



PORTABLE SMART WIRELESS PEDESTRIAN CROSSING CONTROL SYSTEM

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Abstract:

Walking is a daily activity but walking safely is much more important. This requires an appropriate crosswalk as a part of the safe transportation infrastructure. In this paper, we design and develop a portable smart wireless pedestrian crossing control system to minimize the road accidents while crossing the road. This system manages the traffic automatically and allow the pedestrian, like school children, to cross the road safely and effortlessly. This system also focusing on the blind people to make them cross the road securely. The system involves the concept of smart sensing to detect the presence of pedestrians and in turn, automatically controls the crosswalk traffic lights. This system is installed on either side of the cross road to detect the pedestrian's presence. The designed system composes of two Arduino microcontrollers, two infrared PIR motion sensors, relays, a buzzer and a bidirectional wireless communication link based on Bluetooth for mitigating wiring installation and

transmitting the signal among traffic light units on both roadsides. The system is designed and implemented as a portable LED-based traffic light testbed with a buzzer that indicates the pedestrians to start.

This developed system is tested and validated in a real environment with a 6 m road width on the college campus. According to the obtained results, the system worked effectively and fulfilled the design criteria where the communication between both sides lights is successfully functioning and the PIR sensors can accurately detect the existence of pedestrians. The developed system is cost-effective, energy efficient, easy to install, and maintenance-free. In this system, the buzzer module helps the blind people and senior citizens to know about the pedestrian cross time so that they can easily and safely cross the road.

Keywords: Smart system, Bluetooth, buzzer, wireless link, traffic lights.

Introduction:

Walking is the simple mode of transportation but this should be an effectively smarter way. Crossing road is a simple term until the term safety hits. This innovative technology provides an adaptive solution for managing the vehicle traffic along with the pedestrian traffic. This technology can also be used at construction sites, school zones or any other locations. This system ensures pedestrian safety and control in traffic flow. Every year roughly 1.35 million people die and up to 50 million more people suffer non-fatal injuries as a result of a road traffic crash according to the World Health Organization. The school children and elderly people are considered to be at a higher risk regarding pedestrian accidents. Majority (40.3%) of pedestrian were children. From this, at least 40% were either killed or severely injured during accidents, with the highest proportion being children aged 6-10. There is evidence that children are only completely capable to select required information to perform the task of crossing the road from the age of 11.



Fig (1) shows children crossing the road

In the existing system, at the road crossing area pedestrians are assisted by using a manually pedestrian crossing control system, which indicates the lighted signs (“WALK”, “DON’T WALK”), Walk with the RED colour and Don’t Walk with GREEN colour. World is moving fast and having little time for others, people’s safety becomes the main concern. World is keep moving with evolving technology and people are facilitating with all needs by using advanced technology. The requirement of technology is for most of the

people especially on the main roads in the city or on pedestrian walk. At most of the parts button functions as the human detector, alerting the system to the presence of a pedestrian and requesting a “WALKING” signal as soon as possible. The pedestrians have to push the button to cross, otherwise system does not know the presence of pedestrians on the crosswalk path. When the button is pushed the “Walking” signal get displayed and pushing the button simply reduces wait time. There are many benefits of this portable crossing control system. The main scheme is about the safety for the people and its intelligent control and real time data ensures that, give chances to the people to wireless connectivity allows for immediate response to emergency situations and causes in the day-to-day life and for future. Main part is about the traffic, which is efficiently managing during crossing time in the system in a general smoother traffic experience for all the road using people. Scalability is one of the standout features of this system. This helps in the large cities and this evolving system can effortlessly expand to meet the increasing demand for people crossing. Its adaptability to different urban settings ensures that it remains a revolutionary solution for a wide range of applications. This system generates a wealth of data which can be harnessed for traffic analysis. This data gives an approach to smarter society.

Identifying the importance of user friendly, the system offers a variety of interfaces for both people who walks can use mobile apps wearable, or even voice commands to request safe crossing roads traffic controllers have access to a user -friendly control panel for real time monitoring and adjustments. Then coming to sustainability, portable smart wireless pedestrian crossing control system is built to minimise energy consumption and environmental impact. It utilizes low power consuming components and can be integrated with renewable energy resources further attached to the urban solutions. It causes low costs and its portability and wireless design, the system dramatically reduces the need for

expensive, fixed infrastructure, saving both money and time and its efficient. It also says maintenance and repairs purposes as components can be easily replaces or updates. s cities continue to grow and evolve, the demand for innovative solutions in urban mobility becomes increasingly urgent. The Portable Smart Wireless Pedestrian Crossing Control System stands as an example of how technology can revolutionize safety and it contains of properties, convenience, and efficiency in urban transportation. Its ability to adapt, its emphasis on real-time communication, and its user-friendly interfaces position it as a visionary solution for the challenges of future cities.

We will discuss deeper into the technical aspects of this system, explore case studies of its successful implementation, and discuss the potential hurdles and considerations that cities must address when adopting such advanced technology. Join us on this journey as we unlock the potential of the Portable Smart Wireless Pedestrian Crossing Control System.

Block Diagram:

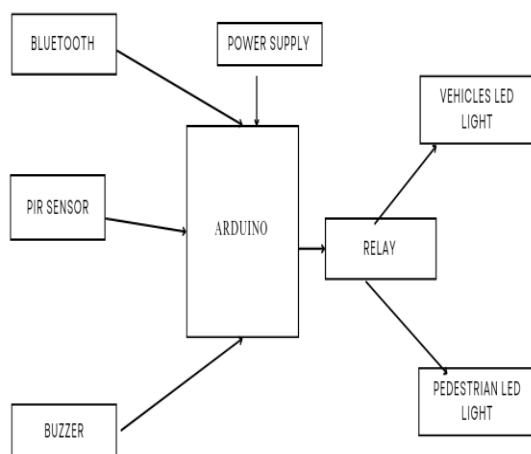


Fig (2) block diagram of the system

The developed system consists of two identical units and each unit composes of five main components, namely an Arduino Uno microcontroller, a PIR sensor, a Bluetooth module, a relay board, and a vehicle/pedestrian traffic light. A mechanical manual switch is also added to the power source circuit for easier

testing/handling. The components' details are described as follows:

1. Arduino



Fig (3) Arduino

Arduino is the core component of this system which acts as a small computer on a single integrated chip to manage all functions by taking inputs and providing outputs. It collects all the input data from Bluetooth, PIR sensor etc.

2. Battery power supply

A battery is a type of linear power supply that offers benefits that traditional line-operated power supplies lack: mobility, portability and reliability. A battery consists of multiple electrochemical cells connected to provide the voltage desired.



Fig (4) Battery

3. Bluetooth

In this system, the wireless communication is achieved using the Bluetooth module



Fig (5) Bluetooth

which reduces wiring and efficiently transfers the data without loss.

4. PIR Sensor

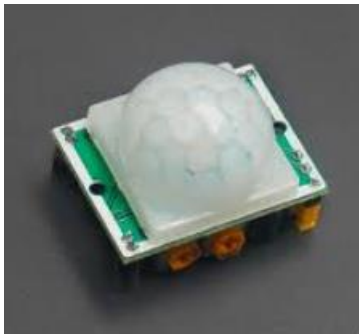


Fig (6) PIR Sensor

Passive Infrared Sensor basically operates based on infrared radiation, which is emitted from the human body. Infrared light is electromagnetic radiation with a wavelength between 0.7 and 300 micrometres. People are the source of infrared radiation. It was found that the normal human body temperature radiates IR at wavelengths of 10 micrometres to 12 micrometres. PIR sensor is made up of crystalline material that generates a surface electric charge when exposed to heat in the form of IR. This change in radiation striking the crystalline surface gives to change in charge.

5. Relay module



Fig (7) Relay module

A 5 V DC, Opto-isolator, 5 channel relay boards are used in the system to perform the traffic lights (LEDs) switching on both roadsides either for vehicles or pedestrians. The relay will be energized/de-energized depending on the decision made by the Arduino microcontrollers and based on the received information from the PIR sensors. Relay receives the input from the Arduino based on the condition met according to the data collected by the PIR sensor.

The Bluetooth wireless communication will be active all time which is the principle behind the system. It improves the communication between the either side of the system which simultaneously react to another side of the system through Bluetooth.

6. Buzzer



Fig (8) Buzzer

Buzzer is an electronic device which functions as an indicator when the pedestrian cross traffic light is enabled.

7. LED traffic lights

A 12V DC, 10 mA Light Emitting Diodes (LED) are utilized to replace the AC lights for conveniently using them for traffic lights which has longer lifetime and it emits light evenly and they are also helpful even in the foggy conditions. Three lights are used for vehicle traffic lights while two lights for the pedestrian. The size of the light is 125 mm (Car), 75 mm (Pedestrian). These LED lights are powered using Lithium Polymer rechargeable batteries (12 V, 2200 mAh, 0.1 mA).



Fig (9) Traffic lights

System Model:

The main idea of this presenting paper is to implement the portable smart road cross walking system to help the people to walk on road safely and crossing the street. Our test type consists of two identical units; each will be placed on either side of the road. The adopted methodology for this system is the control system modelling and implementation and the system fabrication or system manufacturing. In the first part, the development of software and hardware will be done. It started with components selection where sensors, actuators, and controllers were selected. It followed by electrical circuit design and wiring installation. Then the software and algorithm development using the Arduino IDE was conducted. The wireless communication module also integrated with the Arduino microcontroller using the Bluetooth module. After that, the selected components have been tested fixing them to the circuit so as to get accurate results. The manufacturing part focused on the design and fabrication of the implementation of the traffic lights and followed by the implementation of the control circuit in the developed system. At last, the testing and validation of the entire system was carried out. In the proposed system, Passive Infrared (PIR) motion sensor is used in order to determine and find the presence of a pedestrian in either the curb side area or the crosswalk by receiving the infrared waves emitted by the humans. The aim is to automatically work and activate the signal to make it hands-free and does not require a manual action to like the existing systems with push a button. The general operating

mechanism of the system starts with the pedestrian detection by the PIR motion sensor in the crosswalk, the microcontroller will then turn on Greenlight for pedestrian and Redlight to the vehicles. Bluetooth module acts as the in between source of networking between both microcontrollers and traffic lights that placed on both sides of road wirelessly. This wireless connectivity between both the installed system works simultaneously by receiving the inputs from sensors and actuators. This will actuate the traffic lights of vehicles and pedestrians on both roadside and will act as an automatic “push button” crosswalk, thus it makes easy for the movement of pedestrians on the crosswalk especially for children and elderly groups and it also reduces the rate of accidents.



Fig (10) shows the wireless communication between two systems

Design and implementation of this system involves an energy-efficient LED-based pedestrian crossing control system with wireless support and portable in nature. The concept for detecting pedestrian at crossing area and it organizes the traffic. An algorithm has been implemented in Arduino IDE to perform relays control based on PIR sensors' status.

System Working:

The developed system integrates the concept of pedestrian crossing and the wireless connectivity of the system which are implemented on either side of the road by connecting wirelessly using the Bluetooth module. This wireless connection automatically operates the traffic lights both for vehicles users and pedestrian people. This system ensures the

safety for people by automatically detecting the presence of pedestrians at the cross walk.

The control circuit is explained in detailed in this section.

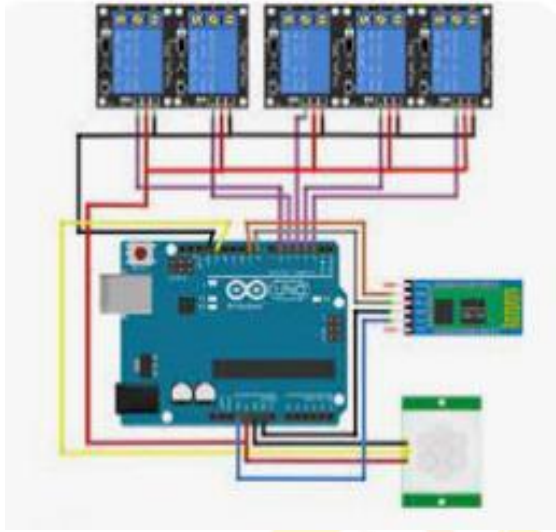


Fig (11) shows the circuit design of the system

The hardware circuit consists of an Arduino microcontroller, a passive infrared sensor, a Bluetooth module, a 5-channel relay module, jumper wires, a buzzer and power supply. Arduino is the core component of the system which is connected to all components and acts as a small computer. The algorithm of the executing system is developed using Arduino IDE which has a simple language to code. Some steps are required in order to make a complete portable smart wireless crossing control system which involved the process of hardware circuit building. The microcontroller circuit is first developed on a breadboard to check the functionality and the component testing then the process of soldering is done. With the small circuit any error can be determined easily and can easily troubleshoot and the connection can be changed without consuming so much time to rebuild the circuit. Because of fewer components the amount of radiation is also less and power dissipation also reduces. Good connections and perfect insulation of wiring are required for safe and continuous operation thus, a plastic sticker is used to improve insulation and avoid any electrical contact with the metal housing of traffic lights which also reduces the chance of

circuit failure and short circuits. The components of the circuit are installed and made connections into the traffic lights housing area of each unit on either side before this all the components are checked and tested individually to ensure that all components are working accurately without any defect, and the completed circuit is first tested successfully on breadboards. After this, the components are transferred to fix in the fabricated system. The implemented system includes two identical systems units on each on one side of the road crossing, thus all the manufacturing steps are repeated twice.

The overall architecture of one side of road is tested and installed based on the width of the road and the sensor range the overall the system is installed. The flow of signal starts from PIR sensor to the Arduino uno microcontroller and Bluetooth, buzzer and relay respectively.



Fig (12) shows the pedestrian detection

There are two sets of traffic lights in our system, one for vehicles and another for the pedestrian. Each side of traffic light consists of three lights for vehicles and two lights are for pedestrian use. The Bluetooth is used to exchange the wireless signal information between the Arduino microcontrollers of the traffic light system located on both sides of the cross walk. This Bluetooth module ensures that both traffic light systems are working simultaneously and accurately according to PIR sensor inputs from the architecture of the system both sides of the crosswalk.

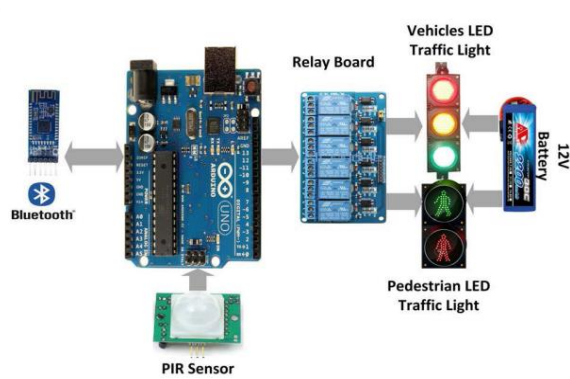


Fig (13) shows the connection of physical components

At the crosswalk, the presence of pedestrian is detected using the PIR sensor, which receives the infrared signal from human who are the source of signals. If the sensor detects the signals on any one side of road the microcontroller is already programmed as if PIR sensor detects the signal, it sends the call to the Bluetooth module connects to the other side of the system wirelessly. Presence of pedestrian is detected; the relay module is connected to the Arduino turn on the “Green” light of pedestrian cross light. The walk of the pedestrian is determined as the 30seconds and at the same time a buzzer start warning pedestrians for the time remained. After 30 seconds, “Red” light starts to glow for pedestrians and the vehicle traffic light glows “Green”. This process works on either side of the road and both the systems communicate simultaneously through the wireless Bluetooth module.

For the purpose of increasing the safety rate for pedestrians, usage of accurate motion sensor is the major thing for the system. The sensor was placed on the height in the traffic light housing which higher than the average height of the person for overall and perfect detection between the stated height. With this system children, pets, elders can cross the road safely. Street cross-walking supports timer on the signal lights which may harm the pedestrians and also vehicles users. There were many improvements have been done on this project are created upon the progress of this project and one of the benefits is the perfect timer which for vehicle vision, when the pir motion sensor detects any pedestrian’s movement or

receives infrared radiation, the system automatically generates an instruction to the traffic signal light with balance timing about 5 seconds of “STANDBY” light for the vehicle’s stop preparation. As a smart portable road cross-walking system, as a pedestrian crossing the road, the signal light remains position of “WALKING” light until no pedestrians are crossing the road for the least time. The present using system may be just applied on a relay between both signal lights for communicating, despite that, this system used a Bluetooth module which can be programmed to increase the effectiveness and accuracy of signal lights’ communication using wireless communication. The electrical components also include a rechargeable battery also successfully installed inside the traffic light housing.



Fig (14) shows the installation of circuit in traffic housing

Result:

The entire installed system composes of two completed traffic light units with stands, both sides of the systems are used for vehicles and pedestrians at the same time by communicating wirelessly. Each unit will be placed on either side of the pedestrian crossing area on the road. The automatic pedestrian detection and wireless Bluetooth based control of traffic lights over are well-functioned. The Bluetooth module uses the 2.4 GHz frequency band to communicate with the other sides of the system which is within its communication range (10 m). The traffic light section has its PIR sensor to detect the presence of the pedestrian at of the road, and to exchange

the information or the obtained inputs with the other unit.



Fig (15) shows the “Go” signal for the vehicles.



Fig (16) shows the “Walk By” sign for the pedestrians.

Conclusion:

Design and developed the portable smart wireless pedestrian crossing control system it enhances the efficient solution for the pedestrian crossing safely, optimise the traffic at the crosswalk. It helps to cross the road in a safe and secure manner without putting any extra efforts while crossing the roads through the heavy traffic signals. The main consideration of the system is that construction, maintenance and energy efficiency of the pedestrian crossing

system. The system’s Bluetooth shows the communication of the traffic lights on all sides of the pedestrian area. The system’s nature makes it easy to deploy and be arranged in such a manner that it can be arranged in any kind of geographical locations. The system is able to conserve energy and reduce the electricity bills by using LEDs using rechargeable batteries. Through the pedestrian crossing the school children and the aged people they can easily cross the road. The pedestrian system uses energy generated by solar panels during day time and uses the energy stored in batteries during night time.

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