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Full Length Article

Enhancing cyclist safety: Real-Time cyclist fallen detection and emergency notification system

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Abstract— *Road accidents are a major cause of fatalities and severe injuries worldwide, with cyclists being among the most vulnerable road users. A significant factor contributing to accident-related deaths is the delay in emergency response following an incident, particularly when cyclists travel alone or in remote locations. To address this issue, this project proposes a smart safety system titled* ***"Enhancing Cyclist Safety: Real-Time Fallen Cyclist Detection and Emergency Notification System."*** *The proposed system is designed to detect cyclist falls or accidents in real time and automatically transmit emergency alerts along with accurate location information to predefined contacts. The system continuously monitors the cyclist's movement and condition to identify abnormal events requiring immediate assistance. By enabling instant communication and location tracking, the proposed solution reduces rescue response time and improves the likelihood of timely medical intervention. The system is developed as a low-cost, practical, and easy-to-install solution suitable for everyday bicycle use. It is especially beneficial for cyclists travelling at night, on highways, or through isolated regions where immediate help may not be available. The integration of real-time accident detection and emergency notification technology enhances cyclist safety, supports rapid emergency response, and contributes to reducing accident-related fatalities.*

Keywords— *Cyclist Safety, Fallen Cyclist Detection, Emergency Notification System, Real-Time Monitoring, Accident Detection, GPS Location Tracking, Emergency Response, Smart Safety System, Internet of Things (IoT).*

Introduction

Since their invention in 1817 [2], bicycles have proven to be a healthy and environmentally friendly mode of transportation for both enthusiasts and commuters alike. Although the bicycle has remained ubiquitous over time, the world has changed dramatically. Today, US roadways are dominated by automobiles; ine cient, aggressive, modes of human transport. Unfortunately, bikers are considered second-class citizens as they attempt to share roadways with motorists [30, 3]. In fact, this has been the situation for most of the lifetime of the bicycle. In 1896, the rst automobile accident ever to occur in the U.S. took place in New York City between an automobile and a bicycle, and proved fatal for the cyclist [4]. According to a more recent report (2007) in the U.S., over 700 bicyclists die annually in accidents with automobiles, while there are over 44,000 annually reported cases of injuries due to bicycle-automobile accidents [5]. A key limiting factor for modern-day bikers is roadway safety. This is primarily due to the inherent unbalanced burden of risk that is placed on a biker during cyclist-motorist encounters. As will become evident in Section 2, existing laws and approaches towards biker safety. At best, laws proscribe remedies for incidents after-the-fact, and bicycle paths are only as good as the limited coverage they provide. Due to the unbalanced nature of the risk during cyclist-motorist encounters, a biker is forced to focus a substantial portion of her cognitive and physical capabilities on the task of maintaining situational-awareness, by continuously probing for the occurrence of rear-approaching vehicles. What is required is a preventative, biker-centric solution to the problem. In this paper, we present an approach that solves the problem by avoiding the low-level cognitive requirements from a biker to her bicycle. To support this approach, we enhance a standard bicycle with sensing and computational capabilities to create a Cyber-Physical bicycle system. The core goal of this system is to provide accurate and timely detection of rear-approaching vehicles to alert the biker of the pending encounter, through the cross-cutting application of mobile sensing, computer vision, and audio processing techniques. Our goal is to allow a bicycle to maintain situational-awareness

Literature Review

Kumar, A., Sharma, R., Smart Cyclist Accident Detection Using IoT Technology
This paper presents an IoT-based cyclist safety system for detecting accidents in real time. The study uses accelerometer sensors, GPS modules, and wireless communication technologies to identify falls and abnormal movements. Emergency alert messages are transmitted immediately to predefined contacts along with location details. The research focuses on reducing rescue response time and improving cyclist safety during emergencies. The proposed system demonstrates accurate accident detection and reliable emergency communication.

Patel, S., Verma, N., Real-Time Cyclist Monitoring and Emergency Alert System
The study discusses a smart monitoring system for cyclists using embedded systems and wireless communication modules. It explains how accelerometer and speed sensors continuously monitor cyclist activity and identify accident conditions. GPS integration is used for obtaining real-time location tracking. The paper highlights the importance of immediate emergency notifications in reducing fatalities. The research provides practical guidance for developing intelligent cyclist safety systems.

Rao, P., Gupta, H., GPS and GSM Based Accident Detection for Cyclists
This research focuses on accident detection and emergency communication for cyclists travelling in isolated areas. The system uses GPS and GSM technologies to send alert messages whenever sudden impacts or abnormal conditions are detected. The study emphasizes improving road safety and reducing delays in medical assistance. Different sensor integration techniques for accident monitoring are discussed. The paper is highly relevant for real-time cyclist protection systems.

Singh, M., Desai, R., Embedded Safety System for Bicycle Accident Prevention
The paper proposes an embedded system for monitoring cyclist safety using accelerometer sensors and alarm modules. It discusses accident identification methods based on sudden changes in acceleration and bicycle movement. Emergency warning systems and real-time monitoring techniques are explained in detail. The study highlights the importance of automated safety solutions for modern transportation systems. Practical implementation challenges and solutions are also discussed.

Li, X., Chen, Y., Wireless Communication for Smart Cyclist Safety Systems
This study examines wireless communication technologies used in cyclist safety and emergency monitoring applications. Bluetooth, GSM, and IoT communication methods are compared for transmitting accident alerts and monitoring information. The paper explains how wireless technologies improve communication efficiency and remote monitoring. Low-power communication methods and system scalability are also analyzed. The research is useful for implementing reliable cyclist monitoring systems.

Sharma, P., Mehta, S., Health Monitoring and Accident Detection for Cyclists
The research presents a cyclist monitoring system integrated with pulse sensors and accelerometer modules for health and safety monitoring. The system continuously monitors heart rate and body movement to detect abnormal conditions during cycling. Emergency alerts are generated whenever accidents or health-related emergencies occur. The paper emphasizes improving cyclist protection through intelligent health monitoring. The study provides useful insights for integrating medical monitoring into cyclist safety systems**.**

Kim, J., Park, D., Smart Transportation Safety Using IoT Sensors
This paper discusses the use of IoT sensors and embedded technologies for improving transportation safety. The proposed system continuously monitors environmental and movement conditions to identify risky situations. GPS and sensor-based tracking methods are used for real-time monitoring and emergency response. The study focuses on improving transportation reliability and public safety. The research is highly relevant for developing IoT-enabled cyclist safety solutions.
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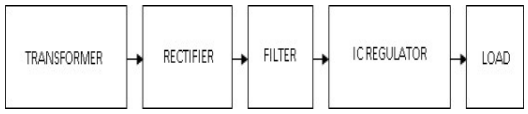
Verma, K., Arif, M., IoT-Based Emergency Notification System for Road Accidents
The paper introduces an intelligent emergency notification system for road accident victims using IoT devices and wireless communication technologies. The system automatically transmits accident alerts and location information to family members and emergency services. The researchers focused on minimizing rescue delays and improving emergency response efficiency. The study demonstrates the effectiveness of automated communication systems in transportation safety applications.

Plett, G.L., Intelligent Monitoring Techniques for Embedded Safety Systems
This research focuses on intelligent monitoring algorithms and embedded system applications for safety-critical environments. It explains methods for processing sensor data and identifying abnormal conditions in real time. Energy-efficient operation and reliable communication techniques are discussed in detail. The paper provides practical approaches for implementing smart monitoring systems in transportation and emergency applications. The study

is valuable for designing efficient cyclist safety systems.



He, H., Zhao, L., AI and Sensor-Based Accident Prediction Systems

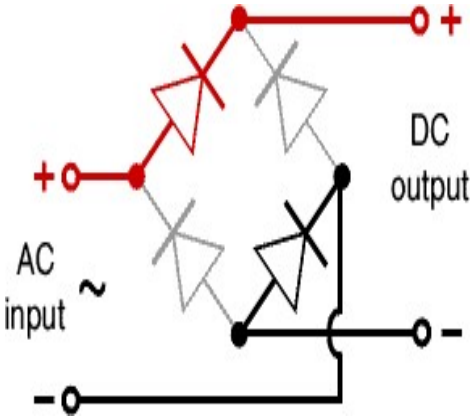
The paper explores machine learning and sensor-based approaches for predicting accidents before severe damage occurs. Historical sensor data and motion analysis techniques are used to identify dangerous movement patterns. The study highlights predictive maintenance and proactive safety measures for transportation systems. Safety improvements and reliability enhancements are discussed extensively. This research is useful for future development of intelligent cyclist accident prevention system

Existing System

Current cyclist safety systems often rely on wearable devices or bike-mounted sensors that detect sudden impacts or changes in motion. Once a fall is detected, these systems may trigger alerts to pre-set contacts or emergency services through smartphone apps or dedicated communication devices.

Proposed System

The proposed system aims to enhance cyclist safety by developing a real-time fallen cyclist detection and emergency notification system. This system will integrate sensors such as accelerometers and Speed Sensor with advanced algorithms to detect falls or crashes accurately. Upon detection, the system will automatically send emergency alerts



to designated contacts or emergency services, including GPS coordinates for precise location tracking. This proactive approach seeks to reduce response times in critical situations, improving the overall safety and well-being of cyclists on the road.

Block Diagram

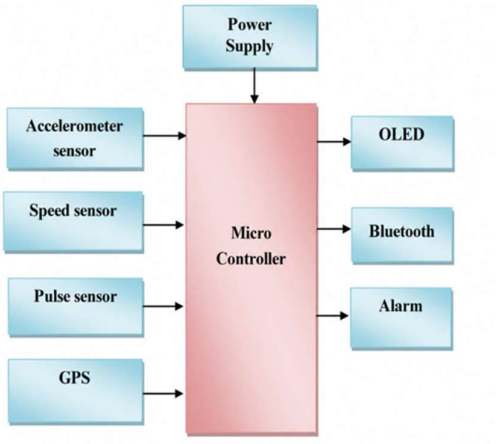


Fig 1 proposed block diagram

Power Supply:

The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. This resulting dc voltage usually has some ripple or ac voltage variation.

Bridge Rectifier:

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied.
to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.
Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.
One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

MICROCONTROLLER
ARDUINO UNO

Arduino/genuino uno is a microcontroller board based on the atmega328p (datasheet). It has 14 digital input/output pins (of which 6 can be used as

pwm outputs), 6 analog inputs, a 16 MHz quartz crystal, a usb connection, a power jack, an icsp header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a usb cable or power it with a ac-to-dc adapter or battery to get started.. You can tinker with your uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in italian and was chosen to mark the release of arduino software (ide) 1.0. The uno board and version 1.0 of arduino software (ide) were the reference versions of arduino, now evolved to newer releases. The uno board is the first in a series of usb arduino boards, and the reference model for the arduino platform; for an extensive list of current, past or outdated boards see the arduino index of boards.

Fig2: Arduino module

OLED Display:

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight). OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even rollable and stretchable in the future. OLEDs represent the future of display technology.

An OLED display have the following advantages over an LCD display:

>Improved image quality - better contrast, higher brightness, fuller viewing angle, a wider colour range and much faster refresh rates.

>Lower power consumption.

>Simpler design that enables ultra-thin, flexible foldable and transparent Better durability - OLEDs are very durable and can operate in a broader temperature range.

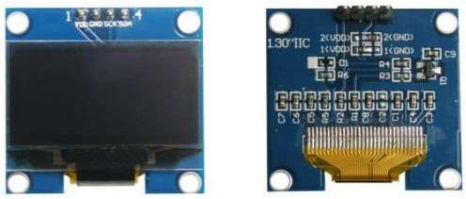
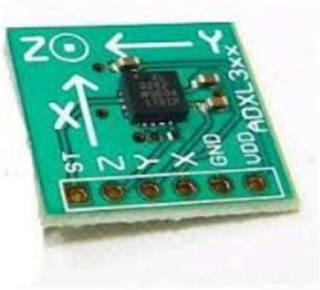


Fig3: OLED Display

MEMS SENSOR

An accelerometer is a micro-electromechanical device that measures acceleration forces. These forces may be static, like the constant force of gravity pulling at our feet, or they could be dynamic - caused by moving or vibrating the accelerometer. There are many types of accelerometers developed and reported in the literature. The vast majority is based on piezoelectric crystals, but they are too big and too clumsy. People tried to develop something smaller, that could increase applicability and started searching in the field of microelectronics. They developed MEMS (micro electromechanical systems) accelerometers.



HEART RATE USING PULSE SENSOR

The Pulse Sensor is a well-designed low-power plug-and-play heart-rate sensor for the Arduino. Anyone who wants to incorporate real-time heart-rate data into their work—students, artists, athletes, makers, and game and mobile developers—can benefit from it.

The best part is that this sensor plugs right into Arduino and easily clips onto a fingertip or earlobe. It is also super small (button-shaped) and has holes for sewing into fabric enclosed in a stainless-steel mesh.

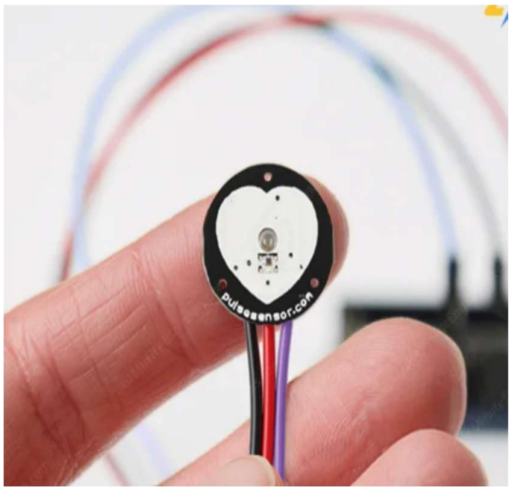


Fig4: pulse sensor

GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a satellite based navigation system that can be used to locate positions anywhere on earth. Designed and operated by the U.S. Department of Defense, it consists of satellites, control and monitor stations, and receivers. GPS receivers take information transmitted from the satellites and uses triangulation to calculate a user's exact location. GPS is used on incidents in a variety of ways, such as:

Fig. 5: GPS Module

BLUETOOTH

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices and building personal area networks (PANs). In 1994 a group of engineers at Ericsson, a Swedish company, invented a wireless communication technology, later called Bluetooth. In 1998, the original group of Promoter companies—Ericsson, Intel, Nokia, Toshiba and IBM—came together to form the Bluetooth Special Interest Group (SIG).

Bluetooth networking transmits data via low-power radio waves. It communicates on a frequency of 2.45 gigahertz (actually between 2.402 GHz and 2.480 GHz, to be exact). This frequency band has been set aside by international agreement for the use of industrial, scientific and medical devices (ISM). By comparison, the most powerful cell phones can transmit a signal of 3 watts. The low power limits the range of a Bluetooth device to about 10 meters (32 feet), cutting the chances of interference between your computer system and your portable telephone or television

BUZZER

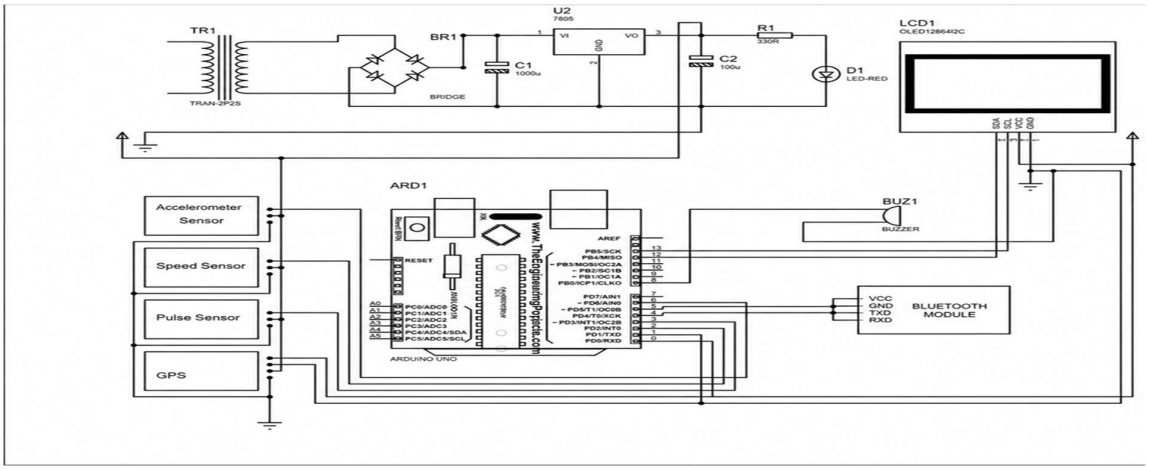
A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the

appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

Fig. 6: Bluethooth

SCHEMATIC DIAGRAM :



RESULTS:

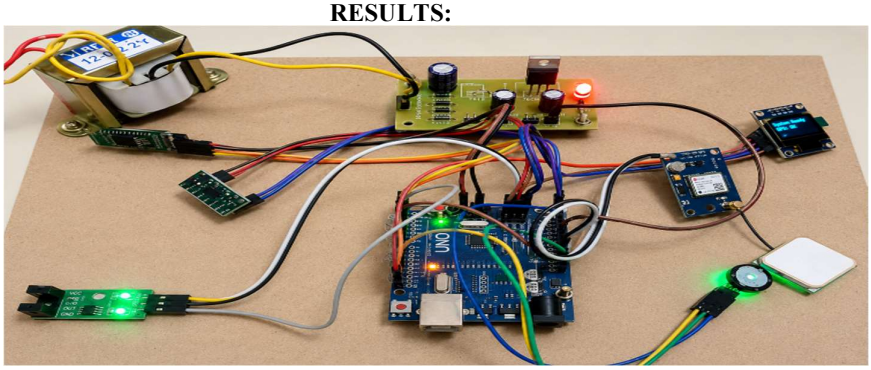


Figure 7: Hardware kit

OUTPUT:

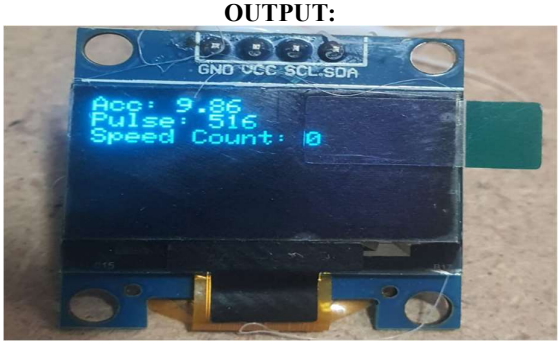


Figure 8 : OLED Display

CONCLUSION:

We introduced the Cyber-Physical bicycle, a system that augments every-day bicycles with video and audio sensors, to perform automated rear-approaching vehicle detection. The purpose of this system is to directly improve the safety of bikers, as they travel on roadways by reducing the cognitive overheads presently associated with roadway bicycle riding. To the best of our knowledge, our system is the rst (i) to apply video and audio-based sensing techniques to bicycles on roadways, (ii) to apply advanced video and audio processing techniques to perform automated vehicle detection from a bicycle, and (iii) to propose novel computer vision techniques applied to the specific domain of biker safety. The experimental evaluation of our prototype Cyber-Physical bicycle system demonstrates the feasibility of this system, which is able to perform real-time rear-vehicle detection from a bicycle with high accuracy. Finally, we presented a number of future directions for this work, which further supports breadth and importance of this problem domain.

ABBREVIATIONS :

- IoT – Internet of Things
- OLED – Organic Light Emitting Diode
- UV – Ultraviolet

- VOC – Volatile Organic Compounds

FUTURE SCOPE :

The proposed "Enhancing Cyclist Safety: Real-Time Fallen Cyclist Detection and Emergency Notification System" has great potential for future development in smart transportation and safety applications. In the future, this system can be integrated with Artificial Intelligence (AI) to improve accident prediction and reduce false detection. Advanced sensors can be added for accurate monitoring of cyclist movement, health conditions, and surrounding road conditions in real time. The emergency alert system can be enhanced with automatic notifications to hospitals, ambulance services, and nearby rescue teams. Integration with IoT and cloud platforms can enable real-time data storage and remote monitoring through mobile applications. Smart helmets and wearable devices can also be connected to improve cyclist safety and

health monitoring. The system can further support voice alerts, live tracking, and camera-based accident recording features. Solar-powered charging systems may also be implemented for better energy efficiency and continuous operation. Overall, this project can contribute towards safer, smarter, and more reliable cyclist protection systems in the future.

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