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Design and Construction of a Digital Bidirectional Visitor Counter (DBVC)

Azeez , W.A.[1*], Oyerinde S. A.[2]

[1,2] Department of Physics, The Polytechnic, Ibadan, Nigeria.

**Corresponding author*

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Abstract: - This study presents the Design and Construction of a Digital Bidirectional Visitor Counter (DBVC). The DBVC is a reliable circuit that takes over the task of counting number of persons/visitors in the room very accurately. Depends on the number of visitors, when the number of visitors reach the maximum required, the number will show on display board to indicate that the Hall is full. When somebody enters the Hall then the counter is incremented by one (+1) and when any one leaves the room then the counter is decremented by one (-1). The total number of persons inside the Hall is also displayed on the (P10 Display board). The microcontroller is used for detecting an entry or exit action and computing the figures (addition and subtraction) to acquire accurate results. It receives the signals from the sensors, and this signal is operated under the control of embedded programming code which is stored in ROM of the microcontroller. The microcontroller continuously monitors the Ultrasonic Receivers. When any object pass through the Ultrasonic Receiver's then the Ultrasonic Rays falling on the receivers are obstructed. The obstruction occurs under two circumstances, either you obstruct sensor 1 (i.e. outside the building) before sensor 2 (i.e. which is inside the building) this shows that you are entering the building or you do it the other way round, which is obstructing sensor 2 before sensor 1 to indicates an exit movement. This obstruction is sensed by the Microcontroller, computed and displayed by a P10 Displayed board.

Keywords: DBVC, Ultrasonic sensor Rays/Receivers, Microcontroller, P10 LED, Display board and Circuit.

I. Introduction

Reliable estimates of the number of visitors are extremely important for planning and managing the use of the areas in question. On the basis of such estimates, it is possible to gain clearer picture of the use of the area and the sites where visitor traffic is heaviest. Information on visitor numbers help the people responsible for managing the areas to control the flow of visitors, for example, by directing them to routes that causeless deterioration to vegetation and landscape. In addition, visitor counts also help to maintain and develop services so that they better correspond to the real number of visitors to the area (e.g. firewood supply and waste disposal). Furthermore, reliable visitor statistics are needed, together with other information gathered from visitor surveys, for evaluating the effectiveness of the area's own activities and for monitoring changes. Visitor counting is simply a measurement of the visitor traffic entering and exiting conference rooms, malls, sports venues, etc. With the increase in standard of living, there is a sense of urgency for developing circuits that would ease the complexity of life. Visitor counting involves the following distinct stages:

1. Careful planning of the visitor count
2. Installation of counters in the terrain
3. Monitoring of counters in the terrain
4. Defining the correction coefficient for the counters
5. Counting the number of visits

Visitor counting thus provides statistics on the number of actual visits that have been made to an area. When this information is combined within formation gained from visitor surveys, it is possible to estimate the number of visitors, i.e. how many people visit the area. In a public place such as shopping malls, religious centers and cinemas, data on the number of visitor is frequently needed for marketing research or statistic purposes. Usually the counting process is done manually by the officers who guard the entrance. If this process is done for a long period of time, it will be prone to human errors. Same goes to a room such as laboratory, main hall, mosque or bedroom. With the advent of industrial and business era in Nigeria and the subsequent establishment of many public areas such as churches, shopping malls, recreational centers and so on, there is a need to make adequate preparation and plans for visitor control and management. This will help to keep accurate information on population density per time, identify potential structural and social risks and effective decision making on issues related to population. Over the years, the usage of Visitor counters has become very positive in terms of monitoring crowd behavior at a particular place. It began with a mechanical tally counter which was introduced to replace the use of tally stick. A tally (or tally stick) was an ancient memory aid device used

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to record and document numbers, quantities, or even messages. Historical reference is made by Pliny the Elder (AD 23–79) about the best wood to use for tallies, and by Marco Polo (1254–1324) who mentions the use of the tally in China. Tallies have been used for numerous purposes such as messaging and scheduling, and especially in people counting, financial and legal transactions, to the point of being accuracy (Shenton, C. 2012) The substitute of the tally stick was the mechanical tally counter, it is a device used to incrementally count something, typically passing. One of the most common things tally counters are used for is counting people, animals, or things that are quickly entering and existing a location. As times went on, an electronic tally counter was introduced which used an LCD screen to display the count, and a push button to advance the count. Some also have a button to decrement the count in case of a miscount. Now, due to technology advancement, various type of people counter has been introduced to automatically count the number of people entering and exiting a building at a particular time. Some of these are laser beam, thermal imaging, video camera and the infra-red sensor. All these sensors play their role respectively as visitor detector. These devices are very reliable and accurate in terms of performance as compared to the mechanical tally counter. In the past years, several well established institutions (libraries, community centers, auditorium, etc.) across the globe have encountered various incidents related to traffic monitoring. It has been a necessity to monitor the visitors to carry out the human traffic management task and tourist flow estimate to vindicate accurate result for the organizational marketing and statistical research. This eventually indicates the patronage rate of goods and services by consumers. Therefore, we deem it appropriate to identify these problems encountered by our various organizations and find solutions to them by designing a digital bidirectional visitor counter (DBVC). The primary method for counting the visitors involves hiring human auditors to stand and manually tally the number of visitors who enter or pass by a certain location. The human auditing application or the human-based data collection was unreliable and came at great cost. For instance, in situations where a large number of visitors entering and exiting buildings such as conference rooms, law courts, libraries, malls and sports venues, going for human auditors to manually tally the number of visitors may result in inaccurate data collection. For this reason, many organizations have tried to find solutions to mitigate the inaccurate traffic monitoring issues. It is our intention to design and construct this digital bidirectional visitor counter (DBVC) with maximum efficiency and make it very feasible for anyone who wants to design and construct the prototype. Building this circuit will provide information to management on the volume and flow of people in a building (Banuchandar et al., 2012).

II. Materials and Method

Digital Bidirectional Visitor Counter (DBVC)

DBVC involves the individual components which are required to assemble the visitor counter to provide effective crowd management as in motoring and controlling. The microcontroller based visitor counter is designed to respond to the flaws in the operation of existing counters. The design has four main sections and circuits. This includes (ultrasonic sensor) , microcontroller sections, alerting section (p10 LED module) and power supply.

Components Description of DBVC

i. Microcontroller (Auduino ATmega 328)
ii. P10 LED module
iii. Crystal
iv. Rectifier
v. Ultrasonic

Arduino Microcontroller

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. The board can be instructed what to do by sending a set of instructions to the microcontroller on the board. Arduino programming language (based on Wiring) will be used, and the Arduino Software (IDE), based on Processing. Arduino microcontroller based on ATmega328 (fig. 1)**.**

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Fig. 1 ATmega328

Ultrasonic Sensor

Ultrasonic sensor is divided into three categories

i. Transmitter
ii. Receiver
iii. Transceiver

Transmitter convert electrical signals into ultrasound , Receiver convert ultrasound into electrical signal and Transceiver can both transmits and receive ultrasound. Ultrasonic sensor works by emitting sound waves at a frequency too high for human to hear.

i. Ultrasonic are easy to use and not dangerous during operations.

Fig. 2: Ultrasonic Sensor

P10 LED Display Module

A P10 LED Display Module is the most suitable for designing any size of outdoor or indoor LED display advertisement board. This panel has a total of 512 high brightness LEDs mounted on a plastic housing designed for best display results. Any number of 2such panels can be combined in any row and column structures to design an attractive LED signboard.

The 32*16 module size means that there are 32 LEDs in each row and 16 LEDs in each column. So there is a total of 512 numbers of LEDs present in each module unit.

Fig. 3: P10 Display Crystal

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A crystal is a substance in which the constituent atoms, molecules, or ions are packed in a regularly ordered, repeating three dimensions patterns. There are 7 groups, collectively called crystal system; Triclinic, monoclinic , orthorhombic , tetragonal, trigonal, hexagonal, and cubic. The symmetry of each group is described by the relationship between the lattice side a, b, and c and angle Alpha, beta, and gamma.

Fig. 4: Crystal

III. Block Diagram and Working Principle

The circuit works on the principle of IR. Ultrasonic sensor are devices that work with infrared light source and a photo detector like a photo diode or photo transistors that acts like a transmitter and receiver respectively. It is placed in front of hall. The microcontroller based visitor counter response to flaws in operation of existing counters. The P10 LED displays the number of people going in and out of the hall.

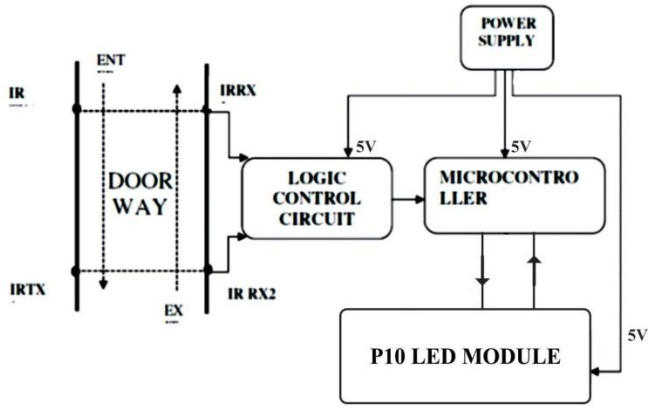

Fig. 5: A Block Diagram

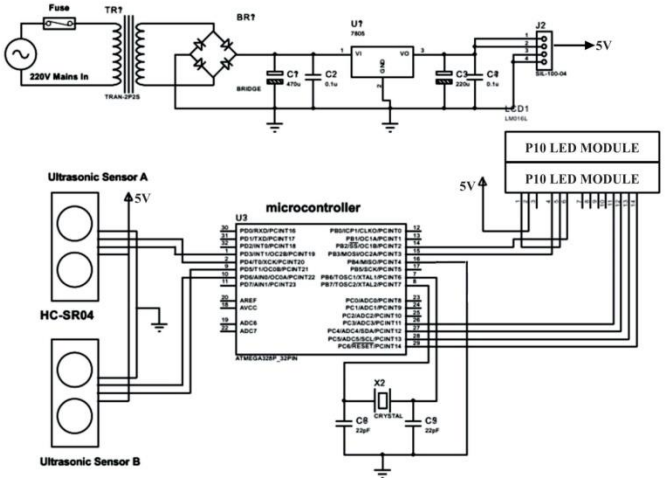

Fig. 6: Schematic Diagram of DBVC

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Power Supply

Power supply block consists of following units: Step down transformer; Bridge Rectifier Circuit, Input Filter and Voltage Regulator. The step-down transformer is used to step down the supply voltage of 240v ac from mains to lower values 5v 5w as the IC's and Ultrasonic used in this project require 5v voltages.

Rectifier

A rectifier is an electrical devices that convert alternating current (AC), which periodically reverse direction, to direct current (DC), which flows in only one direction. The process is known as rectification, since it "straightens" the direction of current.

IV. Results and Discussion

This section analyses and discusses results and findings during and after the implementation of design. It describes in detail the final design perspective as well as highlighting the probable defects engulfing the project. A preview to the entirety of this project establishes the essence and need for embedded systems towards technological advancement.

Fig. 7(a): Sensor showing the transmitter and receiver

Fig. 7(b): Displayed from counter immediately the system is ON

Fig. 7(c): Displayed '0' guest few second after the system is ON, i.e. No guest is inside

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Fig. 7(d): showed the number of guest that entered the room and guest that left the room

Fig. 7(e): Rear view

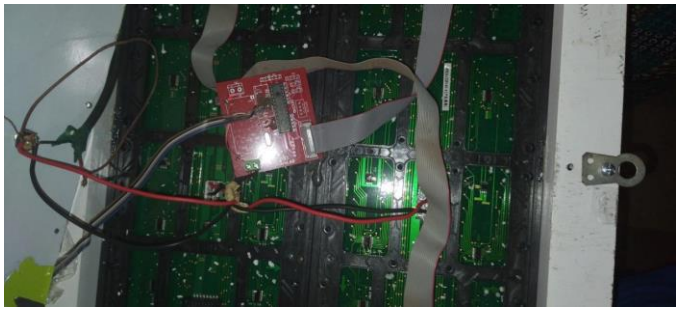

Fig. 7(f): Circuit of the project

Discussions

Figures 7(a-f) represents the pictorial representation of the bidirectional visitor counter. This study incorporates the following; Arduino ATmega328 microcontroller, IR sensors, resistors, and P10 LEDs. The pictorial diagram gives a preview as to what the project entails. The 2-pair of infrared (IR) which consist of a transmitter (TX) and a receiver (RX) is mounted face to face across the doorway. Both sensors are positioned at the entrance with distance apart. This means upon the approach of a visitor the installed 2-pair sensors are triggered by the obstruction. The direction of the visitor is determined by which sensor is obstructed first before

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the other sensor follows. If sensor 1 is interrupted first before sensor 2 is interrupted, it indicates that the visitor is entering. The visitor exits the premises by interrupting the sensor in opposite direction. The output of the receiver circuit sends high or low signals in a form of voltage to the microcontroller. The tally computation (addition and subtraction) is done when it receives low signals from the two IR receivers. It is after this command, which the microcontroller is made to send control signals to the other I/O devices. The microcontroller also sends a data signal to the P10 LED Module to visually display the exact number of visitors remaining in the building. The transmitter circuit consists of a Resistor, and an IR LED. The transmitting unit is required to switch 'ON' the IR LED when powered by the 5V supply. A typical circuit of the IR transmitter is shown in the diagram above. The current flowing through the IR LED is increased to at least 5A by the resistor in order because the LED is consuming much energy.

V. Conclusions

From the results, the digital bidirectional visitor counter is highly efficient and economical. There is no time lag in the operation of the system. The system offers most favorable operation since it functions continuously without errors. Its program can also be modified to take additional input depending on the function desired by the designer. There is no need for human auditor services. In demonstration of the project, the infrared sensing part used to detect the passage of visitors worked. Arduino ATmega328 microcontroller was very efficient in its task performance, thus computation of counts and controlling I/O devices. Also, the P10 Led Module is effective in alerting and notifications. Hence the whole purpose of the digital bidirectional visitor counter was successfully achieved and is applicable in the wider scope. Finally, it is concluded that the designed and constructed DBVC project will count visitors effectively and efficiently by reducing the rate at which error occurs when counting visitors manually as the project was to design and construct a device that would count and display the exact number of people in a building/hall.

VI. Recommendations

The following recommendation however should be considered to ensure effective operation of the DBVC:

i. The sensors should be positioned at the entrance in a way not to attract visitor's attention.
ii. The device should be installed at a narrow entrance suitable for only one person to pass through at a given time.
iii. An uninterruptible power supply should be introduced to the system to serve as a backup power supply.
iv. In the near future, some institutions that deem it necessary to monitor their crowd may no longer rely solely on human auditors and unsophisticated counter systems to tally the number of visitors.
v. The DBVC is thereby recommended for The Polytechnic Ibadan at large, to be used for visitors' counting cum attendance during seminars, conferences, workshops etc.

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