Smart Digital Bi-Directional Visitors Counter Based on IoT

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Abstract. This research presents the design of a smart digital bidirectional visitor counter (SDBVC). The million religious visits especially in Iraq increased the need for accurate smart counting systems for human to count the largest gathering of people in one place. The major focus is on counting huge number of humans enter one place from multiple entrance gates. The central processing unit (CPU) receives all the data from these gates and finally makes the studies about the overall human number, men number, women number, the period of the day that this number reach the highest and smallest number and etc. The proposed project hardware contains multiple Wi-Fi based Arduino microcontrollers (like Node-MCU Arduino): one Arduino in each gate which is called transmitter and one in CPU which is called receiver, multi ultrasonic sensors for each transmitter placed on the entrance gates (men gates data separated from women gates data). ThingSpeak.com is used to save the large recorded data for long time for example many days and give results and records about the number as Arba'een Pilgrimage for Imam Hussein shrine in Iraq. The proposed system gives accurate results on the number of entered and exit people to and from one place.

Keywords. SDBVC, Node-MCU Arduino, Ultrasonic sensor, CPU, Wi-Fi.

1. Introduction
Nowadays, Modern Technology has witnessed an epidemic rise. It makes human life much easier by simplifying the way of our life. It changed the methods of communication, different ways in products manufacturing, method of transportation, knowledge and thoughts of people. There is currently an interest for showing all environments' types using vision technology. This has many benefits, for example, management of resources, security, urban planning, and advertising. From a point of view of technology, computer solutions of vision always consists of detecting, transmitting, and persons analyzing using CPU [1].

A Smart counter for multiple gates to count number of persons in a place system is considered a smart system. It is capable of information recording on the number of moving objects, like cars or individuals that passed through an area, such as gates, an intersection and a tunnel. Also, this system is responsible for analyzing each moving object direction, as entering or exiting a place [2].

Different sides of life need to propose many applications for counting entering and exiting objects. There are many examples to these applications like the interest of the merchants in the consumers number that entering or leaving their markets or malls during a period of time, also, Garage owner need to know the number of cars enter or exit his garage to control parking capacity. In Baghdad for example or any other big city that suffers jamming all time, the number of people and moving cars in any street and any block can control the center of traffic to preventing traffic jams [3].

The authors of [4,5] suggested a project to persons counter and make an automatic room temperature and light control. The control of temperature and light in both works depends on the number of humans in this room. The control of fans in [6] differs from the others that it depends on Wi-Fi of mobile.
The authors of [7] solve the traffic jam of roads by using microcontrollers, ultrasonic sensors, motion sensors, smart cameras and IoT devices on these roads. In the other hand, the Laser radiation and door alarm depends on it also is used to count humans but it must need much cost that our research [8].

Many works make a networks of ultrasonic sensors to increase the system reliability and as a result the complexity of the systems [9,10] while the others make their works as simple as possible to make life most easy by reducing the cost of electricity bills and use the fans and lights depending on the number of people [11,12].

Because of the miners number in any tunnel of a coal mine, for the reasons of safety must be calculated, this work develops a control system to make million visits safe and easy to serve. The number of persons (moving objects), which this work try to obtain, is shown in Fig. 1. Indeed, it is basic information that most environments of monitoring systems require.

![Fig. 1 An Example of people counter.](image)

### 2. Internet of Things

Development boards, like Raspberry Pi and Arduino, are mostly common devices when the programmer prototype new IoT projects. Actually, they are small computers that can be connected and programmed using a standard Mac or PC. After they had been programmed, these development boards can control sensors in the one or more fields by connecting to them directly. In one field, using wireless networks is the best way to connect to the internet; Therefore, Raspberry Pi and Arduino don’t have built-in support for wireless sensor networks (WSN). A cellular module or Wi-Fi was added to the board and the code used to access the wireless model was written.

The Node Microcontroller Unit (Node-MCU) is one type of development boards with open source IoT that will be introduced in this work. There are many features of this board and one of them which considered most unique feature in it is that it has been built-in support for connecting to Wi-Fi. Thus, it makes the IoT application development easier. It is an open source hardware and software development environment which it is built around a cheap System-on-a-Chip (SoC) that is named the ESP8266. This ESP8266 manufactured and designed using express if Systems, that consists from many modern computer crucial elements. However, because of a chip, that ESP8266 is difficult to use or access.

The wires with the analogue voltage will be soldered, to its PINs for the easiest tasks such as transmitting a keystroke on the chip to the computer and like powering it on. It will programmed using instructions of low-level machine which they interpreted by the chip hardware. The firmware of an open source ESP8266 was built on the top of the proprietary chip SDK of the manufacturer. The firmware shows an easy programming environment according to embedded Lua (eLue), that it is an easy and fast language with an established developer community.

A board which incorporates the chips of ESP8266 on a standard board of circuit is called DEVKIT. This board is a built-in USB port which is always wired with the chip up: standard-sized General Purpose Input Output (GPIO) pins which can plug into a breadboard, a hardware reset button, LED lights, and Wi-Fi antenna. This DEVKIT board is shown in Fig.2 which also shows the schema of its pins.
3. Proposed System

The proposed bidirectional visitors counter IoT executed system is shown in Fig. 3 which a sample of the project executed and examined. SDBVC IoT system consists from three parts:

3.1. System Transmitter

The proposed system transmitter circuit consists of number of Node MCU microcontrollers that collect information from the number of Ultrasonic sensors connected to it using Arduino C code and transmit these information which they are numbers of visitors pass this gate in this time using Wi-Fi as shown in Fig. 4.

The number of microcontrollers depends on the number of gates which it depends on the entering roads to the place that the work study the number of people inside it. For example, Karbala city has three roads entered to it, each one must contains at least ten gates to enter people, thus the system need thirty sensors and six controllers (two for each road for men and women) for transmitter system and so on. In addition, number of ultrasonic sensors must connected to each Arduino to sense entering people. To make the transmitter more accurate, a delay of time between any two entered visitors must made by using small sub-gate on the main gate.
3.2. System Receiver
The receiver circuit consists of one Node MCU microcontroller for all transmitter units. It is used to collect the information using Wi-Fi and Arduino C code from all required gates transmitter nodes and show them directly on the Arduino C and then send these data to CPU for processing using ThingSpeak.com channels to get the accurate visitors numbers in the required gates at different time periods as shown in fig. 5 below:

3.3. CPU
The Central Processing Unit receives the data from the receiver and analyses them and it can be programmed using different programming languages or websites. ThingSpeak.com is the open data platform for the IoT and is used in this work to analyze the data as shown in fig. 6. This website will create a special Channel on Internet to receive the result and process it then display. It will fetch the information by using Wi-Fi. The channel has special key with ID, and this information will add to the code of Arduino.
4. Results
By connecting only two sensors the Arduino C will count persons enter this gate and show the count on it as the count of gate1 and gate2 in each time after connecting to Wi-Fi server and send the data to ThingSpeak.com website to analyse them as shown in fig. 7 below.

Then, after sending and receiving the information using Wi-Fi over the channel of ThingSpeak.com website the results will be analyzed by drawing the curves show the relation between time and number of people as shown in the figures below:
Finally, the following tests when connecting four Ultrasonic sensors (two sensors for every transmitter Node MCU microcontroller that means two transmitters and one receiver).

The other test using four controllers for Transmitter and four sensors on them and one receiver shown in fig. 10 below.
5. Conclusions
By connecting two transmitters and send their data to one central processing unit CPU on receiver, very accurate results can be achieved. All the sensors and microcontrollers work properly for long times to count all the visitors to the place that required to test.

The main problems in our work are the increase of temperature of the Node MCU Arduino and sensors. The suggested solution is to use double the number of parameters and nodes to make every node work for 12 hours and the others complete its work. The other noticed problem is the slow speed to connect to the server.

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