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A Smart/Efficient Method to Facilitate Highway Pedestrian Protection

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Abstract

Background/Objectives: To ensure pedestrian safety in highways predominantly at night. Application: By introducing piezoelectric sensors embedded on highways, which automates the notification lamps that help both pedestrian and drivers to know each other's presence. Methods/Statistical Analysis: The basic method we implement is getting the feed of digital HIGH and digital LOW from the piezoelectric crystals. The state of the pedestrian cross decides the output signal of the notification lamp. This helps the fast drivers on the highway to adjust their acceleration with prior alert of movement on the road. The prototype result with few minutes delay of glowing, the notification lamp can be set in real time with little more depending on the length of the cross. Findings: The night time travelers on the highway have the difficulty of vision due to optical problems of the front vehicle glass. The irritation due to high beam of the opposite vehicles distract the proper vision of the road. The pedestrians from local area are becoming a casualty of this situation. And the speed at which the drivers come is not possible to reduce in small period of time. Prior alert is required for this.

Keywords: LED Lamp, MSP430, Piezoelectric Transducer, Vibration Analysis

1. Introduction

The accidents involving pedestrians and Vulnerable Road Users (VRUs) are one of the prime factors contributing to road accident deaths. Millions of people die or get injured in traffic-related crashes while walking, some of whom become permanently disabled. Pedestrian collisions, like other road traffic crashes, should not be accepted as inevitable because they are, In fact they are both predictable and preventable. Road traffic crashes kill about 1.24 million people each year[1]. More than one fifth of these deaths occur among pedestrians.

The pedestrian deaths in highways near rural areas are due to practically non-existent speed regulatory systems in developing countries. Consider a situation, where a villager tries to cross a highway at night. While he is crossing the road, he sees a car approaching him from nowhere at a high speed of over 110kmph. What will the poor villager do? Also, the driver cannot stop the car in time as there is very less time to react due to high speed and poor visibility conditions.

What are the protection methods employed to prevent these kind of accidents? Sadly, there is still no effective method to prevent accidents of such sort.

The following are the main causes for pedestrian accidents in highway:

- High speeding cars
- Poor visibility at night
- Blind spots in road due to poor infrastructure

2. Proposed Architect

2.1 Pedestrian Sensing

The pedestrians approaching the highway are sensed by the piezoelectric sensors embedded under the village road (i.e.) frontage road just before the junction with the

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highway (Figure 1). When the pedestrians step over the embedded piezoelectric sensors, a voltage pulse is generated due to direct piezoelectric effect[5]. This voltage pulse is fed into MSP430 in the prototype which is programmed to give digital HIGH and LOW[6]. In the prototype the piezoelectric sensor is connected to MSP430 by modelling it as a knock sensor (Figure 5).

2.2 Vehicle Sensing

The vehicles approaching the junction are sensed using the piezoelectric sensor embedded under the highway at a predetermined distance before the junction. When the vehicle moves over the piezoelectric sensor a voltage pulse is generated. The voltage generated is fed to MSP430 in the prototype (Figure 5).

2.3 Alerting the Driver

When MSP430 senses the voltage due to pedestrian movement, it triggers a bright red notification light. The notification light is to be mounted on a tall post (Figure 2). So, when the red notification light blinks, it can be sensed by the driver approaching the junction at a farther distance ahead (Figure 4). In addition to the notification light at the top, there is a notification light in the middle for comfortable viewing from a nearer distance. There is a switch at the bottom of the lamp post for control of the notification light during rain (Section 2.1). The height of the notification can be determined by calculating the maximum distance at which the drivers are to be alerted about possible pedestrian movement. Generally, for uneven roads with sharp turns, the notification post is taller.

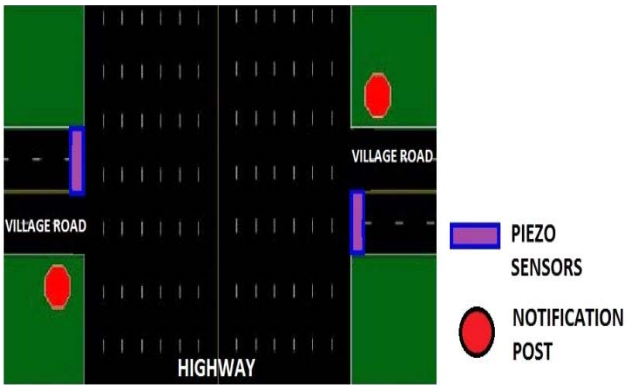

Figure 1. Pedestrian Sensing.

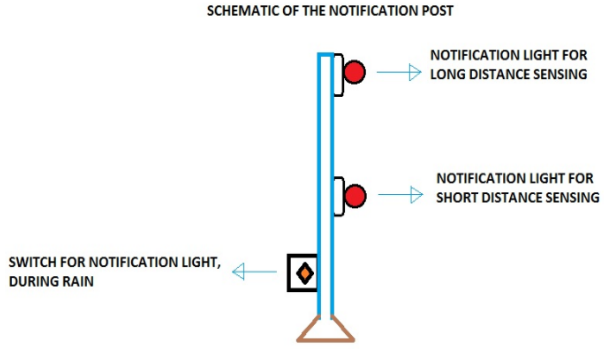

Figure 2. Schematic of the Notification Post.

2.4 Alerting the Pedestrian

When MSP430 receives the voltage pulse generated due to the movement of vehicle over the piezoelectric sensor, it triggers (Figure 8) the red signal facing the two frontage roads. So, a pedestrian who is about to cross the road, will be alerted about the approaching vehicle.

2.5 Precaution taken by the Driver

When the driver sees the notification light, he will become aware of the pedestrian movement in the upcoming junction. So he will re-duce his car's speed, say in this case, from 110 kmph to 70kmph. This will significantly reduce the distance and time taken to stop the car completely, when the driver sees a pedestrian crossing the road which is evident from the braking statistics shown (refer Figure 2).[2]

Assume that a driver detects a pedestrian crossing the road at a distance of 80m ahead. From the statistics, (Figure 3) we can understand that if the vehicle is speeding any more than 78.5 kmph, the accident becomes highly probable. We can also conclude from this research that, the higher the speed, the more probable the accident is.

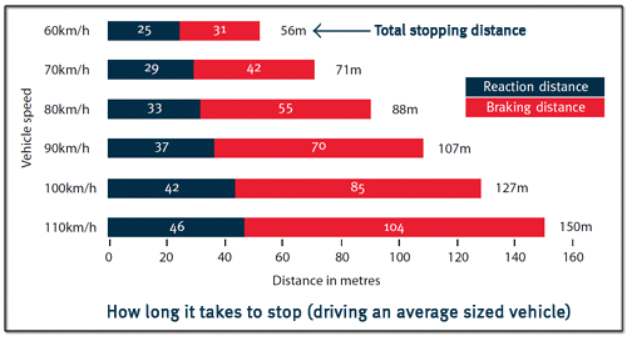

Figure 3. Vehicle Stoppage Reaction.

2.6 Schematic of the Proposed System

The situation can the seen from the following schematic (Figure 4) .Since both the driver and pedestrian are alerted abouteach other's movement earlier than normal circumstances, there is a great chance of preventing the accident.

Normal sensing range = normal pedestrian perception distance

Improved sensing range = Distance at which the driver perceives the pedestrian movement after the system installation

Additional sensing range = the additional distance before which the driver can perceive the pedestrian movement

Additional sensing range = Improved awareness range - Normal sensing range.

(i.e.) Improved Awareness Range > Normal Sensing Range

2.7 Working of the System During Rain

During rain, the piezoelectric sensors are continuously activated. The continuous excitation of the pedestrian piezoelectric sensor causes the notification light to blink continuously. This situation is prevented by the algorithm in the MSP430 (Figure 5).

The voltage pulses from the pedestrian piezoelectric sensor are continuously monitored by the vibrational analysis code in MSP430. If vibrations are sensed continuously for more than predefined time (say, 120 sec) the control of the notification light is shifted from the piezoelectric sensor to the switch present in the notification lamp post (Figure 5). So, if a person wants to cross the road during the rain, he can activate the notification light by closing the switch present at the

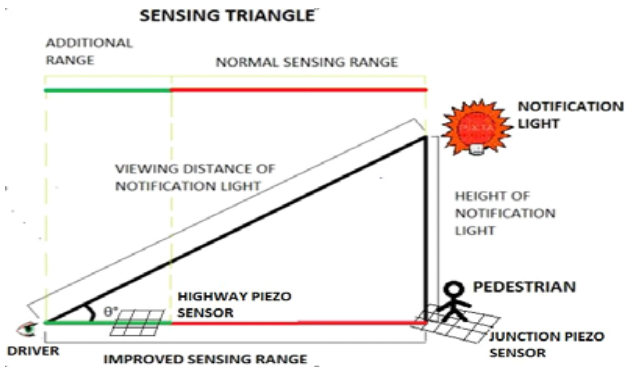

Figure 4. Schematic of Proposed System.

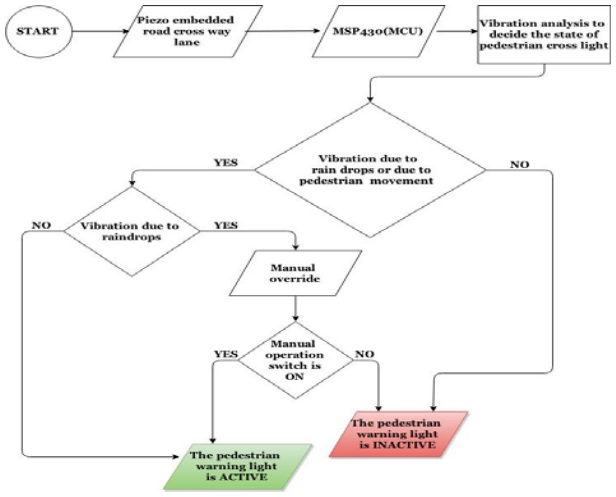

Figure 5. Flowchart for Triggering Notification Light.

base of the notification lamp post. The instant when the continuous vibration due to rain stops, the control of the notification light is shifted to the pedestrian piezoelectric sensor again which is evident from the following prototype and flowchart.

3. Sensors

3.1 Design of Sensors

The physical design of the piezoelectric sensors required is already available in the market [4]. But, such commercial sensors are highly precise. Precision and sensitivity of such magnitude are not required in our application as we are just detecting vibration due to movement. Even a tiny voltage generated by piezoelectric sensor can be detected by the MSP 430 used in the prototype. So large scale manufacturing of low sensitive, durable sensors will bring down the cost significantly.

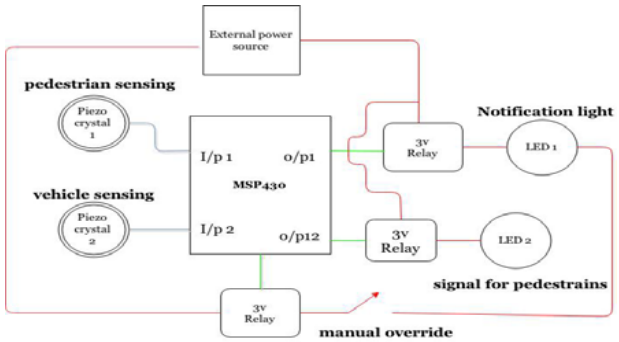

Figure 6. Circuit Diagram.

Figure 7. Normal Condition

3.2 Installation of Piezoelectric Sensors

The proposed piezoelectric strips can be installed by following process[4].

- The area is marked on the road where the piezoelectric sensors are to be installed.
- The road is drilled according to the depth required.
- The piezoelectric sensor is fixed to plastic clamps.
- The clamped sensors placed into the drilled hole.
- Rubberized catalyst is poured into the drilled area and is levelled to the road surface.
- Even if the road is laid again, the sensors can be calibrated in accordance to new road conditions.

3.2.1 Advantages

- There are Lot of Notable Advantages in this Invention.

The prominent advantages are mentioned below.

- The number of accidents occurring in the highways, especially developing countries can be prevented.
- It provides safety to the pedestrians crossing the highway at night, saving numerous lives.
- The disasters that happen when a driver tries to avoid hitting the pedestrian are avoided.
- The pedestrians can cross the road without any fear.

4. Result and Analysis

When a high speeding vehicle (green car in Figure 8) moves over the piezoelectric sensor embedded in the highway, red signals facing the service roads are triggered (red lights near the pedestrian crossing in Figure 8). Thus, it acts as a warning for the pedestrians who are about to cross the road.

Similar is the triggering of the notification light for the drivers when a pedestrian crosses the road.

Figure 8. Car Triggers Signal for Pedestrian.

5. Conclusion

Not only in India, every part of the world has accidents happening every day and this solution is helpful to increase safety. A study by Opas Somchainuek[7] reveals the accidents happening in Thailand. Hence, it is clearly visible that Roadside safety is very important and need of the hour. The highway drivers and the pedestrians can safely move through with better alert system like this, thus reducing the danger for the pedestrians and drivers. This may add a value addition to our traffic system in terms of safety precaution and reduce the causalities on the major highways.

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