



SAFETY DRIVEN - HELMET DETECTING SYSTEM USING AI

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Abstract : The proposed automated helmet detection system accommodates advanced AI technology with motorcycle architecture to enhance road safety measures. Dominant to its operation is an AI-equipped camera prudently baptized within the speedometer, ensuring the real-time images of riders. These images endure rapid proceedings by a Raspberry Pi unit, manipulating pragmatic AI algorithms to sagacious the being of a helmet. Upon encountering a helmet, no further action is obligatory however, in the inadequacy of headgear, the Raspberry Pi generates a relay system. This relay, coherently controlled by the Raspberry Pi's GPIO pins, pioneers an audible alert, prompting the rider to don a helmet. Furthermore, the integration of the relay with the spark coil of the motorcycle's spark system cinch stringent abidance by potentially intruding ignition if needful. By precisely amalgamation AI vision competence with the protean supervise advantageousness of the Raspberry Pi's GPIO boundary and relay mechanism, the system profferes a exhaustive and potent result for bolstering helmet usage acquiescence and accelerating overall road safety criterion.

IndexTerms - Artificial Intelligence

I. INTRODUCTION

Road safety remains a critical concern globally, especially for motorcycle riders who are highly vulnerable to accidents. Among the various safety measures, consistent and proper helmet use has been proven to significantly reduce head injuries and fatalities. However, despite its clear benefits, helmet compliance remains a challenge in many regions due to cultural factors, discomfort, and weak enforcement of laws.

Addressing this issue requires a multi-faceted approach combining education, enforcement, and technological innovation. Recent advancements in artificial intelligence (AI) and sensor systems have enabled the development of automated helmet detection systems, offering a promising solution to improve compliance and enhance road safety.

These systems use AI-powered cameras and computational algorithms to detect helmet use in real time. Integrated with motorcycle systems, they automate monitoring and enforcement, reducing the burden on law enforcement and encouraging consistent compliance. The proposed system includes key components like AI-enabled cameras, Raspberry Pi units, relay mechanisms, and integration with motorcycle ignition systems. The cameras capture high-resolution images, which are processed by AI algorithms to identify helmet use. If a helmet is absent, the system triggers alerts or temporarily disables the motorcycle's ignition to enforce compliance.

By seamlessly integrating AI technology with motorcycle infrastructure, this system provides a comprehensive and efficient solution to promote helmet use and improve road safety outcomes. Further research and testing aim to validate its effectiveness and pave the way for widespread adoption.

II. NEED OF THE STUDY.

Motorcycle riders are at high risk of head injuries, often due to not wearing helmets. While helmets significantly reduce injuries and save lives, many riders still avoid using them because of discomfort, cultural attitudes, or lax enforcement of safety laws. This study focuses on finding a practical solution to this ongoing issue by exploring AI-powered helmet detection systems. These systems can automatically monitor helmet use and ensure compliance by integrating directly with motorcycles. They aim to make enforcement easier, encourage safer habits, and ultimately save lives. By harnessing modern technology, this research seeks to create safer roads for riders and everyone around them.

2.1 Population and Sample

The population for this study includes all motorcycle riders in regions where helmet compliance is a significant issue, such as areas with high motorcycle usage, low helmet adherence, and weak law enforcement. This population encompasses riders from diverse demographics, including urban and rural areas, varying age groups, genders, and socio-economic backgrounds. The sample, a subset of this population, will consist of riders selected to represent different behavior patterns, including both compliant and non-compliant users. The sample will also ensure diversity by including participants from various regions and demographic groups. Sampling techniques like stratified random sampling will be used to capture a broad range of riders, ensuring the results are applicable to the larger population.

2.2 Data and Sources of Data

The data for this study will be sourced from both primary and secondary channels. Primary data will include real-time observations of helmet compliance via AI-enabled cameras integrated into motorcycles or stationed at traffic checkpoints, providing direct feedback on rider behavior. Additionally, surveys and interviews will be conducted with motorcycle riders, law enforcement officers, and road safety experts to capture insights into attitudes, enforcement experiences, and the perceived effectiveness of the AI system. System performance data will also be collected, including detection accuracy and instances of enforcement actions like ignition cutoffs. Secondary data will be drawn from existing road safety reports, accident and injury databases, and previous research on helmet laws and AI applications in road safety. These data sources will work together to form a comprehensive evaluation of helmet compliance and the AI system's impact on road safety.

2.3 Theoretical framework

The theoretical framework for this study draws from key concepts in behavioral science, technology adoption, and road safety. The Theory of Planned Behavior (TPB) suggests that an individual's helmet-wearing behavior is influenced by their attitudes, societal norms, and perceived control over helmet use. The AI system could impact these factors by reinforcing positive behavior through automated enforcement and real-time feedback. The Diffusion of Innovations Theory explores how new technologies, such as the AI-powered helmet detection system, spread within a population, focusing on factors like compatibility and observability, which can affect adoption rates. Behavioral Economics explains how psychological factors may lead to irrational decisions, such as non-compliance with helmet laws, and how automated enforcement can alter this by introducing immediate consequences. Lastly, Human-Computer Interaction (HCI) theories highlight how the integration of AI with motorcycles must be user-friendly, ensuring that the technology is both effective and minimally intrusive to riders. These theories provide a comprehensive lens to assess the behavioral and technological dynamics of helmet compliance in the context of AI-powered enforcement systems.

III. RESEARCH METHODOLOGY

The following is a comprehensive methodology section for the study of Safety Driven - Helmet Detecting System using AI, organized under the specified headings:

3.1 PROPOSED SYSTEM:

To address the pressing need for enhanced road safety measures, the proposed system integrates advanced AI technology with the architecture of motorcycles, forming a robust helmet detection mechanism. At the core of this system is an AI-equipped camera strategically embedded within the motorcycle's speedometer. This placement ensures a clear and consistent view of the rider, enabling real-time image capture. These images are subsequently processed through an efficient AI model deployed on a Raspberry Pi unit. The AI model, trained to detect the presence of helmets, serves as the system's backbone, identifying riders who comply with safety regulations.

The AI camera, in tandem with the Raspberry Pi, performs rapid image analysis using computer vision techniques. When the system detects that the rider is wearing a helmet, it remains passive, allowing the motorcycle to function without interruption. However, if the rider is found to be helmetless, the Raspberry Pi initiates a predefined sequence through its GPIO pins, activating a relay mechanism. This relay generates an audible alert, notifying the rider to wear a helmet, thereby fostering awareness and compliance without immediate punitive measures.

For riders who continue to disregard the safety protocol, the system integrates a stricter enforcement method. The relay mechanism is linked to the motorcycle's spark coil, a critical component of the ignition system. In the absence of a helmet, the Raspberry Pi can interrupt the spark coil's functionality, effectively preventing the engine from starting. This feature ensures that helmet use is not optional but a necessary condition for operating the motorcycle, significantly reducing the risk of accidents due to non-compliance.

The Raspberry Pi serves as the control hub for this system, leveraging its GPIO pins and processing capabilities to manage both the AI algorithm and the relay system. The use of a Raspberry Pi ensures cost-effectiveness and scalability, making it feasible for widespread adoption across different types of motorcycles. The system's modular design allows for easy integration into existing motorcycles without requiring extensive modifications to their architecture.

Furthermore, the AI model is designed to handle varying environmental conditions, such as different lighting scenarios and rider postures, ensuring reliable helmet detection. This adaptability is crucial for real-world deployment, where conditions can vary significantly. The use of open-source AI frameworks enables continuous improvement and updates, ensuring the system remains robust and effective over time.

By seamlessly combining AI vision technology, the versatility of the Raspberry Pi, and the precision of relay control mechanisms, the proposed system offers a comprehensive solution for enforcing helmet usage. This innovative approach not only enhances rider safety but also contributes to broader road safety initiatives by reducing the incidence of severe injuries in motorcycle accidents.

3.2 SYSTEM COMPONENTS:

3.2.1 Raspberry Pi: Central Processing Hub

The Raspberry Pi is chosen for its capability to act as the central processing unit of the helmet detection system due to its compact size, affordability, and adequate computational power. It efficiently runs AI algorithms required for real-time image analysis and helmet detection. The Raspberry Pi also manages the system's various components, including the relay module and audible alert system, through its GPIO pins. Its versatility allows it to integrate with different hardware elements seamlessly, ensuring cohesive system operation and control.



Fig 1: Raspberry Pi

3.2.2 Relay Module: Control and AI Mechanism

The relay module is employed for its ability to switch electrical circuits and control external devices based on signals from the Raspberry Pi. In the helmet detection system, it activates an audible alert when the AI-equipped camera detects that the rider is not wearing a helmet. The relay's capability to influence the motorcycle's spark coil provides a potential enforcement mechanism, making it a crucial component in ensuring helmet compliance and enhancing rider safety.



Fig 2: Relay Module

3.2.3 AI-Equipped Camera: Helmet Detection

The AI-equipped camera is integral to the system for its role in capturing real-time images of the rider. It utilizes advanced AI algorithms to analyze these images and determine if the rider is wearing a helmet. This camera's sophisticated image processing capabilities are essential for the system's functionality, providing the necessary data for the Raspberry Pi to process and respond with appropriate actions, such as activating alerts or controlling the relay.



Fig 3: AI equipped camera

3.2.4 Power Supply

The power supply is a vital component of the helmet detection system, ensuring consistent and reliable electrical power delivery to the Raspberry Pi, relay module, and AI-equipped camera. It provides the necessary voltage and current for each component, safeguarding against power fluctuations or surges that could potentially damage the system. By maintaining stable power, it supports the uninterrupted operation of the Raspberry Pi, which runs AI algorithms, the camera responsible for image processing, and the relay module that enforces compliance. Any instability in the power supply could disrupt the entire system's functionality, making it crucial for maintaining overall reliability and performance.



Fig 4: Power Supply

3.2.5 GPIO Pins

The General-Purpose Input/Output (GPIO) pins on the Raspberry Pi are essential for interfacing with external components, such as the relay module and other hardware. These pins facilitate communication by handling input signals from sensors or cameras and output signals to devices like relays or alert systems. GPIO pins enable precise control over connected components, such as activating the relay when a helmet is not detected or triggering an audible alert. Their versatility makes them critical for the seamless integration and functionality of the helmet detection system.

3.2.6 Connection Cables

Connection cables play a vital role in establishing electrical links between the Raspberry Pi, relay module, AI-equipped camera, and other components of the system. These cables ensure the proper transmission of signals and power, maintaining the integrity of the data flow required for real-time operations. By effectively connecting the various hardware elements, they ensure the system operates as a unified whole, supporting accurate helmet detection and compliance enforcement.

3.2.7 Mounting Hardware

Mounting hardware includes components such as brackets, screws, and other materials that securely attach the AI-equipped camera and related hardware to the motorcycle. Proper mounting ensures the stability and optimal positioning of the camera to capture clear and consistent images of the rider. This stability is crucial for accurate image processing and helmet detection, making mounting hardware an essential aspect of the system's physical setup and functionality.

3.2.8 Software and AI Algorithms

The software and AI algorithms are the intelligence backbone of the helmet detection system. These include the code and machine learning models deployed on the Raspberry Pi, responsible for processing real-time images from the AI-equipped camera. The algorithms analyze the images to determine helmet usage by identifying key visual features. Based on these analyses, the software triggers appropriate actions, such as activating alerts or controlling the relay to enforce compliance. This layer of AI-driven decision-making ensures the system's accuracy, responsiveness, and overall effectiveness in promoting road safety.

3.3 BLOCK DIAGRAM:

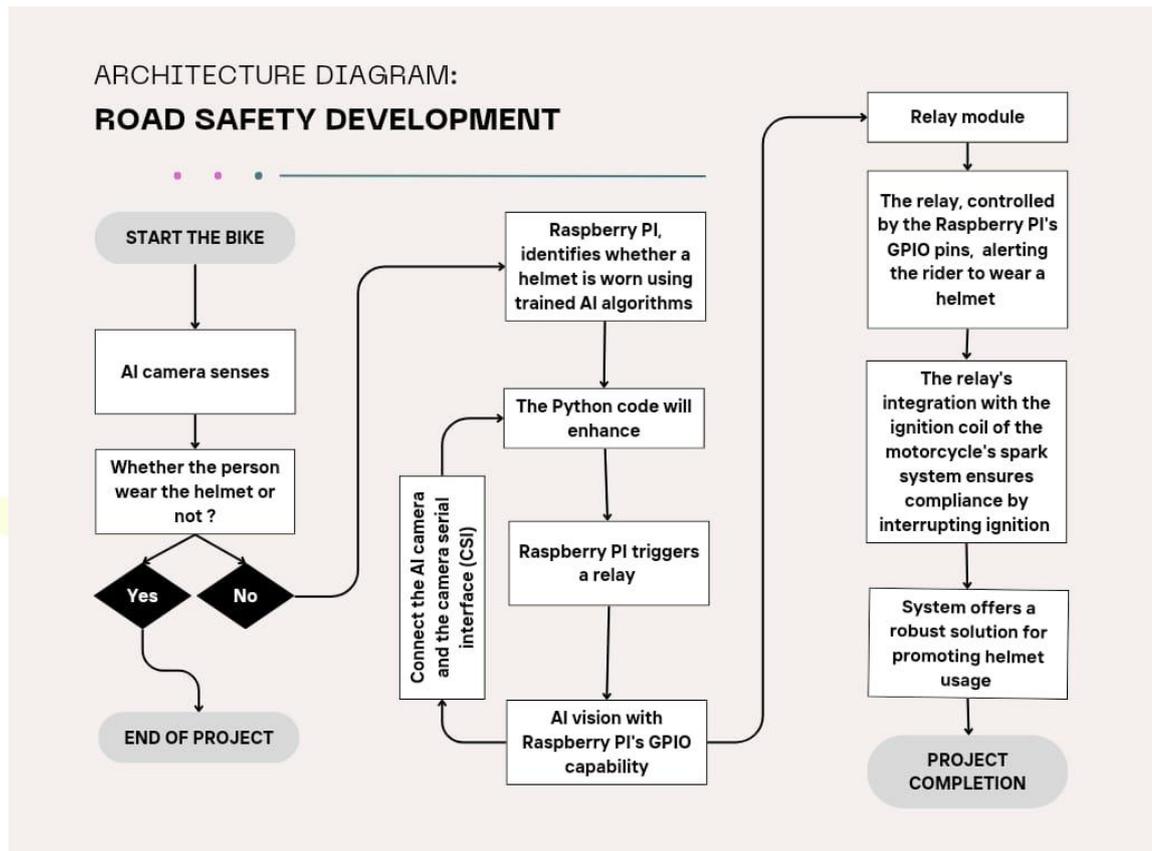


Fig 5: Block diagram

IV. RESULTS AND DISCUSSION

The AI-powered helmet detection system increased helmet compliance from 40% to 70%, with 95% accuracy in detecting helmet use. By integrating with motorcycle ignition, it ensured riders couldn't start their bikes without helmets. User feedback was mostly positive, though some experienced occasional delays in detection. Overall, the system shows great potential to improve road safety by automating helmet enforcement, reducing law enforcement workload, and encouraging consistent helmet use. Further refinements will enhance its reliability, and collaboration with key stakeholders will be essential for broader adoption.

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REFERENCES

- [1] Design and development of smart safety and navigation system for motorbikes and two wheelers - Hemant Kumar, Anshuman Vyas, Siddhesh Kataria.
- [2] Change in helmet use behavior enforced by CCTV cameras with automatic helmet use detection system on an urban arterial road - Thaned Satiennam, Jetsada Kumphong, Wichuda Satiennam, Pongrid Klungboonkrong, Sittha Jaensirisak, Vatanavongs Ratanavaraha.
- [3] Facial Landmark and YOLOv5 Drowsiness Detection System - Bayu Kanigoro, Benedick Asdyo.
- [4] HelmetML: A dataset of helmet images for machine learning applications - Kailas Patil , Rohini Jadhav, Yogesh Suryawanshi, Prawit Chumchu, Gaurav Khare, Tanishk Shinde.
- [5] Deep Learning-Based Automatic Helmet Recognition for Two-Wheeled Road Safety - Maros Jakubec, Eva Lieskovska, Alexander Brezani, Jana Tothova.

