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# CROWD SAFETY: A REAL TIME SYSTEM FOR COUNTING PEOPLE

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***Abstract*— Man-made disasters are the outcome of lack of awareness, lack of sensitivity towards the safety measures to be taken to prevent unforeseen accidents. Large crowds always invite accidents if preventive measures are not taken with proper planning. When the number of people waits in queue before a shopping mall on a special sales day or gathering at religious functions or at a sports gallery, it is very much evident that large crowding is part of normal life. This exposes a new problem space of crowd management. Excessive crowding and poor crowd management can cost loss of precious life very easily. Hence the need for developing an automated crowd management system will be highly appreciated by the society. Crowd management involves keeping track of the crowd, the space available and balancing between the crowd and space. In this paper, we propose a prototype for counting the people as a part of developing better crowd monitoring system. The system counts people and displays the result in a user friendly interface. The system has been tested in different places and found working fine for counting people.**

Keywords: Crowd Monitoring, LDR & Programmable Interface Controller

## I. INTRODUCTION

Crowd monitoring is the process of monitoring and controlling large groups of people for their safety and security. It also provides ways to efficiently utilize space and reduce cost involved in maintenance [1]. It includes different phases like planning, organizing, guiding and evaluating results of corrective actions. Crowd safety and security in public areas are primarily the organizer's or operator's responsibility. A health and safety management system is required to monitor and control potential crowding risks in public areas. The four interacting elements that contribute to a better and efficient system are; time, space, information, and energy. The behaviour of the crowd is another attribute that plays a vital role in efficient crowd monitoring system. Other attributes include facility, size, means and routes of entrance and exists, communication, jamming and queuing [3].

It is clear that a stampede death never occurs due to the presence of 1-10 people at a place. It always happens when a huge crowd gathers at one place for some or other reason. Whenever we have experienced any stampede death to our society the crowd of people has been held responsible. When one person in a crowd starts running due to any kind of rumour the entire crowd follows him or her without having any time for the second thought to be processed and this causes the deaths on mass level. With the tremendous growth of population and the facts given that having a bad system can easily jeopardize the precious life, "Why do crowds need to be managed?" is becoming a penny worth question and "What is the best way to manage a crowd?" is becoming a million dollar question. The best reasons for the "Why?" Includes; Big gatherings of people raise the odds of a dangerous occurrence happening. Secondly, individuals within a crowd always take for granted that others have the responsibility. Thirdly, big crowds or gatherings of people make changes in action slower and more complicated. Fourthly, big crowds or gatherings of people make communications slower and more complicated. And most importantly, big crowds of people raise the possible number of victims [2].

Even though crowd is normal in all over the world, India often faces many problems with crowd particularly in religious functions. Religious is the soul of India and its culture. There are number of holy places where the devotees go as pilgrims throughout the year. Whenever there are such mammoth gatherings, there should be proper arrangements to control the people.

Traditionally, crowd management is performed by employing extensive closed circuit television system. This involves extensive cost, time and human effort in setting up and establishing the system. As routine monitoring is tedious, the observers are likely to lose concentration. The need and necessity of the automatic surveillance

for routine crowd monitoring and controlling is again proven [6]

In order to save the life of the public, a model has been developed to count the entry of the people entering into an area. The system has been developed using both the hardware and software implementations. This paper has been organized in the following ways. Section II describes some of the incidents occurred due to overcrowding and Section III discuses previous work done. The Section IV describes prototype of the system and Section V discuses experimental results. Conclusion and future work is given in Section VI.

## II. LIST OF DANGERS ENCOUNTERED

Numerous incidents have been recorded in which uncontrolled crowding has resulted in injuries and, in some instances, death. There are inherent dangers associated with every large public gathering. Every year there are reports of overcrowding and crushing incidents from around the world. It is very particular to say that more number of incidents is occurring in India during Temple festivals. Hence there is a growing need in India to develop a very useful automated crowd monitoring system. To put the problem into perspective, the following list highlights just some of the events that have ended in tragedy.

- January 15, 1999 - 51 Hindus killed and 100 injured in a stampede after part of a shrine collapsed. Over 1.5 million present in a ceremony in Kerala, India.

- August 24, 2005 – 56 die, hundreds of people injured in a stampede at Vaishnavi Devi temple, India

- September 30, 2008: 147 people were killed during the Chamunda Devi stampede at the Chamunda Devi temple in Jodhpur, India

- March 4, 2010: At least 71 killed and over 200 injured at Ram Janki Temple in Kunda, India

The above listing shows some incidents occurred in India, where there is a growing need for better crowd monitoring system.

## III. RELATED WORK

In general, the detection methods are broadly classified into two categories. The first one is obstructive and the second is non-obstructive [6]. The first type to detect the number of people requires personal contact, which obstruct the path. Examples of these types are turnstiles and mat-type foot switches. The above sensors are suitable for counting a few people and are not adequate for crowd monitoring. On the other hand, there are non-contact and non-obstruct sensors. From these types, is CCTV visual camera. In CCTV based research efforts, individuals are first detected by human models or detectors and then tracked in order to count the number of pedestrians. Masoud et al. [2] used difference images to detect moving blobs, and pedestrians are detected by rectangular patches based on their dynamic behavior. Liu et al. [3] proposed a method based on human appearance models to detect pedestrians. In this method, human models are created using a set of low level image features, and the number of people is counted using these human models. Also, Sidla et al. [4] proposed a model-based method to detect the number of humans in scenes. In this method, humans were successfully detected using active shape models (ASM) even if their bodies were partially occluded. However, these methods cannot be applied to multicamera systems or embedded systems because they usually require a great amount of computational power.

In this paper, we propose a simple and effective method to count the number of people by using Light Dependent Sensors (LDR). The sensors are fitted in two sides of the doors, so that when light beam is cut, automatically the counting process starts by the program stored in programmable Interface Controller.

## IV. PROTOTYPE DESCRIPTION

The prototype of the crowd monitoring system includes the following main components in the hardware part. The components are i) Power Unit ii) Step-down Transformer iii) Light Dependent Sensor (LDR) iv) Programmable Interface Controller (PIC) v) LCD Display. The Software part includes development of a system which accepts output from the hardware unit as input and displays the result. The working of prototype is as follows: The 230V power supply is connected to the Transformer. The Step-Down Transformer takes the voltage and converts it into 5V. The 5V supply is connected to Light Dependent Sensors (LDR). The sensor has two hands where 5 mA light is emitted between two hands of the sensor. The two hands are fitted in the left and right sides of the door. Fig. 1 a) shows an entry gate where hands of the sensor are fixed. Fig. 1 b) shows people movement through the gate. The picture shows the entrance of Sri Sangameswarar Temple

at Bhavani where a flow rate of people is very high throughout the year.

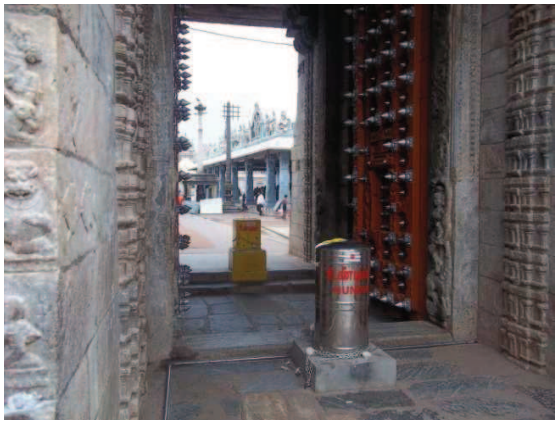

Fig. 1. a) Entry gate

Fig. 1. b) People flow through the entry gate

For effective counting, the pathway is designed as a single entry by using wooden barriers. The following Fig. 2 a) and 2 b) show the scenario.

Fig. 2. a) Passage of people through wooden barriers (Front view)

Fig. 2. b) Passage of people through wooden barriers (Back View)

When a person enters through the door where sensor hands are fixed, the 5mA light passed is cut and the information is passed to the LDR and then to Programmable Interface Controller (PIC). An assembly language program has been written to process the data received from LDR. The assembly language program stored in the PIC is working and increments the count by 1. When the person enters, the light beam is cut, then counter is incremented by 1 and, when a person exits from the area via the door, the counter is decremented by 1. This information is displayed in the Liquid Crystal Display (LCD) and also in software user interface. Fig. 3 provides the prototype of crowd monitoring system.

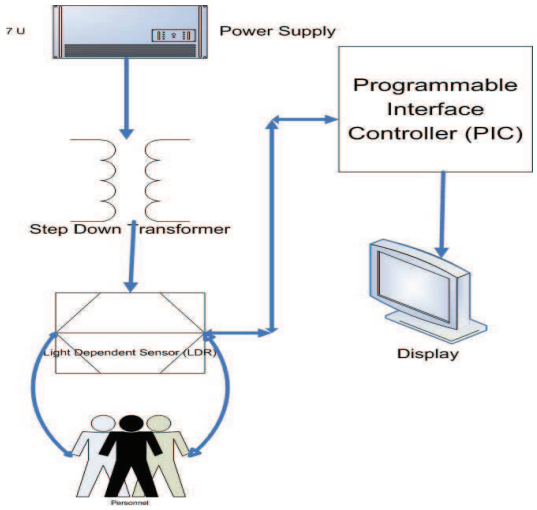


Figure 3. Prototype of crowd monitoring system

The components of the prototype are discussed one by one in the following sections.

A. Power Supply Unit

Since all electronic circuits work only with low dc voltage it needs a power supply unit to provide the appropriate voltage supply. This unit consists of a transformer, rectifier, filter and regulator. AC voltage typically 230v is connected to the transformer that steps the AC voltage down to the level to the desired AC voltage. A diode rectifier then provides a full wave rectified voltage that is initially filtered by a simple capacitive filter to produce a DC voltage. In our prototype, the power supply unit provides pure DC 5V

B. Step down Transformer

Step down transformers are designed to reduce electrical voltage. This kind of transformer "steps down" the voltage applied to it. In our prototype, the step down transformer converts 230 AC to 15-0-15 AC.

C. Light Dependent Resistors

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light, resistance drops dramatically.

D. Programmable Interface Controller

The PIC microcontroller device used in this prototype is PIC16F877A. The PIC16F877 is 40 pin IC. For this prototype development, we used PICs because it is of low cost, wide availability, extensive collection of application notes, availability of low cost or free development tools, and serial programming and re-programming with flash memory capability. There are five ports in this microcontroller, namely PORT A, PORT B, PORT C, PORT D and PORT E. Each pin in the ports can be used as either input or output pins.

## V. EXPERIMENTAL OUTPUTS

In virtue of Visual Basic, the proposed method has been successfully implemented as an actual system for counting people. Comparing to previous methods, the method has higher accuracy in counting the people. The interface designed for displaying output is user friendly. The output shows the number of persons inside a particular area. It also includes date and time. The data collected from this system can be used for various analysis purposes viz. hourly, daily, monthly and yearly report for understanding the crowd behavior in one particular place. The following tables show the result of people counting process held at Sri Sangameswarar Temple, Bhavani. We conducted the experiment by allowing the individual to pass through a queue where the system is installed. The following table depicts the output of our system.

| S. No | Date | Time | Actual Strength | System Count | Percentage of correctness |
|---|---|---|---|---|---|
| 1 | 1/11/10 | 09:09:10 | 80 | 80 | 100% |
| 2 | 1/11/10 | 09:16:20 | 120 | 120 | 100% |
| 3 | 1/11/10 | 09:22:50 | 160 | 160 | 100% |
| 4 | 1/11/10 | 09:29:40 | 183 | 183 | 100% |
| 5 | 1/11/10 | 09:35:50 | 200 | 200 | 100% |
| 6 | 1/11/10 | 09:40:59 | 230 | 230 | 100% |
| 7 | 1/11/10 | 09:45:10 | 270 | 270 | 100% |

TABLE I
PEOPLE COUNTING RESULT OF CROWD MONITORING SYSTEM WITHOUT OCCLUSION

From the above table, it is clear that the system accurately counts the number of people entering into an area. The following table depicts the result where occlusions are in the crowd while passing through the entry gate

| S. No | Date | Time | Actual Strength | System Count | Percentage of correctness |
|---|---|---|---|---|---|
| 1 | 1/11/10 | 10:01:02 | 18 | 16 | 89% |
| 2 | 1/11/10 | 10:02:40 | 24 | 22 | 92% |
| 3 | 1/11/10 | 10:03:50 | 30 | 27 | 90% |
| 4 | 1/11/10 | 10:06:40 | 35 | 32 | 91% |
| 5 | 1/11/10 | 10:09:50 | 42 | 36 | 86% |
| 6 | 1/11/10 | 10:12:59 | 51 | 46 | 90% |
| 7 | 1/11/10 | 10:20:10 | 59 | 55 | 93% |

TABLE II PEOPLE COUNTING RESULT OF CROWD MONITORING SYSTEM WITH OCCLUSION

The above table shows the result of our experiment where the people moving through the entry gate are partially or fully occluded.

## VI. CONCLUSION

In this paper, we suggested a simple and user friendly prototype for counting the number of people entering into a particular area. The system has been developed by keeping in mind that successful counting of people entering into an area as part of the development of full pledged crowd monitoring system. In future work, to resolve the occlusion issue, we try to incorporate a camera in our system and it can also be used to store the images of the public for future references.

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