two passive infrared (PIR) sensors. It has the advantage of being able to operate in a light-free environment and to operate independently of the person's appearance, in that it is based on heat from the human body. However, it has frequent false alarms and poor resolution for resolving many people. In [43]–[45], they discuss people counting using multiple infrared sensors. Infrared sensors detect people and count the number of people moving in both directions, taking into account the time differences detected on subsequent infrared sensors. This is the most popular people counting technology in the current life, but it has the disadvantage that it can not cope with the concurrent passing people. Therefore, it is commercialized as a counting sensor in a narrow door where only one person can pass. In [19], they proposed a people counting sensor based on an IR-UWB radar sensor. The proposed method is to count eachperson approaching or departing from the radar, which aims at a situation where only one person can pass at the same time.To summarize, studies related to gate counting so far have mainly focused on vision based studies, followed by studies

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using RF signals or (passive) infrared technologies to compensate for the disadvantages of computer vision. However, other systems, not vision, are difficult to count multiple people passing at the same time, and, even, people counting technologies based on vision sensor are inadequate to be applied to situation where very large numbers of people are passing through such as the subway, or performance has not been verified for such situation.In this paper, we propose a system and algorithm for counting the number of people passing through a virtual layer using RF signals based on IR-UWB radar sensors. The proposed people counting system has advantages of RF signal such as robustness to appearance of human, freedom from privacy problem, and ability to operate in light-free or smoky environment. At the same time, the good range resolution characteristics of the IR-UWB radar sensor provide detection capability for multiple people passing at multiple distances concurrently. The proposed system and algorithm are applicable to not only a small number of people, but also to a large number of people passing at the same time.

III. PROPOSED SYSTEM

In proposed system we can find out the person entering the hall, exiting the hall with the image so that the particular person can be found. We can even able to find the metallic objects like ipad, phones, tablets etc which is been prohibited in school and colleges.

IV. ALGORITHM

Step 1: Gather the Components

Step 2: Hardware Setup

Step 3: Creating a Website for the Raspberry Pi

Step 4: Make the Website an IOT Remote Control

Step 5:set up the GPIO pins and Ultrasonic pins

Step 6:Initially the IR sensor sense whether the detected person is a human being.

Step 7:when the person enters the limit the ultra sonic sensor starts to count the person.

Step 8:The pulse duration is been calculated for both pulse start and pulse end.

Step 9:The pulse duration is been given as
pulse_duration = pulse_end - pulse_start
Step 10:The distance is calculated as
distance = pulse_duration * 17150
Step 11:if distance<40
"Entry person detected"
if distance1<40
"Exit person detected"

V.CONCLUSION

We propose an IR-UWB radar based system for counting the number of people passing through a passageway for each direction. The proposed system is implemented using two designed radar sensors and Raspberry Pi 2 module. In order to verify the performance of the designed module, we installed the modules in the subway station for one week and verified the counting performance for the general subway users. The performance of the proposed module was verified for various time intervals ranging from 2 minutes to 1 hour and 1 day, and most of the errors were within 10% except for a few cases. The proposed sensor module uses an IR-UWB radar-based RF signal, so it can be used even in

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the case of fire, smoky, and lightless condition. We expect that the proposed counting sensor module can be used to measure the flow of people for various purposes without privacy problem in configuring smart city.

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