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ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

Ai based smart bike & helmet using image processing and speed based helmet enforcement

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ABSTRACT

The AI-Based Smart Helmet is an intelligent safety system designed for motorcyclists to enhance road safety and real-time accident response. The helmet integrates various sensors and modules—including GPS, camera, vibration sensor, speed switch, and DC motor—connected to a Raspberry Pi programmed using Python. It monitors rider activity, detects accidents, and triggers immediate safety actions. Upon detecting an abnormal event such as a fall or overspeeding, the system activates a buzzer, displays alerts on an LCD monitor, and transmits data via IoT to emergency contacts or authorities. The camera captures real-time footage, while GPS provides precise location tracking. A regulated power supply ensures stable operation. This compact, AI-enhanced system aims to reduce fatalities by providing timely alerts and automated responses during critical situations. Its modular design allows for scalable features and can be integrated into smart city infrastructure for broader safety applications.

Keywords: AI-based Smart Bike, Helmet Detection, Image Processing, Real-time Safety System, IoT Integration

1. INTRODUCTION

In the developing countries like India, the motorcycle riders are increasing day-by-day, wherein it also constitutes to the unprecedented increase in the number of motorcycle accidents across the country. To overcome this drawback, the proposed research work explains and demonstrates a method to enforce better safety protocols through the automatic detection of motorcyclists with and without a safety helmet by using a real-time traffic surveillance footage. The real-time automatic detection of motorcyclists with and without a safety helmet is estlished through detecting a vehicle and track pipelining it with OpenCV, sklearn, utilizing a descriptor known as the histogram of oriented gradients (HOG), and support vector classification (SVC), which are the combination of tools pertaining to machine learning and image processing mechanisms. With OpenCV Library method, a bike rider is identified in the surveillance video. Further by using a popular machine learning algorithm model called LinearSVC, the classifier label identifies whether the rider is wearing a safety helmet. The data attained in correspondence to the count of bikeriders with and without safety helmet is stored in MySQLdatabase with respective timestamps and is also visualizedthrough tabular and graphical views in the developed desktop interface application. With 87.6% model accuracy, our paperproposes a solution to enhance the existing safety measures and provide a time-efficient approach to handle traffic regulations This proposal aims at the security and safety of motorcyclist against road accident while also providing them with a luxurious comfortable two wheeler experience. Each smart vehicle has built in a circuit and various functions. The circuit of each vehicle is designed in such a manner that the bike won't start unless the rider wears the helmet .The

camera installed on the bike will capture the rider wearing the helmet or not. In the case of failure, it transmits strike to the server. such three strikes will indeed disengage The motor service for the motorcyclist. Intelligent System for Helmet Detection using Raspberry Pi ensures helmet possession by a motorcyclist at all times by capturing a snapshot of the rider's helmet using Pi Camera and confirming object detection by Haar cascading technique.The main idea behind the project is to reduce road fatalities among motorcyclists. Due to ignorance of riders for the Helmet compulsion law, every motorcyclist's safety has been compromised. Intelligent System for Helmet Detection solves this problem by leaving the rider no choice as the engine of the vehicle is operated through a single channel relay which is only closed after detection of the rider's helmet. An interactive LED display will alert the rider if the helmet is not detected after which the rider needs to ensure the possession of a helmet or else the System will display a warning message which will earn the rider a strike if it is ignored. Three such strikes will lead to the RTO server penalizing the rider for breaking the law.

2. LITERATURE SURVEY

Two-wheelers, the mode of transport most Indians use, continue to be the most vulnerable to accidents. Indian roads were at their deadliest in 2014 claiming more than 16 lives every hour on average. Over 1.41 lakh people died in crashes, 3% more than the number of fatalities in 2013. Accidents involving two-wheelers and accounted for nearly half of the lives lost in road crashes. While 13,787 twowheeler drivers were killed in crashes, 23,529 other people were killed in accidents involving these vehicles, while close to 1.4 lakh people were left injured in them. The top five states - Uttar Pradesh, Tamil Nadu, Maharashtra, Karnataka and Rajasthan - accounted for over 40% of the fatalities. Among 53 mega cities, Delhi registered the highest number of fatalities at 2,199 and Chennai recorded 1,046 such deaths. Bhopal and Jaipur ranked third and fourth with the city roads claiming 1,015 and 844 lives respectively[1, 2]. A motorcycle's helmet is a type of protective headgear used by the motorcyclist. The main purpose is for safety, which is to protect the rider's head from the impact during an accident. It protects the rider's head as the helmet provides ventilation system. Speeding and not wearing a helmet are the main reasons of fatalities and injuries. Here we are implementing a model which uses DC Motor, Relay and Raspberry Pi which in real time system is related to the ignition system of the Motorcycle. The system automatically detects motorcycle riders and determines that they are wearing safety helmets or not. The system extracts moving objects and classifies them as a motorcycle or other moving objects based on features extracted from their region properties using K-Nearest Neighbour (KNN) classifier. The heads of the riders on the recognized motorcycle are then counted and segmented based on projection profiling. The system classifies the head as wearing a helmet or not using KNN based on features derived from 4 sections of segmented head region. Experiment results show an average correct detection rate for near lane, far lane, and both lanes as 84%, 68%, and 74%, respectively [3]. The helmet is the main safety equipment of motorcyclists, but many drivers do not use it. If an motorcyclist is without helmet an accident can be fatal. This paper aims to explain and illustrate an automatic method for motorcycles detection and classification on public roads and a system for automatic detection of motorcyclists without helmet. For this, a hybrid descriptor for features extraction is proposed based in Local Binary Pattern, Histograms of Oriented Gradients and the Hough Transform descriptors. Traffic images captured by cameras were used [4]. It is known that head gesture and brain activity can reflect some human behaviours related to a risk of accident when using machine-tools. The research presented in this paper aims at reducing the risk of injury and thus increase worker safety. Instead of using camera, this paper presents a Smart Safety Helmet (SSH) in order to track the head gestures and the brain activity of the worker to recognize anomalous behavior. Information extracted from SSH is used for computing risk of an accident (a safety level) for preventing and reducing injuries or accidents. The

SSH system is an inexpensive, non-intrusive, non- invasive, and non-vision-based system, which consists of an Inertial Measurement Unit (IMU) and dry EEG electrodes. A heptic device, such as vibrotactile motor, is integrated to the helmet in order to alert the operator when computed risk level (fatigue, high stress or error) reaches a threshold. Once the risk level of accident breaks the threshold, a signal will be sent wirelessly to stop the relevant machine tool or process[5]. A smart helmet is a special idea which makes motorcycle driving safer than before. This is implemented using GSM and GPS technology. The working of this smart helmet is very simple, vibration sensors are placed in different places of helmet where the probability of hitting is more which are connected to microcontroller board. So when the rider crashes and the helmet hit the ground, these sensors sense and gives to the microcontroller board, then controller extract GPS data using the GPS module that is interfaced to it. When the data exceeds minimum stress limit then GSM module automatically sends message to ambulance or family members[6]. This project is specially developed as to improve the safety of the motorcycle's rider. Motorcyclist will be alarmed when the speed limit is exceeded. A Force Sensing Resistor (FSR) and BLDC Fan are used for detection of the rider's head and detection of motorcycle's speed respectively. A 315 MHz Radio Frequency Module as wireless link which able to communicate between transmitter circuit and receiver circuit. PIC16F84a is a microcontroller to control the entire component in the system. Only when the rider buckled the helmet then only the motorcycle's engine will start. A LED will flash if the motor speed exceeds 100 km/hour[7]. Intelligent Safety Helmet for Motorcyclist is a project undertaken to increase the rate of road safety among motorcyclists. The idea is obtained after knowing that the increasing number of fatal road accidents over the years is cause for concern among motorcyclists. Through the study identified, it is caused the helmets used is not in safety features such as not wearing a helmet string and not use the appropriate size. Therefore, this project is designed to introduce security systems for the motorcyclist to wear the helmet properly. With the use of RF transmitter and RF receiver circuit, the motorcycle can move if there is emission signal from the helmet, in accordance with the project title Intelligent Safety Helmet for Motorcyclist. Security system applied in this project meet the characteristics of a perfect rider and the application should be highlighted. The project is expected to improve safety and reduce accidents, especially fatal to the motorcyclist[8].

3. PROPOSED SYSTEM

The proposed AI-Based Smart Helmet integrates intelligent modules including GPS, camera, vibration sensors, speed switch, and Raspberry Pi controlled via Python. This system detects real-time anomalies such as falls or overspeeding, and responds by triggering buzzers, displaying messages on an LCD, and sending alerts via IoT. The camera captures the scenario while GPS provides precise location tracking for rapid rescue. This smart approach ensures prompt action and significantly enhances rider safety and accident response efficiency.

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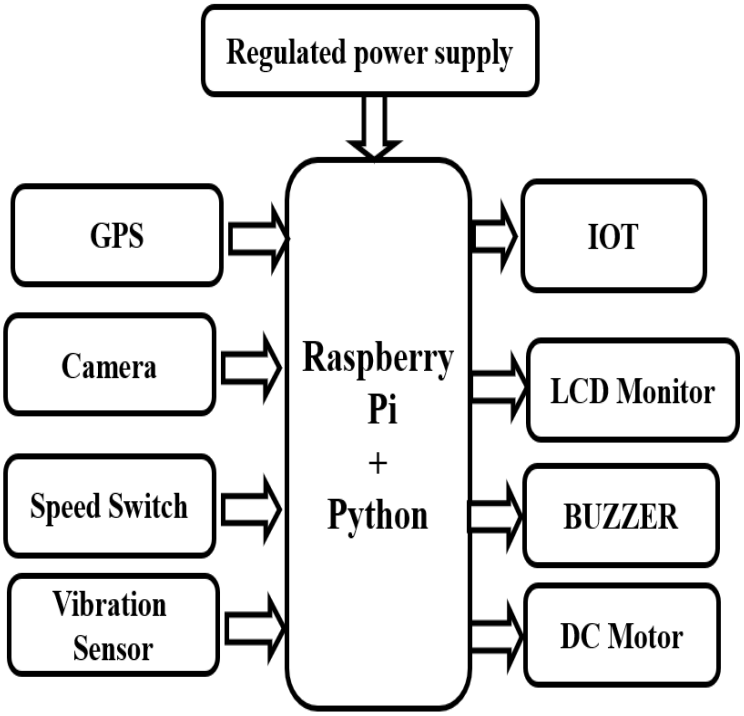

Fig.1.Block diagram

Working of the Project:

The AI-Based Smart Helmet operates using a Raspberry Pi as the central processing unit, programmed in Python. The system is powered through a regulated power supply to ensure stable voltage to all connected components. The system is designed as a smart safety solution for two-wheeler riders, integrating multiple input, processing, and output components to monitor and respond to potentially dangerous situations. The input units include a GPS module, which continuously tracks the rider's location and communicates it to a Raspberry Pi; in the event of an accident, the location is sent via IoT to emergency contacts or services. A camera captures live footage during travel, which can be stored or transmitted for review in case of incidents. A speed switch monitors the vehicle's speed and triggers alerts if it exceeds predefined safety limits, helping to prevent reckless driving. Additionally, a vibration sensor detects sudden crash-like movements, and if an abnormal vibration pattern is recognized—such as one consistent with an accident—it activates emergency response protocols. At the heart of the system lies the Raspberry Pi, serving as the processing unit. It receives input from all the connected modules and processes this data in real-time using Python-based logic. This allows the system to identify anomalies such as collisions, sudden halts, or over-speeding events, and make decisions accordingly. The output units respond to these detections to ensure safety and emergency response. A buzzer sounds an alarm to alert nearby people of a potential accident or hazard. An LCD monitor provides visual feedback by displaying real-time data like speed, GPS coordinates, and alerts. A DC motor may be used to simulate features

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ISSN 2249-3352 (P) 2278-0505 (E)
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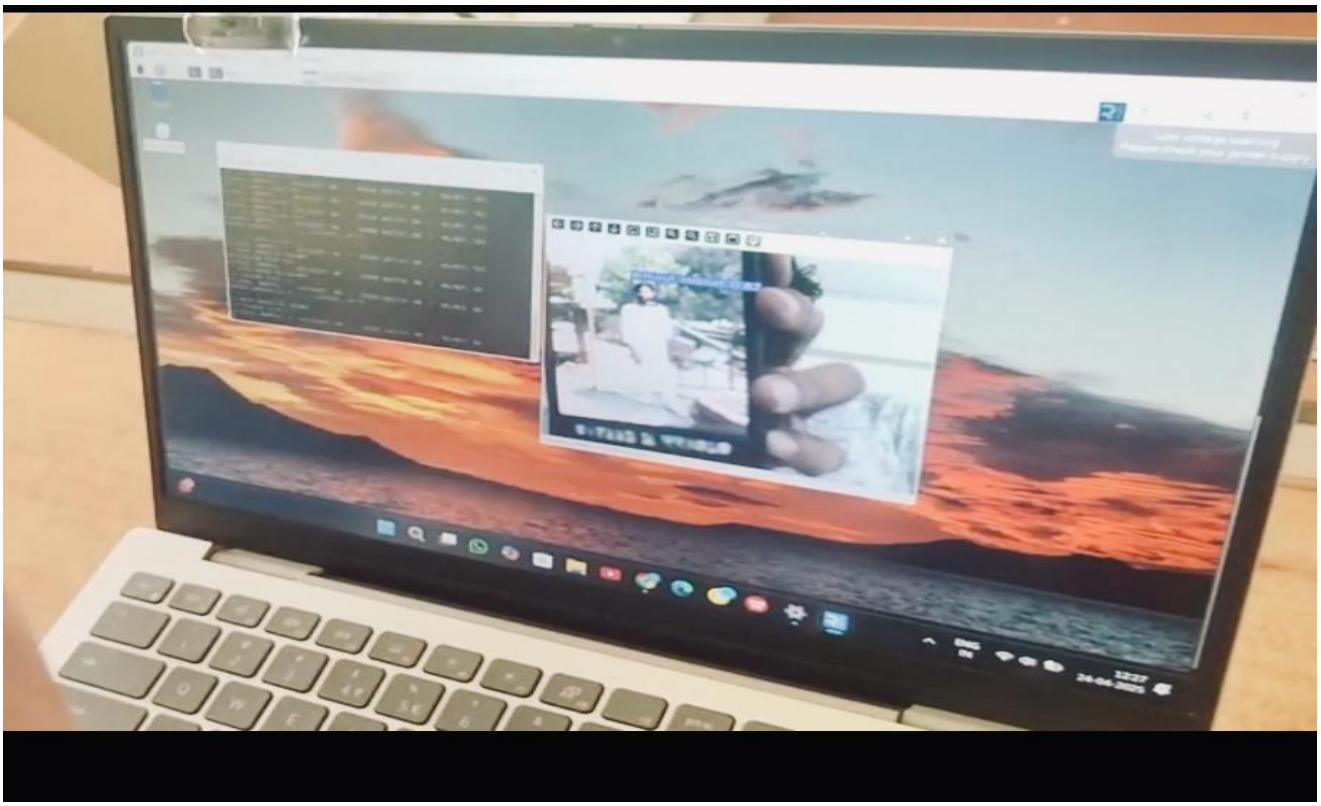
like engine locking or to enable helmet-integrated functionalities such as visor adjustment. Lastly, the IoT module plays a critical role in transmitting real-time alerts and GPS data to designated emergency contacts, ensuring timely assistance when needed. This integrated system thus offers a proactive and responsive solution for enhancing road safety. The integration of these modules creates a real-time monitoring and safety mechanism that enhances the protection and response capabilities for motorcyclists.

4. RESULTS



5. CONCLUSION

The AI-Based Smart Helmet project successfully demonstrates an intelligent, real-time safety system for motorcyclists by integrating sensors, a camera, GPS, and IoT technology with a Raspberry Pi. It effectively detects critical situations like accidents, over speeding, and vibrations, and responds instantly with alerts through a buzzer, display messages, and location sharing via IoT. This proactive approach significantly enhances rider safety by ensuring timely assistance during emergencies. The system showcases how embedded technology and AI can be combined to build innovative solutions for road safety and accident prevention.

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