

Smart Crosswalk System

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Abstract

Many accidents occur at the signalized intersections of city highways, which are due to the pedestrians not using the crosswalk and due to the negligence of the vehicle operators jumping the traffic signals. There are many solutions for this particular problem but a smart crosswalk is an efficient system among them. A Smart Crosswalk is a system where barrier gates are used to help people cross the road to reach the other side in a safe way. This system lessens these issues, which are the most hazardous accidents occurring in the transportation field. The paper describes what a smart crosswalk system is and how it uses machine learning and embedded system.

Keywords: machine learning, embedded system, pedestrians, crosswalk, PIC microcontroller, Artificial Intelligence, Embedded C, barrier gates, servo motors, pedestrian gates

I. INTRODUCTION

Many developments have been made in the transportation field but very less has been done for the pedestrians [2]. Crosswalk is an important component in the designing of roads. Road accidents are caused due to the improper communication between the vehicles and the pedestrians [3]. It has been seen that the most dangerous accidents occur at the urban crosswalks [1]. A total of 1.51laks pedestrians were killed in 2018, an increase of nearly 3, 500 compared to 2017. This is due to the negligence of the pedestrians as the statistics show that 32% of them listen to music, 14% of them text, 9% of them browse the Internet, 7% use social media, and 3% play games or watch TV/videos while crossing roads [4]. This calls for an immediate action to be taken. A smart city can be created by using machine learning and other technologies to solve these problems [6]. A smart cross walk system is one of the solutions for this emerging problem. The reason why it's called a smart crosswalk is because it influences the decisions and actions of the public [5]. People must know the need to use cross walks as they ensure them safety. There are many systems, which have been developed to detect pedestrians and alert the drivers about them, but many false alarms can be generated by signaling every pedestrian. The driver can neglect these false alarms [1]. Smart cross walk at traffic signals help control the traffic very effectively. The proposed system consists of an automatic barrier gates and pedestrian gates along with traffic signals. The traffic signal timing changes automatically and delay is provided with the help of microcontroller. To conclude, this system is very effective in avoiding all kinds of accidents related to pedestrians that imbibe the public to follow the traffic rules.

II. EXISTING TECHNOLOGIES

Most of the zebra crossings do not have enough safety measures helpful for the pedestrians. However there are a few roads which follow certain precautions to avoid road accidents. Mostly zebra crossings, over bridges, signalized pedestrian crossings, etc. are being used. But the pedestrians are not willing to use these tools which are causing many road accidents. Many people have started to look for effective solutions to reduce the number of road accidents at the zebra crossing. Few of them are listed below:

A. Cameras

The smart pedestrian signals technology works through sensors which are connected to an optical system which is located at the zebra crossing. This optical system is connected to the signal. Here, any extra time required for the pedestrian to cross the zebra crossing is calculated and the signal time is changed accordingly. This allows the pedestrians to cross the road hassle free. However, the equipment is expensive and the number of accidents won't be reduced as it doesn't prevent the people from crossing.

B. Automatic Detection of Zebra Crossing

This system automatically detects the crossing area from a sequence of images. It also analyses flaky paint, impairment of crossing and defilement. There are three types of crossings: seriously impairment, partially impairment and clear crossing which are indicated by red, yellow and green respectively. If the crossing is too close or too far to analyze, then it is indicated in blue. The red lines indicate the intensity histograms as shown in figure (1). This equipment can be installed in vehicles. The installation of the devices is complex and time-consuming.

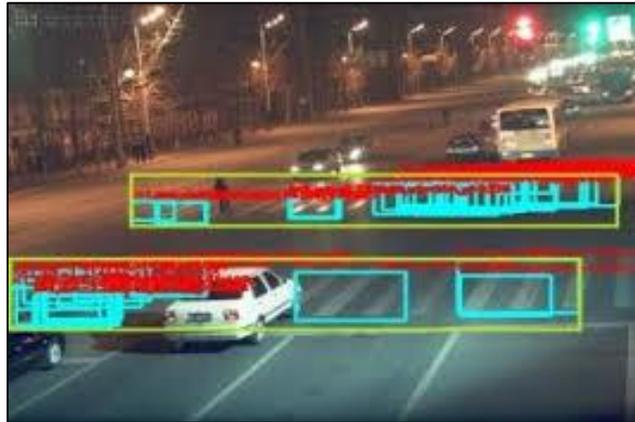


Fig. 1:

C. Over-Bridge and Subways

An over-bridge or a foot over-bridge is a permanent structure which allows the pedestrians to cross the road without impacting the traffic. This way neither do the pedestrians or the vehicles have to wait. An over-bridge connects two opposite sides of the road. Similarly, a subway is an underground passage where the pedestrians can move from one side to the other side of the road. The main disadvantages of over-bridge and subways are that the construction is very expensive and the entire process is time-consuming. Physically handicapped people find it difficult to use an over-bridge or a subway.

D. Pedestrian Refuge Islands

A refuge island is a small section of pavement or sidewalk which is completely surrounded by other road materials. Here, the pedestrians can stop in the between while crossing a road. Refuge Island must be a minimum of 1.2 meters wide. It is typically used when a street is very wide, as the pedestrian crossing can be too long for some individuals to cross at a stretch. Due to the negligence of the pedestrians, this system isn't that effective. Even though all these systems have been implemented there isn't any decline in the death rate so, we propose another system.

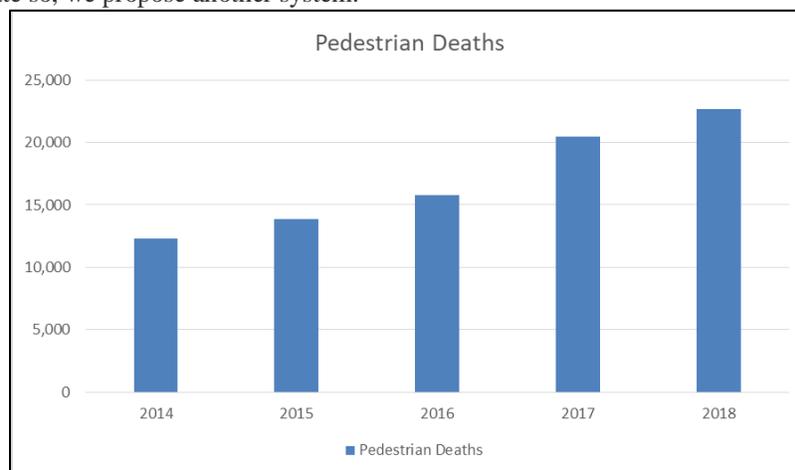


Fig. 2: This graph shows the increase in the Pedestrians' death rate from the past 5 years

III. PROPOSED SYSTEM

We designed another form of crosswalk system to overcome the limitations of the mentioned above existing systems. This system helps pedestrians to cross from one side to another. This system contains traffic signals and barrier gates which are programmed so that whenever there is green signal at the pedestrian signal and red signal at the vehicles' traffic signal, pedestrian gates at the crosswalks open which help them from crossing the road and the barrier gates that are paved on the roadbeds project upwards which alert the driver to stop the vehicle. Whenever there is a red signal at the pedestrian signal and green signal at the vehicles' traffic signal, the pedestrian gates at the crosswalk close which stops pedestrians from crossing the road and the vehicles then move as the barrier gates go down. This system is repeated for the other three sides of the road for every 18 seconds [7].

A. Design and Architecture

1) Hardware:

This system contains a PIC microcontroller, crystal oscillator, regulated power supply, servo motors, LED indicators (pedestrian lights and traffic lights), barrier gates and pedestrian gates.

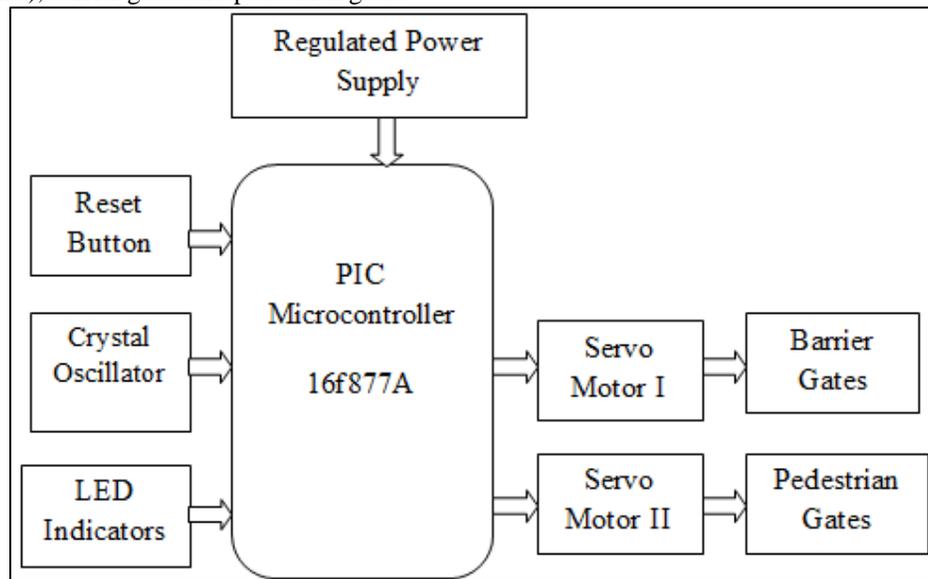


Fig. 3: Block Diagram of Smart Crossing Systems

2) Microcontroller:

A microcontroller is a computer on chip which is used to perform a specific action or a service. In this project, we used a PIC 16f877A microcontroller. This microcontroller is inexpensive, has rapid speed and is easy for programming than other microcontrollers [9]. It consists of a 14kb flash memory where the memory can be erased, 256 bytes of EPROM & 36 bytes of RAM. ICSP pins are also present in this microcontroller, which are used to burn the program on the board and with this special feature, there won't be a need to compile the program every time. Both serial and parallel communication is possible.

3) Crystal Oscillator:

A crystal oscillator of 12MHz is used to generate square pulses.

4) Regulated Power Supply:

It is the device or a system that provides electrical energy or other types of energies to an output load. It converts AC voltage (230 V, 50 Hz) to DC (5 V). It contains a transformer, AC mains, bridge rectifier, voltage regulator, capacitor and resistors.

5) Servo Motors:

A servo motor is an electrical device which can push or rotate an object at a particular angle. It consists of a DC motor, potentiometer and a control circuit. The motor has a gear assembled with a field of coil. A high torque can be established with a servo motor and can withstand heavy weights. Pulse width modulation is sent to the motor which then determines the shaft position & depending on the duration of the pulse, the rotor will turn to the desired position.

6) LED Indicators:

An LED is a p-n junction diode which emits light when a voltage is applied across the terminals. The electrons combine with the holes and the energy is released in the form of photons. The intensity of the light depends on the energy levels of the electrons jumping in between the atomic orbitals of the semiconductor. The material is made of gallium arsenide.

7) Barrier Gates and Pedestrian Gates:

The material used for the barrier gates and pedestrian gates is mild steel. Mild steel is made from recyclable steel and is galvanized which protects the gates from corroding.

The barrier gates have to be the same level as the road when they are closed. The height of barrier gates should be 3 ft. and the height of pedestrian gates should be 4 ft.

8) *Reset Button:*

It is used to reboot the entire process.

9) *Software:*

The software we used is embedded C and which we implemented through machine learning.

10) *Embedded C:*

The programming language we used in this system is embedded C. We used PIC compiler to compile the code. Then we have designed the same system in Proteous that converts machine code into hex code, then this code is compiled to check if there are any errors and then dumped into the microcontroller after successful compilation. Embedded C is developed for programmers with programming experience in C, C++ or Java who want to gain skills that are necessary for the programming in embedded systems [10].

11) *Machine Learning:*

It allows computers to learn without being explicitly programmed [11]. Machine learning is an application of artificial intelligence which comes up with the potential that the systems can learn things automatically and develop the system without being stated. It is mainly used for improving the software codes that can acquire data and utilize it to grasp skills for themselves [8]. Fortunately, machine learning relies on nature's bounty for both inspiration and mechanism [12].

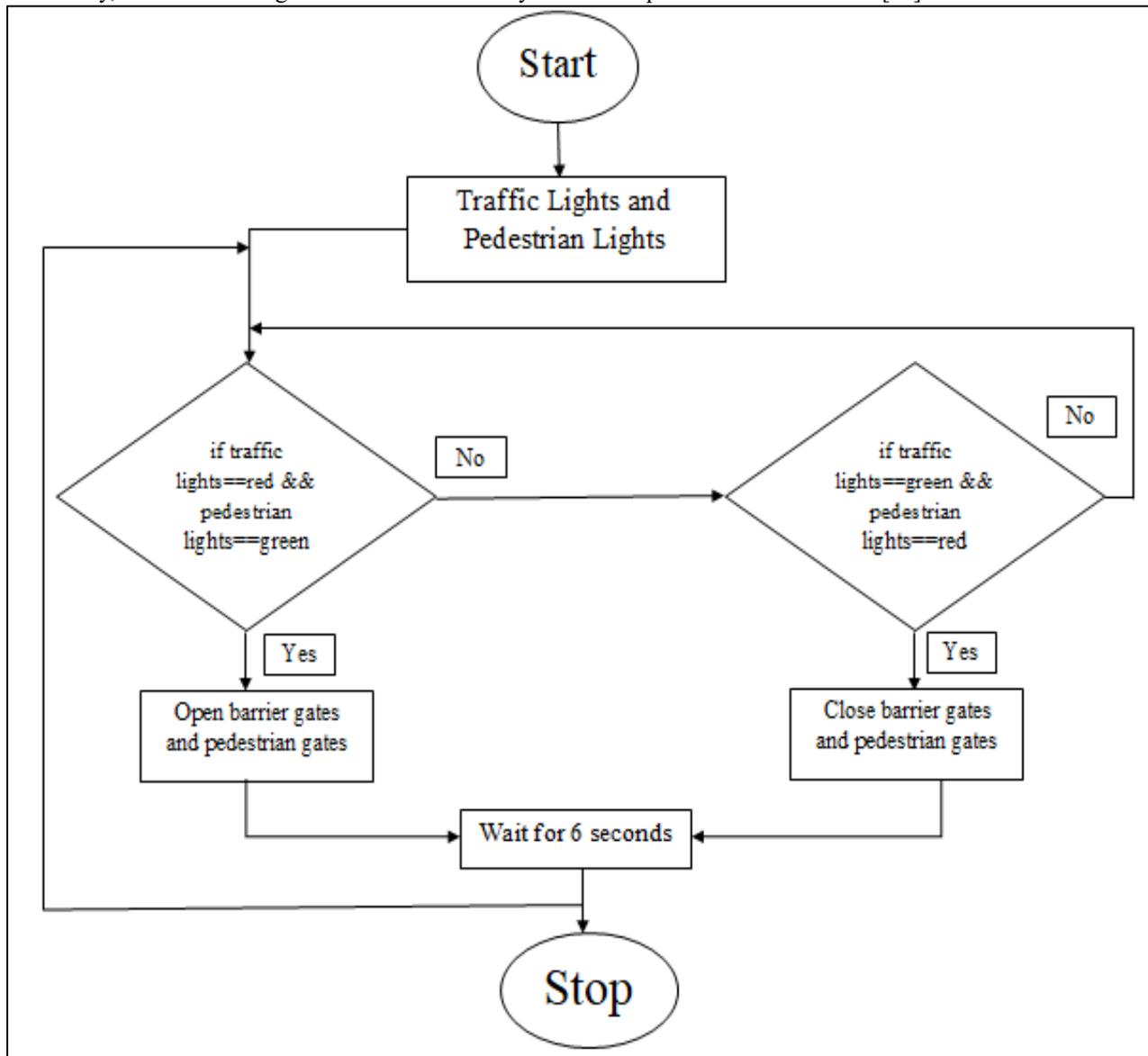


Fig. 4: Flowchart describing the functioning of the system

The inputs given to the system are traffic lights and the pedestrian lights. It first checks the condition whether the traffic light is red and pedestrian light is green. If it is true, the barrier gates and the pedestrian gates will open and will wait for 6 seconds. If

it is false, then the condition whether the traffic light is green and pedestrian light is red will be checked. If it is true, the barrier gates and the pedestrian gates will close and will wait for 6 seconds. If it is false, then the process repeats from the beginning.

The code for the above flow chart can be viewed in the link:

<https://docs.google.com/document/d/1zZud6jDDIE0tTiUqO9VTf-hNLE9xqSertpqkePNAo/edit?usp=drivesdk>

IV. RESULTS AND DISCUSSIONS:

This system is highly effective as it is easy to install, the PIC micro controller is efficient and hardware equipment is easy to operate and consumes low power. It can be accessed easily by everyone. This system also runs for a long time. However, the proposed system doesn't have a provision to detect ambulances and any emergency vehicle. The interfacing of servo motors with the PIC microcontroller is sensitive and the feedback of traffic signals operated is not stored.

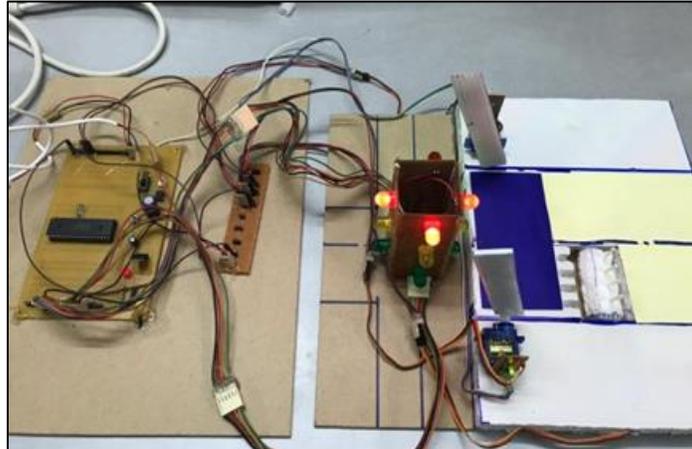


Fig. 4: When the traffic light turns red and pedestrian light turns green, the barrier gates and pedestrian gates open

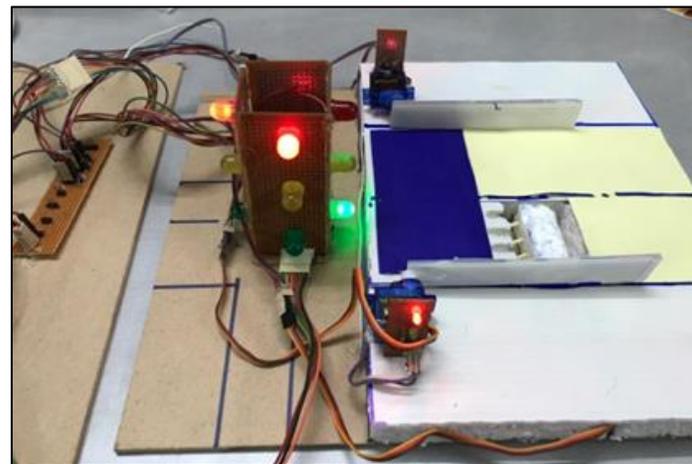


Fig. 5: When the traffic light turns green and pedestrian light turns red, the barrier gates and pedestrian gates close

Digital Image Processing can be used to detect ambulances or fire trucks. When these vehicles are detected, the barrier gates can be opened for them. This project can be extended using GSM modem. In a GSM module the information will be sent to the respective authorities regarding the status of traffic density and signal light information. We can also extend the project by adding GPS module through which we can get the details of the traffic signals along with location details. Another way of upgrading the project is by adding wireless camera through which we can monitor the status of traffic lights being operated at the cross walk locations. Programming can also be done in Python which can be linked with IOT.

V. CONCLUSION

In this paper, we present a crossing system provides safety to people and also brings the drivers' attention to the pedestrians. The servo motor controls the barrier gates. The controlling module of the whole system is the PIC microcontroller. The Microcontroller is loaded with an intelligent program written using embedded 'C' language. To conclude, the project "SMART CROSSWALK" helps to manage the traffic effectively and also mitigates the number of accidents. It also enforces the public to follow the traffic rules.

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