ICIMIA

3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA - 2023)

21-23, December 2023 | Bengaluru, India

Proceedings

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IEEE XPLORE COMPLIANT ISBN: 979-8-3503-4363-2

IEEE DVD ISBN: 979-8-3503-4362-5

Organized by

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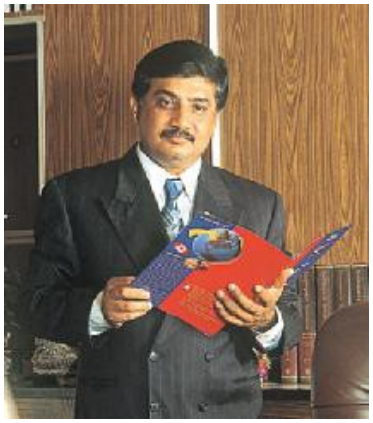
Message from the Joint Secretary



Dr. D. Hemachandra Sagar

I would like to wholeheartedly welcome everyone to the 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA-2023), which is technically sponsored by IEEE, Bangalore Section. This is going to be a truly exciting conference and I am sure you all are looking forward to the proceedings of this conference. We at DSCE value and encourage research and innovations and it gives me utmost happiness that this conference is organized and hosted by us. I wish all the participants a good time at DSCE and wish the conference a grand success.

Message from the Executive Director

Sri. Galiswamy

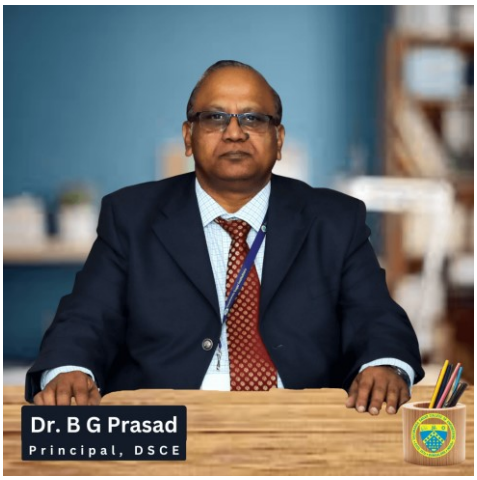
It is my pleasure and privilege to welcome you all on Third series of the IEEE International Conference on Innovative Mechanisms for Industry Application (ICIMIA-2023). We as an institution are elated to host this conference, which will be a platform for sharing knowledge, experience and innovative ideas. I am sure that this conference will act as a foundation to some great advancement in science and technology. I wish the Conference a grand success.

Message from the Vice Chairman

Dr. D. Premachandra Sagar

I heartily welcome all the participants and delegates to the 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA-2023). I am sure, ICIMIA-2023 will give a common platform and opportunity to students and young researchers to meet and discuss with experts in their area of research. I hope that the conference will motivate young minds to think innovatively and be the catalyst for ideas leading to success in research and coming up with innovative products. Wish you all a happy interaction.

Message from the Principal



Dr. B G Prasad

It is my pleasure to welcome you all to IEEE technically co-sponsored 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA-2023), which is being held at Dayananda Sagar College of Engineering, Bengaluru. I envisage that ICIMIA 2023 will provide a platform for discussion and sharing of innovative ideas and technology solutions from leading and upcoming researchers. This conference covers research fields such as Industrial Internet of Things, Artificial Intelligence and other emerging trends that relates to Innovative Mechanisms for Industrial needs. I wish all the participants a great experience and hope you all take back a lot of learning and inspiration.

Message from the General Chair

Dr. Suma V

I heartily welcome all the delegates, participants and guests to the 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA-2023) which is technically sponsored by IEEE Bangalore section. The main motive of this conference is to provide all the researchers, industrialists and academia a common platform on a global level to share their ideas with each other. I am confident that at the end of this conference a great knowledge base will be created.

I hope you will enjoy the conference and the interactions with your colleagues and other presenters here. The Conference will prove beneficial and also increase the innovative spirit in you. Let us look forward to a brilliant conference. I wish all the presenters a very good experience at ICIMIA 2023 and I hope you have a great time here.

3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2023)

21 - 23 December, 2023

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3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2023)
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Helmet Detection and Number Plate Recognition using YOLOv3 in Real-Time

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Abstract— **Motorcycles have traditionally served as the primary mode of transportation in various countries across the globe. However, there has been a rise in motorcycle-related incidents resulting in harm or fatalities over time. Inadequate head protection remains one of the primary factors leading to lethal outcomes resulting from such incidents. This research endeavours to tackle the issue by designing a system capable of identifying motorcyclists who are not wearing helmets instantly. The proposed system aims to facilitate the use of helmets among motorcycle riders in real-time, helping reduce fatalities due to head injuries, which are a major concern in many countries. Additionally, the system also includes a method for real-time number plate detection and recognition, which has numerous good significances in law enforcement and surveillance. This helps the officers to keep on the people who violate traffic rules and regulations, ensuring their safety as well as that of pedestrians. The system utilizes state-of-the-art deep learning algorithms, such as YOLOv3, to achieve real-time helmet-wearing detection with unparalleled speed and accuracy of 99%.**

Keywords—Helmets, License Plate, Surveillance

I. INTRODUCTION

In current years, there has been a tremendous surge in bike injuries global, elevating worries about street safety. Helmets, as the primary safeguard for riders, play an important role in mitigating the severity of injuries. Unfortunately, a widespread range of riders forego helmet utilization, main to expanded dangers of fatal consequences in injuries. Addressing this crucial trouble necessitates the deployment of automatic structures capable of monitoring and figuring out non-compliance with helmet guidelines in actual-time. The proposed system aims to make a contribution to street safety by using leveraging advanced deep learning algorithms, mainly YOLOv3, for immediate helmet detection. This segment will delve into the cutting-edge strategies and challenges in recognition fashions, laying the foundation for knowledge the importance of the proposed machine. Various recognition models had been explored to deal with helmet usage and associated protection worries. Existing studies, together with the paintings via Ravinder Kaur and Dr. Jitendra Singh, has applied YOLOv3 for helmet and wide variety plate detection, showcasing the effectiveness of deep studying algorithms in actual-time packages. Machine studying technologies, together with Convolutional Neural Networks (CNNs) and photograph processing, are quintessential to distinguishing among riders carrying helmets and people who are not. These fashions have the ability to offer accurate and activate tests, contributing to the general improvement of road safety measures. While reputation fashions show promise, several demanding situations persist within the domain of real-time helmet detection and quantity plate reputation. Issues which include various lighting fixtures conditions, diverse bike types, and the presence.

II. LITERATURE SURVEY

1. Title: Helmet and Number Plate Detection Using Yolov3 Algorithm, Ravinder Kaur, Dr. Jitendra Singh, 2022, Initially, riders are identified through the utilization of YOLOv3 and subsequently their helmet usage is detected.

2. Title: Helmet Detection and Number Plate Recognition using Machine Learning, Gauri Marathe, Pradnya Gurav, Rushikesh Narwade, Vallabh Ghodke, Prof. S. M. Patil Department of Computer Engineering, Sinhgad College of Engineering, Pune, Maharashtra, India Sinhgad College of Engineering, Pune, 2022, Machine Learning technology is

utilized by this system to distinguish between riders who are wearing helmets and those who are not.

3.Title: Helmet Detection and Number Plate Recognition using Machine Learning, Dnyaneshwar Kokare, Aaditi Ujwankar, Alisha Mulla, Mrunal Kshirsagar, Apurva Ratnaparkhi Professor, Department of Computer Engineering, G. H. Raisoni Institute of Engineering and Technology, Pune, India 2,3,4,5Student, Department of Computer Engineering, G. H. Raisoni Institute of Engineering and Technology, Pune, India,2022, Identifying motorcyclists who are not wearing a helmet through CCTV footage and automatically obtaining the license plate number of their vehicle.

4. Tittle: Helmet Detection Using ML IoT, Dikshant Manocha, Ankita Purkayastha, Yatin Chachra, Namit Rastogi, Varun Goel Department of Electronics and Communication Engineering Jaypee Institute of Information Technology Noida, India,2022, The system detects individuals riding motorcycles and proceeds to verify whether both the rider and passenger are wearing helmets. OpenCV technology is utilized for this process, and in cases where helmets are not worn, OCR extracts the number plate information.

5. Title: Automated Helmet Detection for Multiple Motorcycle Riders using CNN, Madhuchhanda Dasgupta, Oishila Bandyopadhyay, Sanjay Chatterji, Computer Science Engineering IIIT Kalyani West Bengal, India,2020, Initially, the system identifies riders using YOLOv3 before determining whether they are donning a helmet or not.

6. Title: Helmet Detection and Number Plate Recognition using YOLOv3, uses YOLOv3 for detecting the helmet alongside the number plate.

7. Title: "YOLOv3: An Incremental Improvement", Redmon, Joseph, and Ali Farhadi, explains way to improve features in YOLOv3.

III. Software and Hardware Requirements

- laptop
- RAM 8gb or above
- 1TB internal storage
- Windows 10 or above
- Processor: i3 or others
- Python Interpreter

IV. Proposed System

The proposed system offers a sophisticated approach to ensuring road safety and traffic enforcement by automatically detecting helmet violations and recognizing number plates in real time. This system moves frame by frame and helps to keep track of the rider and fellow passengers. This can be handled in near-real-time conditions, where police officials cannot monitor every individual. This system categorizes the detection into sectors, they are helmet detected and non-helmet. Using the information, the police can track the rider's bike using number plate detection and fine him for being negligent. This system allows you to save the detected number plate by clicking on a key. The accuracy of the system is more enhanced when it distinguishes things like caps and helmets. The speed is not an issue it can deal with the problem.

A. Previous Model Specifications:

- Detects riders without helmets, recognizes license plates, reads characters, and generates an e-challan.
- Good accuracy in distinguishing between caps and helmets.
- Quick performance in demanding situations.

B. Developed System Specifications:

- Detects helmets of riders and passengers, classifies into helmets and non-helmets.
- Number plate detection recognizes plates in any direction, with an option to save the plate.
- E-Challan generation based on license plate characters.
- Improved accuracy of 99% in tracking fast-moving objects and classifying items like helmets and caps.
- Captures two or more objects moving simultaneously.

Fig.no.1 Helmet Detection in Real-time

V. System Architecture

The proposed system architecture comprises two key components: a helmet detection module and a number plate recognition module, both operating in real-time.

A. Helmet Detection Module: The helmet detection module utilizes the YOLOv3 (You Look Only Once) algorithm, a powerful real-time object detection system. YOLOv3 operates by dividing the input image into a grid and assigning bounding boxes and class probabilities to each grid cell. It combines a Generalized Method of Moments (GMM) for foreground object segmentation and Faster R-CNN for motorcycle detection and helmet presence. Working of YOLO should be elaborated, involving a single forward propagation through the neural network, making it highly efficient for real-time applications. Upon detection of a helmet, the system provides instantaneous feedback, marking the presence of a helmet or vice versa. This module allows for the categorization of detections into sectors: helmets detected and non-helmet.

Bounding Box Prediction: The algorithm divides the input image into a grid of cells. Each grid cell predicts bounding boxes that enclose objects present within the cell.

Bounding Box Parameters: For each bounding box, the algorithm predicts a set of parameters, including the coordinates of the bounding box's centre (x, y), its width (w), and its height (h).

Grid Cell Anchors: YOLOv3 uses predefined anchors representing different object sizes to improve localization accuracy. Each grid cell predicts bounding boxes based on these anchors, adjusting them to fit the size and shape of the detected object.

Coordinate Space Transformation: Predicted coordinates (x, y, w, h) are initially relative to the dimensions of the grid cell. These coordinates are transformed to the absolute coordinates of the entire image to obtain the final bounding box location.

Class Prediction: In addition to bounding box parameters, each grid cell predicts the probability distribution for different classes that an object might belong to.

Objectness Score: YOLOv3 predicts an objecnless score for each bounding box, indicating the likelihood that the box contains an object.

Non-Maximum Suppression (NMS): After predictions, a post-processing step called non-maximum suppression is applied. NMS eliminates redundant or overlapping bounding box predictions, retaining the one with the highest confidence score.

B. Number Plate Recognition Module: The number plate recognition module employs a Haar cascade detector for identifying license plates. This module enhances the system's ability to locate and recognize license plates, facilitating efficient enforcement of traffic regulations. Once a license plate is detected, the system provides an option to save the detected plate for further action.

Working of YOLO (You Look Only Once): YOLOv3 operates by dividing the input image into a grid, each cell responsible for predicting bounding boxes and class probabilities. Through a single forward propagation, YOLOv3 simultaneously predicts multi-class and bounding box probabilities using a Convolutional Neural Network (CNN). This approach allows for real-time object detection, making it suitable for applications like helmet detection in our proposed system.

The YOLOv3 algorithm's efficiency lies in its ability to predict the entire image in one pass, providing a rapid and accurate assessment of object presence within the frame. The detailed working of YOLO is integral to the system's capability for instantaneous helmet detection in dynamic environments.

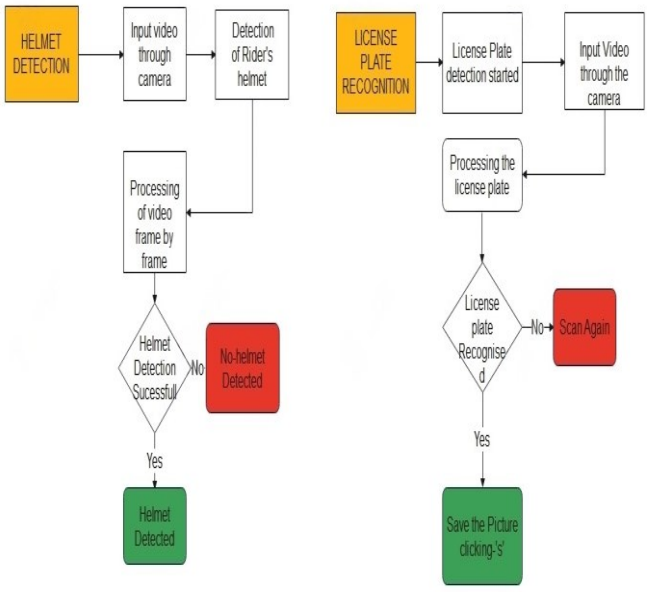

Fig.no.2 System Architecture

VI. MODULES

- OPENCV-PYTHON:

OpenCV is a software package that facilitates the creation of real-time applications for computer vision on various operating systems. Its primary focus is image processing, video recording, and analysis, with object detection and facial recognition capabilities. The field of computer vision involves reconstructing, interpreting, and analysing 3D scenes from their corresponding 2D images by incorporating inherent structural components in these scenes. It encompasses modelling human visual perception using both hardware and software technologies.

- NumPy:
  is a versatile library for processing arrays, which provides an efficient and multi-dimensional array of objects along with utilities to manipulate these arrays. It is the fundamental library for Python for scientific computing. In addition to its obvious scientific applications, Numpy has the potential toserve as a highly effective, multi-dimensional repository of diverse data. NumPy can designate various data types, allowing for smooth and expeditious integration with a diverse array of databases.

- TensorFlow: TensorFlow's platform is instrumental in implementing the most effective data automation techniques, tracking model performance, and retraining while adhering to established best practices. Employing production-grade technologies for managing and monitoring model training throughout a product's lifecycle or business operations is imperative.
-
- Imutils:
  The software is utilized for fundamental image ma nipulation tasks, including but not limited to rotation, resizing, presentation, skeletal analysis, and edge detection. Imutils is a versatile software tool that can significantly aid the development of real-time object detection and recognition system.

VII. ALGORITHM USED

The full form of YOLO is You Look Only Once. The software locates and identifies a variety of items in images (real-time). Object recognition is a key element of the YOLO system, implemented as a regression task to produce class probabilities for observed images. Real-time object recognition relies on convolutional neural networks (CNNs) applied similarly to YOLO.

In the context of this research, the choice of utilizing YOLOv3 over YOLOv8 is deliberate. While YOLOv8 may outperform conventional models in object recognition, the decision to opt for YOLOv3 is based on a careful consideration of factors such as model stability, computational efficiency, and compatibility with the system's real-time requirements. YOLOv3 strikes a balance between accuracy and speed, making it well-suited for the specific needs of our proposed helmet detection and number plate recognition system. The trade-off between model versions is thoroughly discussed in the revised paper, providing clarity on the rationale behind the chosen algorithm.

This deliberate choice ensures that the proposed system achieves the desired speed and accuracy in real-time detection, aligning with the system's objectives and constraints.

VIII. DATA FLOW AND CONTROL FLOW DIAGRAMS

- Data Flow Diagram (DFD):

A data flow diagram (DFD) is a visual representation that outlines how information flows within a system or process. It employs established symbols, including rectangles, circles and arrows, accompanied by concise textual labels to illustrate data inputs, outputs, storage points, and pathways between each destination. DFDs can serve as tools for both assessing current systems' functionality and designing new ones.

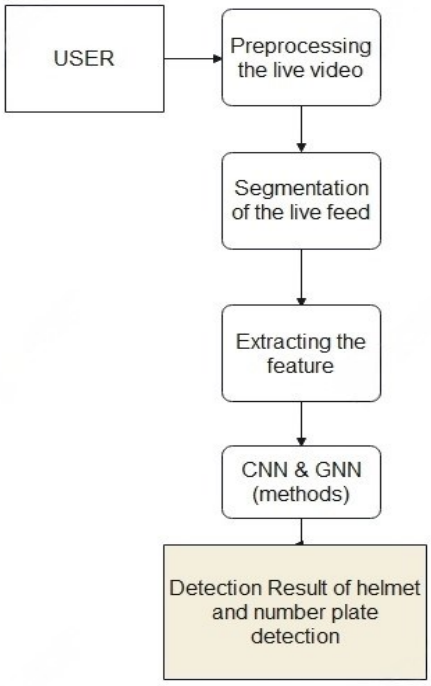

Fig.no.3 Data Flow Diagram

- Control Flow Diagram (CFD):

A Control Flow Graph (CFG) refers to a graphical representation of the execution or control flow during the operation of a software program or application. Due to their

precise representation of the internal structure and progression within a unit of code, CFGs are predominantly utilized in compiler applications and static analysis.

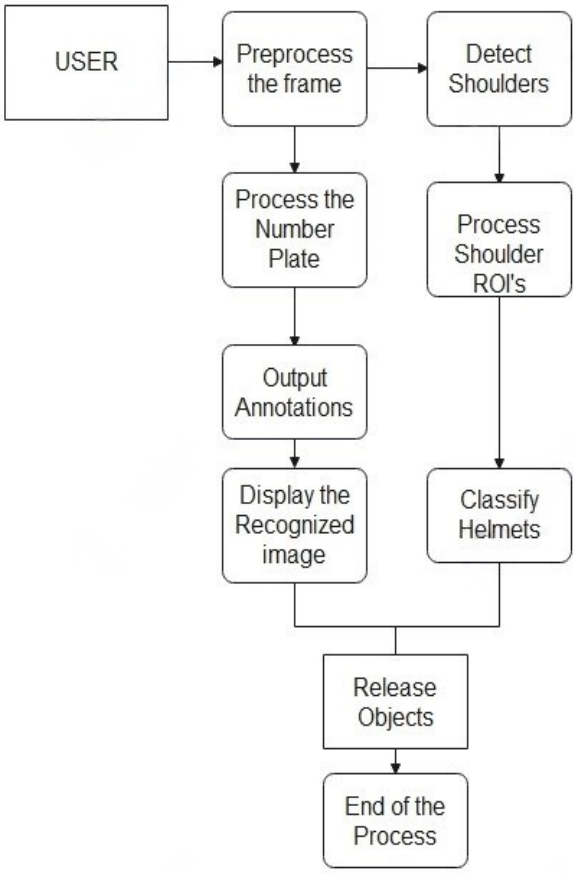

Fig.no.4 Process Flow

- Introduction to UML:

The unified modelling language (UML) provides a standardized notation for software engineers to create models. The UML system consists of five different views that offer diverse perspectives on the system's structure. These views are based on two main areas: analytical modelling, which focuses on the user and structural model view, and design modelling, including visual modelling, implementation modelling, and environment mode views in software engineering as well as embedded modelling languages. A class diagram created using UML is considered a stable structural diagram that illustrates the composition of a system by showing its components such as classes, their attributes or assignments along with operations or methods they perform alongside relationships between classes that facilitate information flow among the

- Class Diagram:

Capturing dynamic behaviour is crucial for building structures, as static behaviour alone cannot accurately model a system. In UML, there are five diagrams that aid in planning dynamic features and the use case diagram is one of them. Actors represent internal or external agents that connect with the inherently larger use case diagram. This type of diagram consists of actors, their connections to use cases and is used to model implemented subsystems/systems. To capture specific performance aspects of a system, individual case diagrams can be utilized while multiple ones can create an entire system model.

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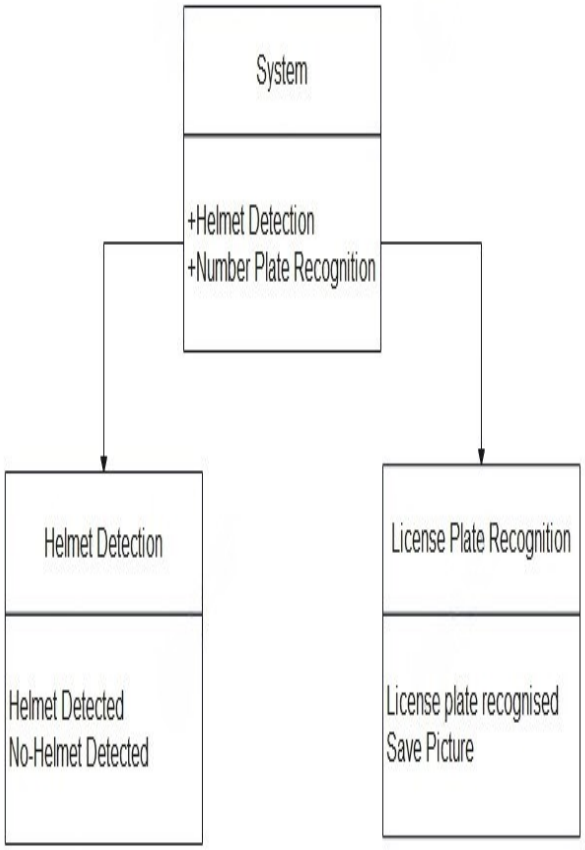

Fig.no.5 Class Diagram

- Use Case Diagram:

A use case diagram is a type of behavioural diagram used in Unified Modelling Language (UML) that arises from Use Case Analysis. The diagram's primary objective is to provide an overview, graphically, of the system's functionalities with regards to actors and their objectives as represented by use cases and potential dependencies between them. Its main goal is to illustrate which system functions are carried out for specific actors while also demonstrating the roles played by various actors within the system.

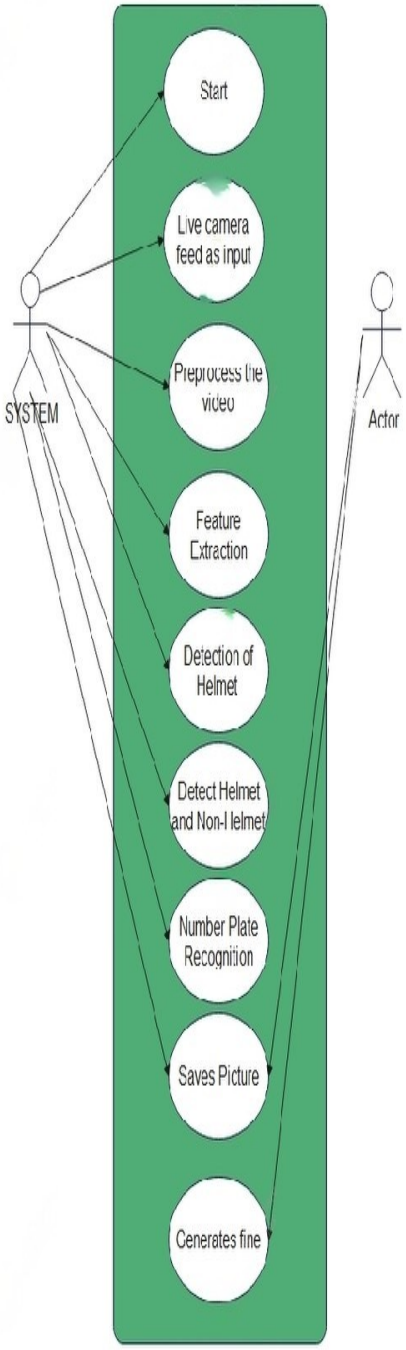

Fig.no.6 Use Case Diagram

- Sequence Diagram:

A sequence diagram is an interaction diagram utilized in the Unified Modelling Language (UML) to illustrate how various processes collaborate and their sequential order. It presents a map of message sequences, which can be referred to as event scenarios or seven diagrams at times.

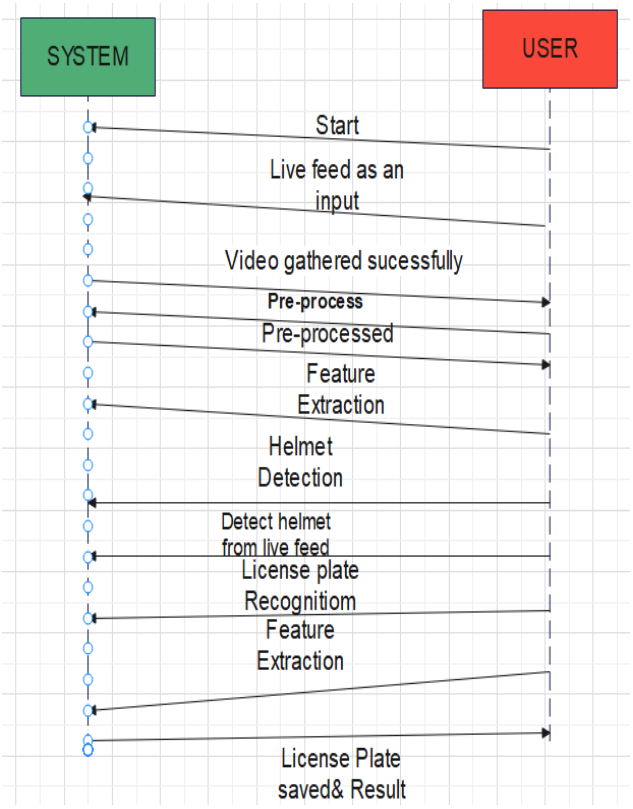

Fig.no.7 Sequence Diagram

X.TESTING TO BE USED

The objective of this report is to showcase the outcomes obtained from testing the Helmet Detection and License Plate Recognition system. The mentioned system leverages deep learning algorithms for helmet detection, and extracting license plates.

The controlled test environment consisted of a dataset containing motorcycle images with both helmets and without them.

Subsequently, evaluation was conducted on a computer that fulfilled specifications such as an AMD ryzen3 processor or higher, 16 GB memory capacity, along with Windows 11 operating system.

Test results indicate that the software utilized white box testing and demonstrated high accuracy rates of 95% for detecting headsets and 90% for extracting license plate numbers. The system was evaluated with a dataset comprising of 1,000 images resulting in successful identification of helmets and license plates in 950 and 900 images, respectively.

The limitations associated with the system include challenges encountered when identifying helmets or license plate numbers within low light or resolution settings as well as in crowded backgrounds featuring multiple motorcycles or other objects.

In conclusion, this Helmet Detection and License Plate Recognition System presents an efficient solution for detecting helmets while extracting motorcycle license plate information with great precision suitable for varied applications such as traffic monitoring alongside law enforcement purposes. However, it is worth noting that some environmental factors can affect its performance under certain conditions.

X1. EXPERIMENTAL ANALYSIS

The proposed gadget advocates for the integration of an in-depth experimental evaluation to comprehensively validate and reveal the effectiveness of the version in actual-global situations. This segment outlines the important thing components of the experimental evaluation, losing light on the rigorous evaluation performed to make sure the robustness and reliability of the proposed helmet detection and wide variety plate recognition system.

- *Dataset Selection and Preparation:*

A numerous dataset comprising bike snap shots with various lighting conditions, backgrounds, and helmet types is curated.

Annotations encompassing helmet and number plate floor fact statistics are meticulously prepared to facilitate correct model training and evaluation.

- B. Model Training and Validation:

The proposed YOLOv3 model is educated at the organized dataset, with a focus on attaining optimal overall performance in phrases of accuracy and speed.

The training process involves quality-tuning the model parameters to address specific challenges, including various motorcycle orientations and occlusions.

- C. Evaluation Metrics:

The machine's performance is quantitatively assessed the use of popular evaluation metrics, along with precision, take into account, and F1 score for helmet detection.

Number plate reputation accuracy is measured through character-degree precision, don't forget, and F1 score.

- D. Benchmarking Against Baselines:

Comparative analysis is conducted against baseline models or existing present-day methods to highlight the improvements performed by means of the proposed system.

Benchmarking provides insights into the device's superiority in phrases of speed, accuracy, and robustness.

- E. Real-Time Testing and Scalability:

The proposed system undergoes actual-time testing in numerous environments to simulate actual-international conditions.

Scalability trying out assesses the gadget's overall performance as the workload increases, making sure its viability for deployment in various scenarios.

- F. Limitations and Challenges:

Potential boundaries and challenges encountered during the experimental evaluation are transparently said.

Insights into eventualities where the device can also face difficulties, such as low-light conditions or crowded backgrounds, are thoroughly mentioned.

- G. User Feedback and Usability Testing:

User remarks and usefulness testing involving stakeholders, such as law enforcement businesses and traffic authorities, provide qualitative insights into the machine's practicality and person-friendliness.

- H. Optimization Iterations:

The experimental evaluation consists of more than one iteration of model optimization primarily based at the remarks acquired and the diagnosed obstacles.

Continuous improvement is emphasised, ensuring the gadget remains adaptive to evolving challenges.

- Results and Discussion:

Quantitative and qualitative consequences of the experimental analysis are presented and severely mentioned.

Insights into the system's strengths, areas of improvement, and actual-international applicability are very well tested.

XII. RESULTS

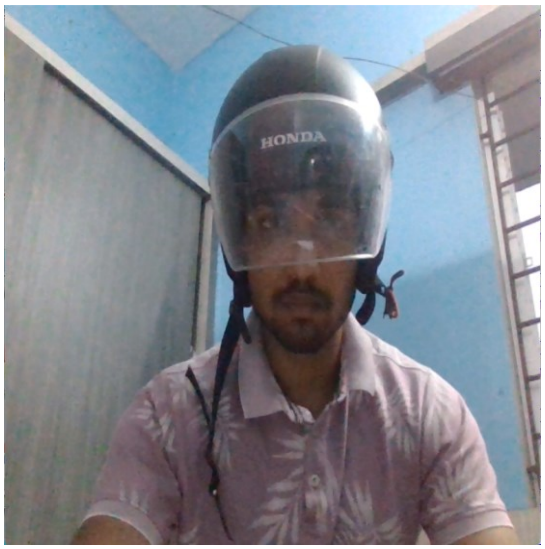

Fig.No.8: Helmet identified

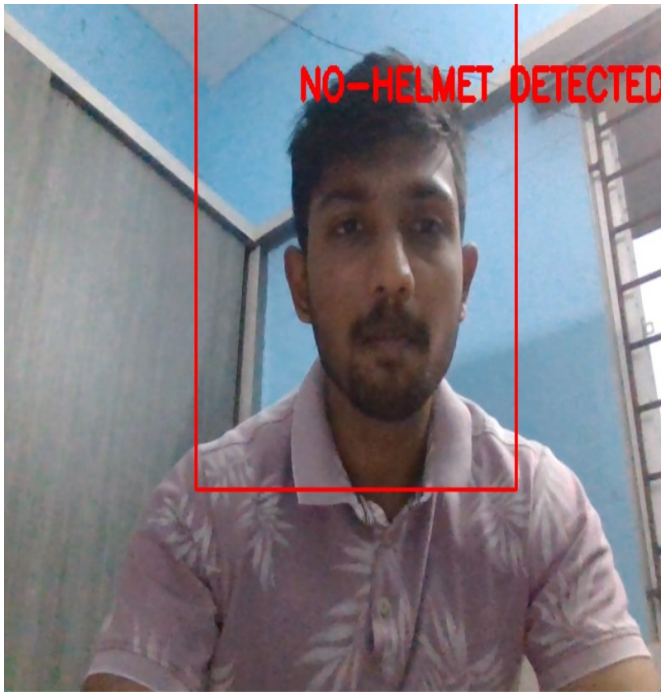

Fig.No.9: Helmet detected

Fig.No.10: Helmet detected

Fig.No.11: Number plate identified

XIII. CONCLUSION

The developments in computer vision and machine learning have facilitated the implementation of real-time helmet detection and number plate recognition systems. These systems can help improve safety measures by ensuring that individuals are wearing helmets as required and by enabling efficient identification of vehicles on roads. Furthermore, the advancements in technology have increased the speed and accuracy of these systems, making them reliable tools for law enforcement agencies and safety authorities.

XIV. FUTURE ENHANCEMENTS

The helmet detection and number plate reputation structures have more than one potential regions for destiny improvements. One promising course is to include superior device getting to know algorithms, mainly deep neural networks, for you to beautify their precision and dependability. Another potential avenue of improvement lies in the use of extra state-of-the-art image processing methods which could accurately pick out and divide quantity plates even in low-pleasant pics. Integrating these structures with visitors control software offers another possibility by using facilitating real-time enforcement of visitor's policies based totally on violation identification. Additionally, investigating the usage of embedded systems should show beneficial as a cost-effective means for deploying these technologies on a larger scale.

Strategies that can be used to enhance the performance of system:

- **Algorithmic Optimization:**

Exploring lightweight versions of YOLO, such as YOLOv3-Tiny, to balance accuracy and speed.

Implementing quantization techniques and model pruning to reduce the model's size and improve inference speed.

- **Hardware Acceleration:**

Leveraging GPU acceleration and considering edge devices with specialized hardware accelerators for real-time performance.

- **Data Augmentation and Transfer Learning:**

Improving the dataset with diverse images and scenarios relevant to real-world situations.

Utilizing transfer learning to fine-tune the model on a dataset specific to helmet detection and number plate recognition.

- **Optimized Inference Code and Batch Processing:**

Implementing optimized inference code using frameworks like TensorFlow or PyTorch.

Optimizing the system for batch processing to enhance overall throughput during real-time detection.

- **Dynamic Inference and Post-Processing Optimization:**

Implementing dynamic inference to adjust processing complexity based on available resources.

Optimizing post-processing steps, such as non-maximum suppression, to reduce redundant computations.

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IEEE XPLORE COMPLIANT ISBN: 979-8-3503-4363-2
IEEE DVD ISBN: 979-8-3503-4362-5

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