Pedestrian-safer IoT-based Smart Crossing System with Object Tracking

Abhijit Pathak, Md. Adil, Md. Jabed Hossain, Taiyaba Shadaka Rafa, Umme Salma Pushpa

Abstract*: *In the field of technical research the Internet of Things (IoT) has become an interesting topic. The device is interconnected over the internet. We usually think of IoT in terms of independently owned cars and smart homes, but in extreme practical matters one of the best applications of IoT technology. In many disciplines, IoT is increasing rapidly from a technical point of view, in particular with the smart crossing system. In the meantime, it is a very populous country in Bangladesh. A lot of people cross the street every day. A lot of wide roads are to be crossed in Bangladesh. Even dead troubles. There is a lot of vehicles on the lane. There are many wide roads in Bangladesh that are a lot to cross. Troubles, even dead ones. Many vehicles are on the road. Bangladesh is also a developing country, and the laws of road crossing are not very strict, in which case it is very important to have a pedestrian-safer IoT-based smart crossing system with object tracking. Often people are facing an accident, in particular school children have trouble crossing the road, old people face the same problem. A cost-effective solution to this issue is the key contribution of this paper using a simple framework based on Arduino UNO R3. The device is fully autonomous and can calculate the planned parameters of a pedestrianized IoT-based, smart crossing platform with object tracking in an efficient way. Ultrasonic sensors and one IR sensor were used for measuring the parameters needed for the device. Moreover, in Bangladesh this program is more important and essential. This smart crossing system detects people as well as reduce road accidents.

Keywords: Arduino Uno R3; Ultrasonic Sensor; IR Sensor; Servo Motor; Pedestrian Crossing.

I. INTRODUCTION

Traffic control systems worldwide have been increasingly technologically focused over the 21st century and IoT-based automation has reached the point of advancement of this technology. In other words, the process of automation is limited only to the developed countries or some developing countries. Although technology-based, many developing and underdeveloped countries still rely heavily on traffic managers' physical and tactical services. The role of orienting and handling traffic can be extremely tedious and difficult for a person to concentrate on 24/7 and to give the best performance using automatic systems. The latter countries' traffic systems, in particular road crossing must also be listed. Bangladesh is one of the most credible indicators of people's ignorance to traffic laws. At the workplace and during school, the road is extremely busy every day. The town roads in particular. Many vehicles are now on the roads. There are a lot of problems crossing the road. Hundreds of people die every day from road crashes, especially from the road crossing. Every year in road accidents in Bangladesh, at least 4,284 were killed and 9,112 others injured. Bangladesh doesn't have a digital pedestrian crossing system. So, for Bangladesh, it is important. Thousands of people walk the road every day [1]. This paper introduces a smart crossing device based on the IoT, to provide a simple answer to the controversial and day-to-day problem. The pedestrian illegal crossing behaviour is a major fact in the road safety issue. The main concerns are the following:

Pedestrians cross the streets without noticing the incoming traffic, usually because their attention is distracted.

- The traffic distances are typically miscalculated by pedestrians.
- Pedestrians cross the lane, usually because of lack of space on sidewalks.
- Pedestrians cross the streets in the middle of the block or out of the designated crosswalks.
- Pedestrians do not follow the signs of traffic lights.

Therefore, we used Ultrasonic and one IR sensors in this project. Some useful parameters are used to calculate the need and frequency of an activated and inactive pedestrian crossing. In order to construct and operate the device inexpensively and easily. Measurement sensors are used for understanding the number of people who need to cross at a specific time. In addition to other important parameters, such as time, road characteristics, etc., the Arduino devices calculate this measurement. We need to use 3 sensors in this project. The pedestrian crossing bar is observed by 2 sensors and 1 sensor operate for the specific distance. When people and vehicles are placed face to face, voice is incorporated and announced. Then they stopped and didn't cross the road. The primary aims of our case study on a selected subject are:

- to demonstrate that pedestrian safety must be the top priority.
- to learn the thoughts and views of people on the use of road crossing safety equipment and systems.
- to create an innovative road system.

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For Bangladesh, this system will be effective. The proposed solution is very simple and very inexpensive to build, and this is enhanced by the initiative to move on to automation in traffic control in Bangladesh in particular, which has a limited budget on hand.

II. LITERATURE REVIEW

Pedestrian crossing is a way for vehicles and people to cross the road. The risk of accidents is increasing with the population. The total number of accidents decreases every year due to action to reduce accidents.

Past work has provided important data on the demographic features of peatlands (such as age, sex) and how they affect the behaviour. These studies concentrate on comprehensive experiments aimed at figuring out the effects of age on decisions on road traffic crossings that affect vehicle distance or speed (Oxley et al., 1997; Lobjois and Cavallo, 2007). Many of the experiments were performed in a simulated world. Specific studies have also reported conduct of road crossing in gender and transportation. Males appear to have less waiting time to be dangerous than females (Khan et al., 1999; Tiwari et al. 20, 1999 [2];

There have also been several researches on the value of pedestrian velocity at various locations (Knoblauch et al., 1996; Rastogi et al., 2011; Varhelyi, 1998), including the crossing of zebra and designated intersections (Tarawneh, 2001). Scoping with these tests, men walk considerably more quickly than women when crossing paths. A recent study focuses on the actions at mid-block locations in China, versus illegal pedestrian traffic junction (Cherry et al. 2012Finding out the fundamental features, along with the conflicts of the footpath, has been documented by few studies in mixed streets and developed a model of microsimulation (Shahin 2006). An image of a road scene read featuring a footpath. There are three key phases in the proposed technique. First, the crossing region is extracted from the image. Secondly, to extract points based on the Fisher criteria in the applicant field. Third, final crossing judgment on the basis of projective invariants (Mohammad Schorif, 2005) [3].

A study conducted in Beijing examined the pedestrian behavior and traffic at unmarked midblock crossings. The authors clarified the state of pedestrian velocity shift with pedestrian behavior (Shi et al. 2007). In some studies, the effectiveness of education programmes, also address the behavior of pedestrian road crossings (Dommes etal., 2012). The importance of environmental features such as crossing facility type, volume of road travel and geometry in road travel behavior had been identified in studies (Kadali and Vedagiri, 2013). In addition, several researches investigated the actions of footpath crossing before and after restoration of road traffic (Gupta et al., 2010). Suchitra Junction Footnote Crossing Comportment on NH-44 with Discrete & Continuous Model (IJIRST/ Volume 3 / Issue 04/ 002) [4].

The action of the pedestrian crossing is typically influenced by different factors relating to pedestrian characteristics, footpaths, road conditions, and the environment. Rosenbloom et al. (2008) found an inappropriate crossing activity for children, so that they did not pause at the curb or look at them until they crossed. Female walkways accept more breaks and less risks than male footpaths are found. Oxley et al. (2005) performed experimental experiments on a pedestrian's age selection effect. For all age groups, selection of gaps has been primarily based on distance from the vehicle [5].

III. METHODOLOGY

Many studies have been performed to study pedestrian activity affected by various factors such as foot orientation, paths, ambient characteristics, etc. The action of the footpath is controlled primarily by the principle of accepting gaps. There is a vital gap in any pedestrian to cross the street. Most correspond with the minimum distance that pedestrians who choose to cross the street in the center of the building embrace. This parameter may be related to road and vehicle and pedestrian features.

A. *System Block Diagram*

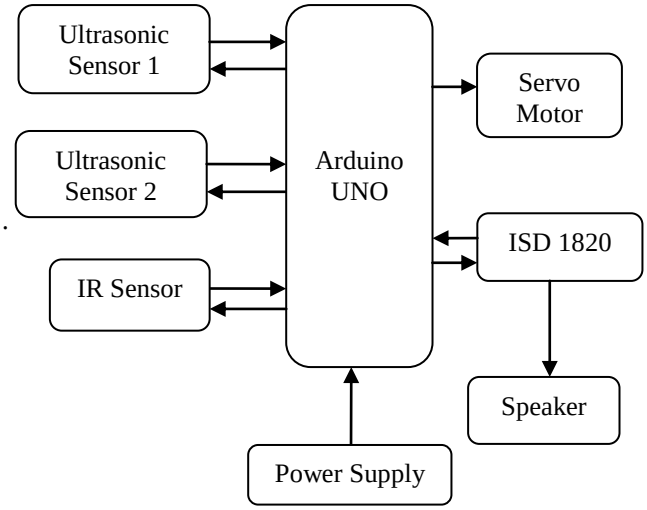

Figure 1. System Block Diagram

In the block diagram of this system, two ultrasonic sensors and one IR sensor with Arduino Uno transmit signals from the Arduino to the receiver and act as a measuring distance. The transmitter is connected to the ISD1820 voice module and the microcontroller also receives an open-source signal to show a Bengali voice message output for time count.

B. *System Architecture*

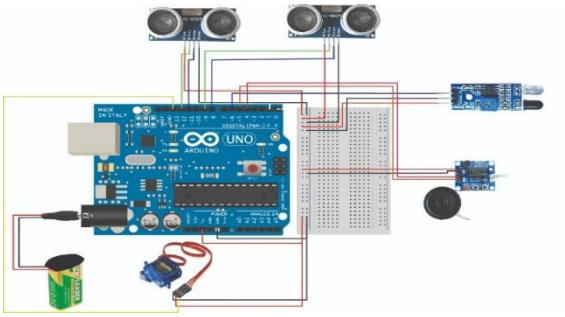

Figure 2. System Architecture of the Proposed System

C. *Connection Diagram*

Arduino Uno	Ultrasonic Sensor 1			
	Echo	Trig	Vcc	GND
Pin Mode	Pin 11	Pin 12	No	No
5v	No	No	Yes	No
GND	No	No	No	Yes

Arduino Uno	Ultrasonic Sensor 2			
	Echo	Trig	Vcc	GND
Pin Mode	Pin 8	Pin 9	No	No
5v	No	No	Yes	No
GND	No	No	No	Yes

Arduino Uno	IR Sensor		
	Vcc	GND	OUT
Pin Mode	No	No	Pin 6
5v	Yes	No	No
GND	No	Yes	No

Arduino Uno	ISD 1820			
	Vcc	GND	P-E	Rec
Pin Mode	No	No	Pin 4	Pin 5
5v	Yes	No	No	No
GND	No	Yes	No	No

Breadboard		Servo Motor
Vcc	GND	OUT
No	No	Pin13
Vcc	No	Vcc
No	GND	GND

D. *System Algorithm*

Step-1: Start
Step-2: Initialization
Step-3: Ultrasonic sensors run
Step-4: Sensor 1 and Sensor 2 will run & check whether any obstacle is found or not.
(a) if yes, then it will go to step-5 otherwise, it will follow the step 3
Step-5: IR sensor will operate & check whether any Obstacle is found within 60 cm?
(a) if yes, the gate will be off/down and it will continue from step-2.
(b) if no, the gate will be on/up with a voice message for time counting.
Step-6: Stop

E. *System Flowchart*

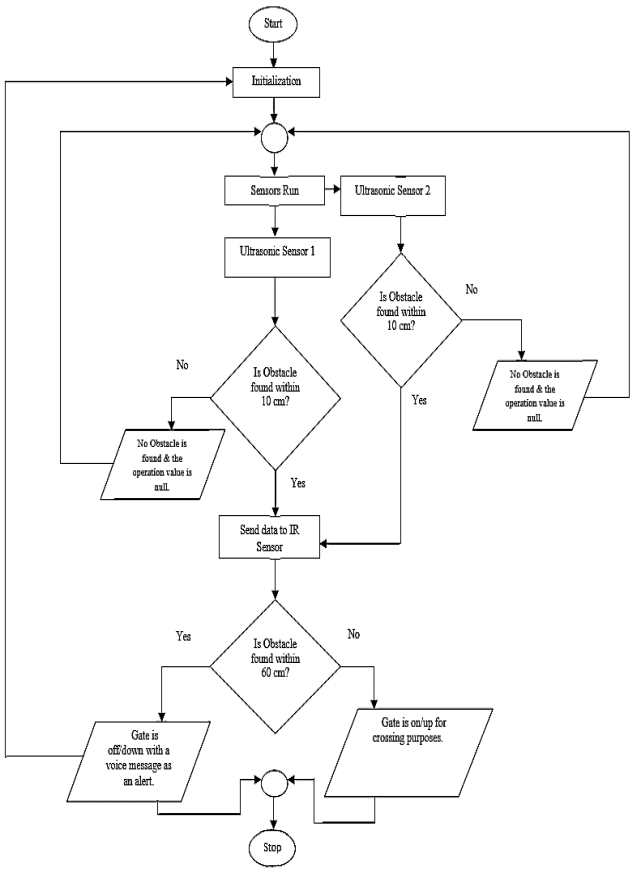

Figure 3. System Flowchart

IV. HARDWARE

The hardware needs to complete this digital zebra crossing system is as follows:

- Servo Motor
- IR Sensor
- Ultrasonic sensor HC-SR04
- Arduino Uno R3
- Voice module ISD 1820
- Breadboard
- Jumper Wires

A. *Servo Motor*

Servo motor is a rotary actuator or linear actuator which enables accurate control of the corner or linear position, speed and acceleration. It's just a basic engine that can work with a servo mechanism. It's called dc servo motor if the drive is used for DC control. And when the Ac engine is driven, the AC servo motor is named. It consists of three elements, Output Sensor and Feedback System [6].

Figure 4. Servo Motor

B. *IR Sensor*

This is an electronic device; the IR sensor can determine an object's heat as well as sense the motion. IR is invisible to the human eye since its wavelength is longer than the visible light. Everything that emits heat has a temperature that emits infrared radiation. There are two types of active and passive infrared sensors available. Both active infrared sensors emit and detect infrared. Light emitting diode (LED) and receiver. IR sensors act as proximity sensors [7].

Figure 5. IR Sensor

C. *Ultrasonic Sensor*

The ultrasonic sensor is an electronic device that measures the distance of the target object by emitting ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than audible sound speeds. Ultrasonic sensors have two main components, the transmitter and the receiver, in order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the transmitter and the receiver. The formula for this calculation is D = 1/2T*c where d is the distance, c is the sound speed ~343 meters / second [8].

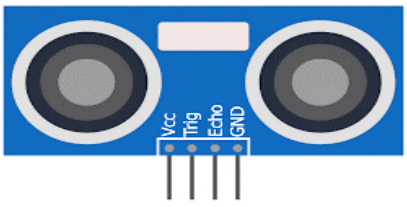

Figure 6. Ultrasonic Sensor

D. *Arduino Uno R3*

Arduino is an open source framework used to build a software for electronics. Arduino consists of both a programmable physical circuit board and a piece of software or IDE running on your computer. Arduino IDE used machine code to write and transfer to the Arduino physical board. Sets digital and analog input / output pins that can be interfaced to various expansion boards and other circuits. And you can program the microcontrollers using the programming languages C and C++. So, every board on Arduino requires a way to link a power [9].

Figure 7. Arduino Uno R3

E. *Voice Module ISD 1820*

Voice record module is based on ISD 1820 and is a system that records multiple-messages. It can deliver true recording of single chip voice, no-volatile storage and replay capabilities of about 10 seconds. This module is simple to use and can be operated by push button on board or microcontroller such as cheap kit Arduino STM32 etc. So, it's a simple way to keep records under track, play and repeat, etc... [10]

Figure 8. Voice Module ISD 1820

F. *Breadboard*

A breadboard, with a set of tiny holes, is a rectangular plastic board. These holes allow anyone to easily insert electronic components into prototyping (meaning building and testing an early prototype of) an electronic circuit, such as this one with a battery, switch, resistor, and LED (light-emitting diode) [10].

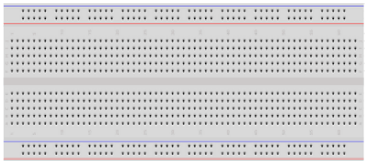

Figure 9. Breadboard

G. *Jumper Wires*

The jumper wires are just wired with connector pins on each end, which allow them to attach without soldering two points to each other. Usually jumper wires are used with breadboards and other prototyping devices to easily modify a circuit as required [10].

Figure 10. Jumper Wires

V. PROTOTYPE DESIGN

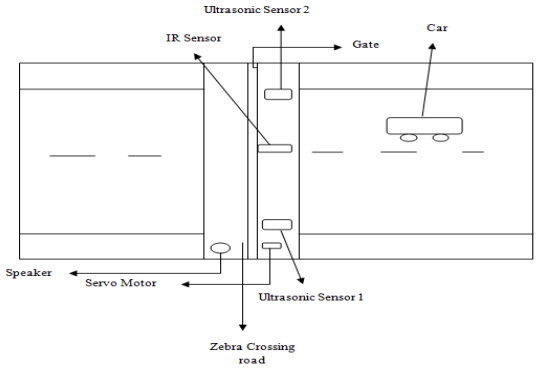

Figure 11. Structure of the Proposed Model

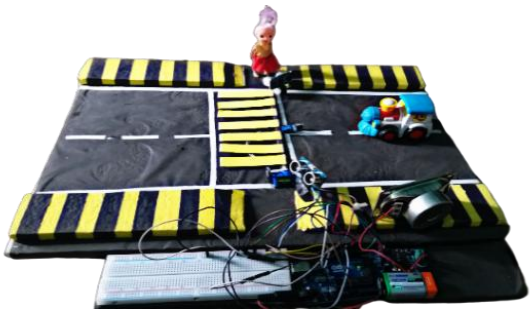

Figure 12. Snapshot of the Prototype

Bangladesh is a densely populated region. Many of this country's inhabitants walk the route unconsciously. The drivers are not driving consciously, either. Which really avoids the risk of accidents on the road. To this purpose we can use this method of smart crossing to reduce this risk. Bangladesh's school-college students have to cross the road recklessly due to the bad traffic conditions in Bangladesh. Accidents and deaths on the road are reported. Students crossing the road should use the pedestrian-safe IoT-based smart crossing device approach to reduce the accident. This approach can also be used in hospitals or industries, similarly. This mechanism can also be used to monitor the train at railway station.

VI. EXPERIMENTAL ANALYSIS

Road accident is a major problem in Bangladesh. Many people die in road traffic collisions every year. Some of them die while they traverse the lane. o, we're talking about how to avoid the accident. We have designed a plan for this. We have used two ultrasonic sensors and one IR sensor in our project, such as when a pedestrian stands for a road crossing. And the sensor will send a signal to the IR sensor in its 10 cm pedestrian (that will traverse road) when it is detected. Then the sensor can see if any vehicle lies within 60 cm. When any vehicle can be located within 60 cm, the zebra crossing line / gate will not be up / on, but it will be confirmed that this is a dangerous time, please wait a few minutes. And moving vehicles should stay normal. At the other side, if no vehicles within 60 cm are found the zebra crossing line / gate will be on / up. And the driver may get the car stopped. The pedestrian will then cross the path safely. We came to reduce the number of accidents that occur when crossing the road.

Table- I: Decision making process in distance measurement

Ultrasonic Sensor 1 Value	Ultrasonic Sensor 2 Value	IR Sensor Value	Action
< 10 cm	< 10 cm	≥ 60 cm	Gate Off
<10 cm	<10 cm	≤ 60 cm	Gate Off
≥10 cm	≥10 cm	< 60 cm	Gate On
≥10 cm	≥10 cm	≥ 60 cm	Gate Off

Bangladesh is also a populated nation and most of this country's inhabitants are unaware of crossing the highway. At the same time the speed is not known to the driver. In this scenario, if the speed of the car is high, accidental accident can be caused due to lack of control.

VII. FUTURE SCOPE

In this project, a display will be added, and it will provide more benefits and be helpful to cross the lane.

- A monitor to demonstrate on scanning part of human verification by detecting his / her face without human verification that it does not work.
- And also screen a time count on the board with a voice announcement.
- Camera with Image processing technique can be implemented to monitor the reckless vehicle in the street and to detect a crossing of the zebra during the day or at night.

VIII. CONCLUSION

It was found that 62.16% of the total pedestrian crossing were using overpasses, 19.37% were using zebra-crossing and the remaining 18.27% were traveling illegally. It is significant that approximately 82% of pedestrians use legal facilities. This increase is due to the existence of a median barrier, the presence of traffic police, better control and better regulation. The reasons for not using the overpass showed that 34.47 per cent of the pedestrians had a short time in their hand to reach the overpass or the zebra-crossing, 19.15 per cent of the pedestrians said that the overpass and the zebra-crossing were at a long distance from their crossing point, and 10.21 per cent of the pedestrians said that they had to wait a long time to use the zebra-crossing.

In general, Bangladesh's most effective solution to prevent accidents is a Pedestrian-safer IoT-based intelligent crossing network with object tracking. We addressed the automated zebra crossing system in this article. Three sensors are used to make a crossing device in real time. One will have a very difficult outsmarting in the proposed method to get the advantage of the system for him / herself. The digital design of this particular device is entirely determined by the traffic and the area characteristics, which are automatically evaluated in upgrade models. The system minimizes the risky transportation market, and the reliability and simplified cost-effectiveness of the system contributes to this, making it a challenging project for Bangladesh that hardly takes regulations into consideration. Implementing ultrasonic sensors and IR sensors in the systems adds to their cost-effectiveness as opposed to current systems automation. Otherwise, Bangladesh has a lot of traffic jams, their approach to reduce traffic jams is very effective. Hundreds of people die in road traffic accidents every year. Particularly in road crossings. So, this system is required in Bangladesh, particularly for pedestrian crossing. So, it would reduce road accidents. Thanks to the implementation of this project in busy roads across developed countries, it is expected that the issues and hazards associated during road crossing will be eliminated.

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10. Pedestrian crossing behaviour analysis at intersections by Akash Jain1, Ankit Gupta21, Rajat Rastogi3 Study

AUTHORS PROFILE

The author, **Abhijit Pathak**, works as the position of a Lecturer in the Department of Computer Science and Engineering, BGC Trust University Bangladesh. His present research focuses on 'IoT' and 'Robotics'. He is particularly interested in Artificial Intelligence, Human-computer Interaction, Data Mining, Software Quality Assurance. In his almost twelve years of teaching experience, he has a contribution to fourteen articles published in International journals and conferences of repute. He completed his graduation and post-graduation in the discipline of Computer Science and Engineering. He has skills and experiences in Computer Vision, Automation & Robotics, Cyber Security, Internet of Things, Big Data, Docking, Agricultural Robotics. At present, He is working as a Faculty Sponsor at BGCTUB ACM (Association for Computing Machinery) Student Chapter.

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The author, **Md. Jabed Hossain**, a Computer Science & Engineering student of BGC Trust University Bangladesh, Chattogram, Bangladesh. He still does not have a research paper. It is his first IoT-based research paper and suggested in a concept. He works mainly on the Internet of Things (IoT), Robotics, and research to solve his country's problems and issues.\

The author, **Taiyaba Shadaka Rafa** is an ongoing undergraduate student of Computer Science & Engineering at BGC Trust University Bangladesh. She has a research paper that seeks to relieve blind people's suffering when they cross the road and resolve obstacles while driving. This research paper has already been published in the International Journal of Engineering Inventions (IJEI), a peer-reviewed international journal published in volume 9, issue 1. She specializes in IoT and Robotics.

The author, **Umme Salma Pushpa** is a student of Computer Science & Engineering at BGC Trust University Bangladesh, Chattogram, Bangladesh. This author has one research paper. Her research paper published in the International Organization of Scientific Research (IOSR), a peer-reviewed journal. Her main research works focus on Robotics & Web Development.