Venue Overcrowding Prevention System

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ABSTRACT: ***Overcrowding of the venue leads to the attendees' health and safety risks, which can often lead to injury or harm. The goal of this paper is to design and implement a circuit to avoid overcrowding of venues by counting people and controlling entrance door. Two main circuit designs accomplish this objective; one for counting, and the other for regulating. The counting circuit is based on the use of infrared rays and the FC-51 proximity sensor to detect motion. The control circuit is based on the PIC16F887 microcontroller which is assisted as peripheral by servo motors and buttons. When the venue is complete based on the allocated maximum number of persons permitted in accordance with the proximity sensor, a signal is sent to the servo motor attached to the entrance door for a 90o displacement to close the door. This closing of the entrance limits further inflow into the venue; thus overcrowding of the venue is avoided. The results obtained showed that the expected output voltages for the design of the power supply unit for each subunit were within a tolerance range of ±0,6V. The systems for input, control and display operated also properly. As such, the proposed application may be deployed in a desired place to prevent overcrowding.***

KEYWORDS: ***Circuit, Displacement, micro controller, servo, proximity sensor, Safety measures.***

INTRODUCTION

In general, there is a large gathering during the pilgrimage, at this contributes to public speeches that cause catastrophes and disasters There are many challenges and issues that the stampede management authorities and volunteers during these public protests. Sporting times, celebrations, music concerts and political rallies draw people big crowd. It causes stampede, overpopulation and stampede can cause many issues, such as causality, getting serious injuries and bleeding, and can even lead to death in worst case situation. When the venue is complete based on the allocated maximum number of persons permitted in accordance with the proximity sensor, a signal is sent to the servo motor attached to the entrance door for a 90o displacement to close the door. This closing of the entrance limits further inflow into the venue; thus overcrowding of the venue is avoided. The results obtained showed that the expected output voltages for the design of the power supply unit for each subunit were within a tolerance range of ±0,6V. The systems for input, control and display operated also properly. As such, the proposed application may be deployed in a desired place to prevent overcrowding [1].

It's difficult to control people in a venue alone, not to talk about knowing the exact number of people in a hall so as to stop further inflow into that section. A hall's overcrowding will result in accidents such as the collapse of the foundation, the stampede and the degradation and overuse of its facilities. The failure to manage crowd in events can result in a fining of the organizer. People can be counted as they come in and leave to overcome the problem of overcrowding, but this can become cumbersome and consume time and energy for any human being. Together with the fact that humans are vulnerable to some degree of error, because they do not have a great sense of numbers, the propensity to work with the wrong numbness. Coupled with the fact that humans are vulnerable to a degree of error because they don't have a huge number of senses, there is a strong propensity to operate with the wrong number of people in the hall and this approach is inefficient as such. It has been said that some archeological evidence shows that humans counted as far back as 50,000 years ago.

The proximity sensors used in this paper are subject to various relevant technologies and researches. Passive infrared (PIR) sensors are used to sense movement; they determine if a person (or an object) has moved

within or beyond the range of the sensors. They calculate infrared (IR) light in their line of sight, radiating from objects. Another important variety of sensors can be used to build smart environments using PIR sensors. An energy-saving device consisting of a light-dependent resistor (LDR) [2] and PIR is built to regulate room temperature and switch on/off lights. Work has been performed, and more is underway to develop high-grade human tracking technology indoors. A coded aperture-based pyro-electric motion tracking device was developed which could detect human movement in one of the 15 cells in a 1.6-m square area using four PIR detectors. Only a human tracking device is developed using a low-cost sensor cluster made up of PIR sensors and Fresnel lens arrays to achieve the desired spatial segmentation.

The project presented in this paper involves designing and implementing a system which is used to prevent and solve the overcrowding of venues. This device tracks the number of people in the hall by counting them as they enter and/or exit the doors, and when the hall's set capacity is reached, closes the door. The smart device introduced in this paper is used to track people's in-flow and out-flow to know the number in the space, and to test if it is up to capacity. This smart system is much more effective than the scenario in which one person counts because it (the machine) does so continuously and more efficiently in the sense that it does not interfere with movement or trigger rowdiness.

This smart system is designed using a set of sensors that are interfaced with a microcontroller chip, the PIC16F887, an LCD, and servo motors. To accomplish this anti-overcrowding device, two motion sensors are mounted at the hall entrance for accurate monitoring of people as they move in and out of the hall. The observed data is read by the microcontroller as a signal from the sensor and converted from analog to digital using its embedded Analog to Digital Converter (ADC) [3] until an increasing or decreasing number is set for entry or exit from the space, respectively. The LCD shows those counts. To make the system work satisfactorily, a number is set as its maximum capacity and the microcontroller chip sends a signal to the servomotor to close the entrance door when the difference in entry and exit equals this set "threshold."

COMPONENT USED

Proximity Sensor

A proximity sensor is a device that can sense the presence of nearby objects up to a certain distance, without any physical contact. That is called the nominal range above which no object would be detected by the sensor. Their operating principle is the sensing of IR rays and as such, it's an IR sensor. There are 2 types of IR sensors; active or passive IR sensors. These three laws govern every IR sensor: Planck's Radiation Law, Stephen – Boltzmann Law and Wien's Displacement Law. The law of Planck states that "any object radiates at a temperature not equal to 0K." Stephen – Boltzmann law states that "the total energy released by a black body at all wavelengths is proportional to the absolute temperature's fourth power." According to Wien's Displacement law; "a black body's radiation curve for different temperatures must hit its height at a wavelength inversely proportional to the temperature".

A typical IR sensor system's basic elements are the IR source or transmitter, the transmitting medium, the optical component, the IR detector or receiver and the signal processor. Specific wavelength IR lasers and LEDs are used as sources; the medium could be vacuum, air, or fiber optics while photodiodes or phototransistors could be the receivers. Optical materials, such as lenses, are used in the medium to concentrate the Infrared radiation. IR LED appears like regular LED but the emitted radiation is not apparent to the eye. When used in a transmitter-receiver combination, the wavelength of the IR receiver will match that of the transmitter.

Types of IR sensors include the Passive IR sensor, the passive type does not require an infrared source and senses the energy emitted by objects in its field of view; and the Active IR sensor, these types consist of IR source and detector and it is the energy emitted by the source that is transmitted to the receiver by an object. Other types are inductive, capacitive and magnetic proximity sensors, depending on their material. Microcontrollers are small controllers that function as a processing unit, such as single chip computers

embedded in other systems. They are called single-chip computers because they have on-chip memory, I/O circuitry, and other circuitries that allow them to act as small stand-alone computers without external circuits. The key functions of microcontrollers are as follows:

(A) Its programming language is easy to use;

(B) Its use as storage device of EEPROM and/or EPROM allow programming flexibility; and

(C) Their ability to be used in various roles simply by adding to them other tools (such as a timer module, serial I / O port, ADC or personal computer).

The PIC16F887 is a microcontroller with 40 pins (most of which are multi-functional), and its key features as shown are;

(A) RISC architecture, i.e. 35 instructions only for learning;

(B) 0-20MHz operating frequency;

(C) An oscillator (internal);

(D) 2.0–5.5 power supply voltage;

(E) 35 pins I / O;

(F) 8 K FLASH memory, i.e. programmability up to 100,000 times;

(G) 256 bytes of memory EEPROM, i.e. data can be written more than 1,000,000 times;

(H) ADC / Analog Converter; and I steering control over the PWM output

Servo Motor

Such engines are also called servos. The word servo comes from the Latin servus which means slave, assistant, or helper. The word was suitable when used only as auxiliary drives with analog power. Servos can now be operated digitally, as semiconductor technology evolved, making their application ideal for main drives as opposed to secondary drives. Servos are small electromechanical devices that have the sole purpose of rotating a small shaft that extends from the top of the servo housing. It has three wires from the side with a light-to-dark color convention where the lightest carries the signal, the darkest is the ground wire, while the control is the middle wire. Servos rotate at precise angular displacement and are used as such in industries such as packaging, robots, machine tools, handling systems, sheet metal manufacturing, paper processing, and material handling (SEW-Euro Drive, 2006). For one direction the average displacement is 180o, rotating from 0 to 90 degree or from 0 to 180 degree. Nevertheless, a modified servo may rotate continuously in both directions until it receives a center-position signal [4].

Transformer

These rotations are controlled by means of Pulse Width Modulation (PWM [5], and as such correctly defined pulse widths as the heartbeat of the servo. Servo motors have integrated processors which respond to electrical signals (or pulses) that are sent to them. It is these pulses that determine the angle the servo arm will be displaced at. Sending signals as pulses implies switching on and off a digital signal in one cycle. This leads to a digital kind of analog signal. A servo is driven by analog signal, and since there are signals either present or not, i.e., digital, PWM is used to control (or drive) the servos [6]. A transformer is any electrical device which transfers electrical power at constant frequency from one voltage level to another. It operates on the basis of Faraday's electromagnetic induction principle which states that a conductor in a magnetic field has a voltage induced in it which is proportional to the rate of flux shift. This concept is demonstrated mathematically in (1).

$E=N \times \partial\emptyset/\partial t$ ... (1)

Where E is the induced electromagnetic force (EMF) in volts, the number of coil turns is N and the number of Webbers magnetic flux. A pictorial view of a transformer construction showing its center and terminals and its symbol is shown in Figure 5, where the primary voltage is VP, the secondary voltage is Vs, the number of primary winding is NP, the number of secondary winding is NS, and the flux relation is either.

The total power of a transformer on both sides is equal; hence,

P1 = P2 … (2)

Where P1 is primary winding power, P2 is secondary winding power. When deducting the number of coil turns, current and winding voltages are factored into (2)

$VPIP=VSIS$ … (3)

As such, the turns ratio, K is given in (4):

$K=VPVS=NPNS=ISIP$ ... (4)

Some minor components used in the specification are keypad, light emitting diode (LED), resistors, push button, bridge rectifier, capacitors, and voltage regulators.

DESIGN AND IMPLEMENTATION

Device architecture included the circuit required for this project to be implemented. This consists of sub-circuits; power supply unit, input unit, display unit and control unit.

Power Supply Unit

The components of this system require a supply of 5Volts dc to function. This voltage level was achieved through rectification. The components used for this unit are: transformer, DC bridge rectifier, condenser, and voltage regulator. On Proteus the unit was simulated and its circuit diagram is shown in Figure 1.

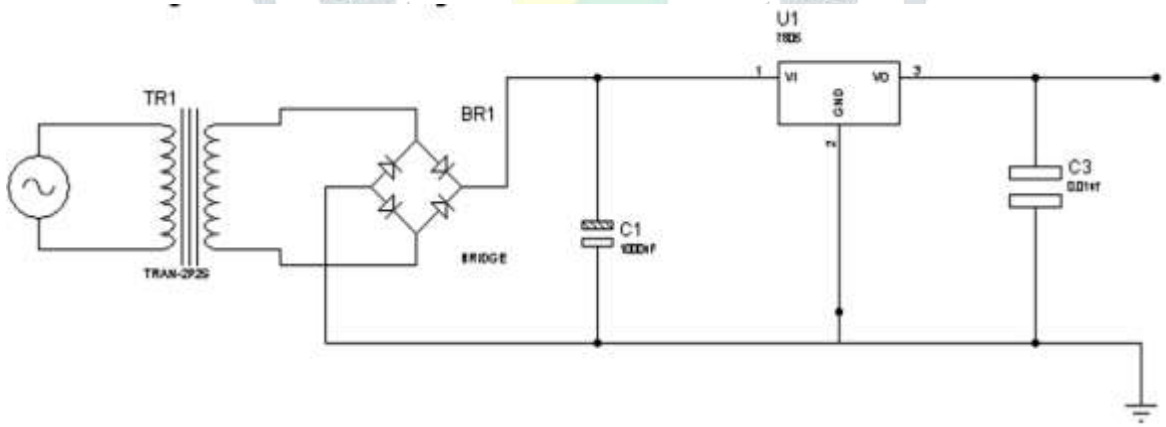

Figure 1: Power Supply Unit.

The microcontroller requires 5V to operate properly; thus, as shown in Figure 6, a 5V regulator is used to deliver steady 5V to it. The voltage regulator LM7805 (U1) [7] used in this project needs an input voltage 2V greater than its predicted output voltage and thus a minimum input voltage to LM7805 is 7V. The transformer with an output close to this range is the step-down transformer of 220V/9V, and thus has been used in this project. It has a current 500mA ranking, and that meets this system's requirement.

Conversion to direct current (dc) from an alternating current (ac) voltage is called rectification. This was achieved using a bridge rectifier in a rectification circuit. The rectifier was composed of paired diodes as

shown in Figure 5. Since diodes allow current to flow in one direction only, the diodes make the rectifier output just on one side.

The dc that was obtained by rectification was not pure. A wave filtration process was performed to attain the desired level of dc. It was achieved with a filter condenser connected across the rectifier output. This condenser helps to maintain a constant dc by charging up when the positive voltage increases and when the voltage starts to go below the required voltage, it (capacitor) discharges into the load while maintaining the required voltage.

Input Unit

The inputs to this device consisted of a 4x4 matrix keypad connected to the microcontroller and IR[8] sensors. Four pull down resistors were used to connect the pins of the column of the keypads to ground according to the design specification of the manufacturer. The keypad inputs the hall capacity number, while the sensors send input signals to the microcontroller for each sensed obstacle (person). The maximum permissible keypad input is set to five integer. Hence the input limit is 99,999.

Display Unit

The display unit includes an LCD and two LED's. The LCD, shown in Figure 8, indicates at any time how many people are in the hall. The attendant who is monitoring the hall and its equipment reads this material. The LEDs give information to those who come into the hall. The green LED remains ON when the hall is not full showing that there is space in the hall but goes OFF when the hall is full and the red LED[9] comes ON. The LCD is configured to work in the 4-bit data mode, where the LCD operation requires only 4-bit data-line. This is expressed in Figure 9. The LCD data pins D0, D1, D2 and D3 are grounded while the microcontroller is attached to D4, D5, D6 and D7. The microcontroller also has the RS (Reset) pin and the EN (Enable) pins. The RW (Read Write) pin is attached to the wall, meaning you can write information on it. As electric current passes through them, LEDs emit radiation in the form of light. These are small photoelectric devices and high current can cause damage. This was prevented by linking current resistors limiting to them in sequence.

FLOW CHART

A flow chart shows the steps the system observed before taking the necessary measures to prevent the hall from overcrowding. Figure 2 displays the flow chart of the program conceived and implemented in this paper. From Figure 10 it is observed that there are two decision boxes to control the overcrowding venue by stating the number of people allowed in the hall and closing the hall door when reaching the number. Another aspect of Figure 2's flow chart involved the flow process of the implemented circuit design including sensor reading and display of the population. All the aforementioned units were tested on a breadboard and then transferred to a Vero-board and soldered to give the entire circuit. Data sheets of different devices were used to get good connectivity and avoid compatibility issues. The circuit was tested after soldering, and then placed in a casing.

After the circuit design and assembly, various tests were performed on a prototyping board (bread board) and subsequently, final soldering and packaging. The units were tested separately until the entire device was tested, and required measurements were taken. The power supply unit was energized using the mains supply; measuring and recording the input and output voltages of each part. The prototype was checked and the display unit functioned correctly at the right time with the LCD showing the anticipated result and the LED turning ON and OFF. Checking and proper operation of the input and control systems. It was found when the key was displayed on the LCD, pressing on the keypad. A count was also increased and displayed on the LCD when a person entering the hall was simulated. Once the hall was full, the servo turned and the door connected to it closed.

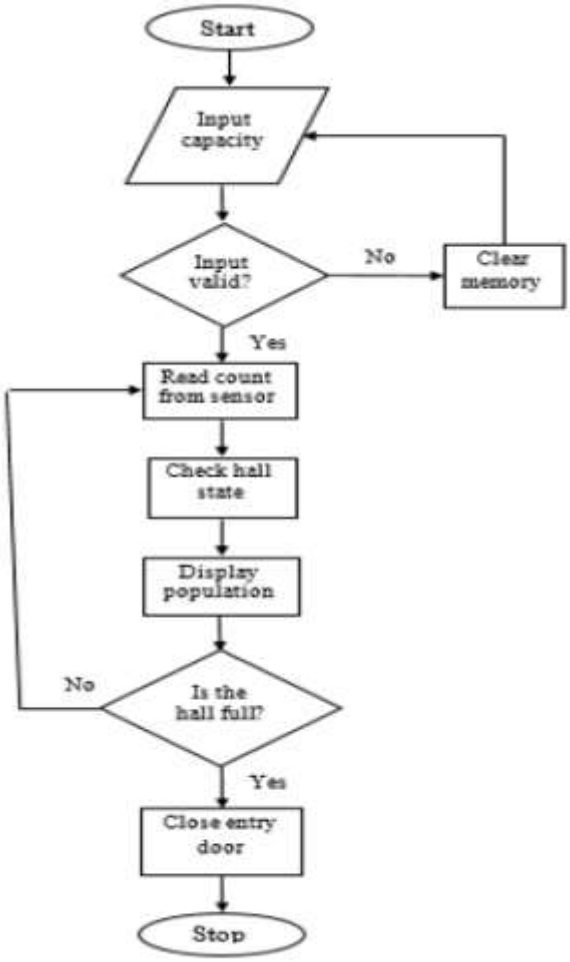

Figure 2: Flow Chart

CONCLUSION

Unchecked, prevented or controlled overcrowding at any venue can lead either to disaster at individuals, structures or equipment. In order to prevent these possibilities we would do well to prevent the trigger itself (overcrowding) at first. This smart system had been designed and built to do this. By measuring the number of obstructions (this is achieved by the sensor) and counting it as either entry or exit as the case may be, the device prevents overcrowding and locks the entrance door to the hall when complete. It shows that people-counting and the introduction of servo-motor-action will avoid overcrowding. The system is flexible, as it allows threshold capacity to vary. It will also take care of an emergency situation by opening all the doors so that you can take appropriate help/solutions. Other modifications that can be added to this project for further industrial and life applications are: a buzzer to the system to indicate that the hall is full; different LEDs at the door to show when the hall is in different states say, 50 percent, 75 percent, 95 percent, etc., use of camera instead of sensors to monitor the entrance and exit doors among many others.

REFERENCES

[1] M. V. Ramesh, A. Shanmughan, and R. Prabha, "Context aware ad hoc network for mitigation of crowd disasters," *Ad Hoc Networks*, 2014, doi: 10.1016/j.adhoc.2013.02.006.

[2] W. Storr, "Light Sensor including Photocell and LDR Sensor," *Electronics Tutorials*, 2013. .

[3] B. Baker, "A Glossary of Analog-to-Digital Specifications and Performance Characteristics (SBAA147A)," *Converter*, 2011.

[4] "Servo Motor," *Specialty Fabrics Review*. 2012.

[5] H. Kajimoto, "Electrotactile display with real-time impedance feedback using pulse width modulation," *IEEE Trans. Haptics*, 2012, doi: 10.1109/TOH.2011.39.

[6] G. Nicoll and M. J. Boss, "Transformers," in *Electrical Safety: Systems, Sustainability, and Stewardship*, 2014.

[7] Texas Instruments, "LM340, LM340A and LM7805 family wide Vin 1.5-A fixed voltage regulators," *Data Sheet*, 2017.

[8] K. Lewis, "Novel EO/IR sensor technologies," in *Infrared Sensors, Devices, and Applications; and Single Photon Imaging II*, 2011, vol. 8155, p. 81550B, doi: 10.1117/12.901162.

[9] N. N. Bakin, V. I. Tuyev, and E. F. Yauk, "LED lighting," 2011, doi: 10.1109/EDM.2011.6006944.