Automatic Barrier Control in the Zebra crossing of Roads for Pedestrian Safety

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Abstract. In the urban areas, the heavy road traffic makes the road crossing unsafe to the pedestrians. This paper aims to avoid accidents happening in the pedestrian crossing of traffic signals. The pedestrian collisions occur due to the unethical behaviour of the drivers skipping the signals. The proposed paper prevents these accidents by introducing automatic barriers for the zebra crossing. These barricades automatically lift during the pedestrian crossing and lay down during vehicle traffic. The defaulters of traffic signals are also monitored through the camera.

Keywords: Barrier control, Zebra crossing, Pedestrian crossing, Accident prevention.

1. Introduction

Road transport is essential for mobility of people and goods as well as it contribute for India’s development. The risk of road accidents exposes people to injuries and fatalities. The growth of population and lack of road infrastructure leads to poor road traffic in India and which results in unacceptable accidents, injuries and fatalities. In the year 2017, 4,64,910 road accidents were reported that claimed 1,47,913 human lives and 4,70,975 persons become injured. Out of four and half lakh lives, 13.8 percentage persons are pedestrians [7]. Safe walking on the road side and protection of pedestrians are to be promoted considering the risk factors. [13].

Smartphone play a major role in this development a vehicle pedestrian safety system. Smartphone generally help to reduce the 4, 00,000 fatalities from the pedestrian collision. This system warned both the pedestrian and the person who drives the vehicle. With the collaborative effort of two years with the Honda and Qualcomm to leverage safety system, so that vehicles can easily communicate through mobile phones to predict the possible collision between the pedestrian and the vehicle. The overview of the work is to warn both the driver and pedestrian so that they can easily take another action before the collision [14].

The simulation methodology was developed by [3] for pedestrian protection system. The system consists of active and passive protection systems with pedestrian warning system, hood lift system and airbags for pedestrians. Their results indicated that the proposed system can reduce pedestrian fatalities by 90 %.
An autonomous emergency braking system (AEB) was studied by [5] and which discussed the problems faced by pedestrian safety systems. To identify the functionality of the attributes of each crash, the camera sensor was used by AEB system which helps to detect the pedestrian. By changing the field of view (FOV) and the level of deceleration, the detection influence and AEB system activation were developed. The majority of the crash scenarios were estimated at the FOV of 35 degrees.

At the signalized intersection, most of the pedestrian fatalities are happen between turning vehicles and pedestrians. This paper analyzes the pedestrian-vehicle conflict index model. That model establishes the quantitative standard of two or multiple intersections. Based on the SCI, the categorization is done and the safety measure is applicable. In the city of Changchun, the SCI model is applied which results in indicating the model potential in an improved manner [2]. The use of the environmental sensors with a brake assist system will keep the driver in the alert condition. Pedestrians are benefited by safety and the fatalities are reduced and the system with environmental sensors is more advantageous over automatic emergency braking systems [4].

The pedestrian and automobile interaction model was developed and tested by [11] for the places with no signals and cross walks. The main aim of the author is to develop the simulation model to understand the pedestrian and vehicle crossing at un-signalized intersection. The test and demonstration are done on pedestrian collision, driver response and the delay due to pedestrians. The simulation model shows improved safety and efficiency.

The use of the environmental sensors with a brake assist system will keep the driver in the alert condition. Pedestrians are benefited by safety and the fatalities are reduced and the system with environmental sensors is more advantageous over automatic emergency braking systems. Due to vehicular movement, the pedestrians are not able to cross the road at even at the time for pedestrian crossing [12]. In several cases, several vehicles stop on the zebra crossing, so that pedestrians can able to walk only on the road. Hence, this proposal is aimed to provide a safety system for the pedestrians for safely crossing the road during the pedestrian green signal.

2. Methodology
The methodology adapted for automatic barrier control in the zebra crossing of roads for pedestrian safety is shown in figure 1.

![Figure 1. Block diagram for a pedestrian safety system](image-url)
3. Materials Used

This section describes the detailed hardware components which have been used to control the process.

3.1 Webcam

The digital camera feeds or streams real-time images to an electronic storage device/network and it can be sent on to alternative networks through systems like the web. The date received in the distant location, the video could be viewed and analysed for identifying traffic violations. The Quantum QHIM 495 lumen web camera is shown in figure 2. The camera is used to detect the vehicle number when it hits the barrier.

3.2 Relay

The most commonly used switching device in electronics is the relay. Relay has a set of input terminals and set of operating terminals. The traditional of relay uses an electromagnet as coil, normally close and normally open contacts.

3.3 Raspberry Pi-3 B+

With the evaluation, Industry 4.0, Arduino and Raspberry Pi plays more important role in development of real-time projects. Remote monitoring and control of automation with Arduino was used by [1] for temperature and pressure measurements. [9] introduced Arduino UNO controller for Development of Z-Robot in which the pick and place operations can be done in any direction. The advanced technique of IOT can be used for traffic control mechanisms [10]. Raspberry Pi can interact with the external devices and has been utilized in a broad range miniature projects to cloud cover. Raspberry pi model B 3+ is the latest model launched with the capacity of the 64-bit processor. This works as the brain of the system which controls the entire process.

3.4 Vibration sensor

The piezoelectric crystal based sensor is used as vibration sensor. The sensor uses the mechanism of changing electrical energy which it is subjected to mechanical energy while measuring the changes in acceleration, pressure and force. It changes strain into an electrical charge. By measuring both capacitances as well as quality, deciding fragrances within the air can be calculated. The sensitivity of selected sensor ranges from 10 mV/g to 100 mV/g.

4. Hardware Prototype

The hardware arrangement for the proposed system is shown in figure 2.

![Figure 2. Hardware setup with barrier arrangement](image_url)
5. Results and Discussions

5.1 Traffic Lights

Traffic lights are used to control the vehicular movements in urban areas especially to avoid road accidents and intersection collision. Generally, Traffic lights consist of three coloured lights which are red, green and amber. Red colour indicates to stop the vehicle before the crossing line. Amber signal indicates “get ready for vehicular movement”. Green light indicates to initiate the vehicle. Traffic signals depend on signal timing. As a whole, traffic lights flash for 1 minute i.e 30 seconds for Red, 5 seconds for amber and 25 seconds for Green.

Traffic lights play a major role when it comes to safety in our everyday life. The main function of the traffic signals is to provide the proper way for a particular opposing movement. This great invention also helps the public to cross the road easily during red signal flashes (where vehicles are going to stop) without any accidents and also helps in decreasing pedestrian crossing accidents.

5.2 Four Way Traffic Lights

In four-way traffic signals have four lanes and each lane has separate traffic lights. This system aims to protect the pedestrian from road accidents. In this work the barricades are placed on the zebra crossing when the traffic light flashes red, the piston actuates the barricades and it is automatically lifted. When the Green signal flashes, the barricades lay down.

5.3 Sequence of Operation

The four way traffic light control using programmable logic controller was discussed in [13] and which acts as a source for developing source for this work. Table 2. gives the sequence of operation of the four way traffic light.

| S.no | East | West | North | South | Colour codes |
|------|------|------|-------|-------|--------------|
| 1    | G    | R    | R     | R     | G- Green     |
| 2    | Y    | R    | Y     | R     | R- Red       |
| 3    | R    | R    | G     | R     | Y-Yellow     |
| 4    | R    | Y    | Y     | R     |              |
| 5    | R    | G    | R     | R     |              |
| 6    | R    | Y    | R     | Y     |              |
| 7    | R    | R    | R     | G     |              |
| 8    | Y    | R    | R     | Y     |              |
The sequence of operation for four lane system is indicated in the above table 2. The timing is selected as 30 seconds for Red, 5 seconds for Amber and 25 seconds for Green [6] The programming of the Raspberry Pi controller is done in python [8] for the above sequence.

5.4 Automatic lifting of the barricade
The automatic lifting of the barricade is done successfully in the heavy traffic roads when the signal goes red and the detection of the vehicle hit against the steel plate is detected by the vibration sensor and that, in turn, actuates the camera and captures the defaulters.

![Barrier mounted on the road](image)

**Figure 3.** Barrier mounted on the road
The figure 3 shows the mounting of the barrier on the road. The barrier itself acts as the road; vehicle can easily run without any disturbance during green signal. This prototype concentrates on north side of the road.

![Barrier lift when red light flash on the road](image)

**Figure 4.** Barrier lift when red light flash on the road
The figure 4 shows how the barrier acts at the time of red signal. When the traffic signal flashes red then automatically the barrier lifts and the vehicles are indicated to stop. Unfortunately any vehicles hit the barrier then the camera which located at the corner will capture the number plate of that vehicle and send that to control room.

6. Conclusion
The prototype discussed in this paper prevents the pedestrian from an accident during heavy traffic areas. By implementing this smart setup, cops will be able to find out the defaulters easily. This is more compatible and economical when setting up on a large scale. The pedestrian collisions occur due to the unethical behaviour of the drivers skipping the signals can be avoided with the presented barrier model. By introducing automatic barriers for the zebra crossing which will automatically lift during the pedestrian crossing and lay down during vehicle traffic.

References
[1] Aravind C, Suji Prasad S J and Ponni Bala M 2020 Remote Monitoring And Control Of Automation System With Internet Of Things International Journal of Scientific & Technology Research 9 945–9
[2] Cheng W, Zhang N, Li W and Xi J 2014 Modeling and Application of Pedestrian Safety Conflict Index at Signalized Intersections Discrete Dynamics in Nature and Society 2014 1–6
[3] Choi S, Jang J, Oh C and Park G 2016 Safety benefits of integrated pedestrian protection systems International Journal of Automotive Technology 17 473–82
[4] Fröming R, Kühn M and Schindler V Requirement Engineering for Active Safety Pedestrian Protection Systems based on Accident Research Advanced Microsystems for Automotive Applications 2006 VDI-Buch 79–106
[5] Hamdane H, Serre T, Masson C and Anderson R 2015 Issues and challenges for pedestrian active safety systems based on real world accidents Accident Analysis & Prevention 82 53–60
[6] https://instrumentationtools.com/plc-based-4-way-traffic-light-control-system/
[7] https://morth.nic.in/sites/default/files/Road_Accidents_in_India_2017.pdf
[8] https://projects.raspberrypi.org/en/projects/raspberry-pi-setting-up/4
[9] Baluprithviraj K N, Guru Prasad R S, Ashwin V, Kirubaharan S R and Idhikash S 2020 Automatic Penalty of Vehicles for Violation of Traffic Rules using IoT International Journal of Recent Technology and Engineering 8 415–20
[10] Indra J, Arun Prabhu P J, Hemaavardhithi K, Keerthana R and Lavanya S 2020 Automatic Cheese Winding Assistance For Dyeing Industries International Journal Of Scientific & Technology Research 9 1002–5
[11] Lu L, Ren G, Wang W, Chan C-Y and Wang J 2016 A cellular automaton simulation model for pedestrian and vehicle interaction behaviors at unsignalized mid-block crosswalks Accident Analysis & Prevention 95 425–37
[12] Marisamynathan S and Vedagiri P 2020 Pedestrian Safety Evaluation Of Signalized Intersections Using Surrogate Safety Measures Transport 35 48–56
[13] Petruzella F D 2019 Programmable logic controllers (Chennai, India: McGraw-Hill Education (India) Private Limited)
[14] Tim F and Alison H 2013 Pedestrian safety: a road safety manual for decision-makers and practitioners (Geneva: World Health Organization)