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YOLO Based Approach for Helmet and Number Plate Detection Using Raspberry Pi

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***Abstract* - In India, road accidents are increasing very rapidly and lots of deaths occur due to head injuries as number of people does not wear helmets. The helmet is the main safety equipment of motorcyclists. However, many drivers do not use it. The main goal of helmet is to protect the riders head in case of an accident. In such a case, if the motorcyclist does not use a helmet, it can be fatal. It is not possible for traffic police force to watch every motorcycle and detect the person who is not wearing a helmet.**

So we are designing system for Helmet and Number Plate 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 Yolov8 algorithm technique.

Keywords: Raspberry Pi, Pi Camera, Object Detection, YOLOv8 Algorithm.

I. INTRODUCTION

The social situation in India is fundamentally extraordinary because of issues, for example, neediness, joblessness just as an extensively lower regard for rules. This makes it unfeasible to go for a totally programmed tollbooth. The business requires a programmed vehicle grouping framework in India not to decrease or wipe out human intercession or work, yet to guarantee that human mediation doesn't bring about any budgetary acts of neglect. The business requires a framework that runs out of sight and simply keeps a cross-beware of the manual. The conventional OCR based methodology for number plate acknowledgment doesn't work for the varieties in painting style of the number plates. In this paper creators have exhibited a picture recovery based strategy to perceive the vehicle number plate caught utilizing an advanced cell to encourage the Car the executive's arrangement of a Smart office premise. In the proposed strategy an advanced mobile phone is utilized to catch the pictures and concentrate highlights of the vehicle number plate. These highlights are coordinated against predefined set of same vehicle number plate pictures in the database. The character pictures are coordinated in a proficient way to make it a continuous arrangement.

As effectively expressed, the framework utilizing fiber optics naturally has countless issues separated from the principle worries of significant expense and support. Albeit an IR blind framework decreases the expense essentially, it is still very costly and less expensive options are desired. As practically every one of the tollbooths utilize cameras for security purposes, it was felt that the possibility of a framework utilizing IP cameras ought to be tried.

As for vehicle wellbeing, India meets just two out of the seven vehicle security guidelines by the World Health Organization (WHO). Bikes represent 25% of all out street crash passing. About 75%motorcycle riders engaged with mishaps kept on wearing head protectors, crash records appear. The primary driver of these fatalities is individuals riding bikes affected by liquor results and infringement of traffic rules which later on brings about genuine mishaps.

The escalating growth in vehicular traffic has presented an urgent need for innovative solutions in traffic management and law enforcement. With an exponential increase in the number of vehicles on roads, manual monitoring has become impractical, necessitating the adoption of intelligent systems to ensure effective traffic control. This study introduces a comprehensive project focused on license plate detection and recognition, leveraging YOLOv8 as a powerful deep learning method. The primary objective is to develop a sophisticated system capable of automating the identification of vehicle licenses, thereby enhancing traffic flow monitoring. This project addresses the challenges associated with real-time operations and complexity, aiming to provide a groundbreaking technology for efficient license plate tracking.

The rapid increase in the number of vehicle on roads has underscored the urgent need for sophisticated traffic management solutions, particularly in the realm of automated license plate recognition (LPR). This study introduces an innovative approach to LPR that harnesses the power of the

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YOLOv8 object detection system and a Raspberry Pi single – board computer.

II. LITERATURE REVIEW

In [1], the authors are Dr. Rama Abirami K, Aishwarya Rani, Atul Kumar, Ayush Bhardwaj, and AyushRungta. The system includes picture acquisition, processing, plate extraction, character segmentation, and recognition. And has the potential to improve law enforcement and parking management, with further improvements in accuracy and functionality suggested.

In [2], the authors are Chirag Patel, Dipti Shah, and Atul Patel. Image scissoring, feature prominent extraction, and template matching are used. For licence plate detection, various algorithms such as colour conversion, thresholding, and fusion are used, while template matching is used for fixed-sized letter identification. ANPR algorithms are discussed in terms of image size, success rate, and processing time.

In [3], the authors are J.M. S. V. Ravi Kumar, B. Sujatha, and N. Leelavathi. The document discusses an automatic vehicle number plate recognition system that utilises machine learning. The system attempts to reduce manual labour, errors, and costs in recognising vehicle number plates by using image processing techniques, morphological procedures, and optical character recognition. This system improves the efficiency and accuracy of vehicle number plate identification using sophisticated technology.

In [4], the authors are Anubha Jain, Kamlesh Kumawat, and Neha Tiwari. Enhancing ANPR with image preprocessing algorithms enhanced recognition rates for HD and hazy photos. This study emphasises the importance of image quality in ANPR systems and presents effective strategies for improving recognition rates, particularly for blurred images.

In [5], the authors are Asma Iqbal, Mohammed Mujataba Maaz, Syed Amaan Fayaz, and Mohd Sohaib Hussain. The project focuses on real-time licence plate identification using Raspberry Pi4, OpenCV, and OCR for vehicle security, as well as automation experimentation with image segmentation and character recognition within the licence plate recognition framework.

In [6], the authors are Vaishnav A, Mandot M, Arrospide, Salgado L, and Mohedano R. Utilises techniques such as sobel-based vertical edge detectors and sliding window methods to address tilt factor by adding an extra layer of vertical projection. It emphasises the importance of robust algorithms for non-standardized formats and real-time testing scenarios.

In [7], the authors are Zhang, Cheang, Varma, Zhu, and Tejas. Cycle GAN and Xceptionbased CNN encoders, ConvNet-RNN, Morphological transformation, and CNN different methodologies were successful in achieving high accuracy rates, demonstrating the potential of advanced technologies in this field. The conclusion emphasises the importance of ongoing research and development in vehicle number plate recognition.

In [8], the authors are CharithPerera, JithmiShashirangana, HeshanPadmasiri, and DulaniMeedeniya. ALPR systems face issues such as changing perspectives, motion blur, and lighting conditions. Datasets differ in complexity and quality, with the Chinese dataset being more difficult to identify.

III. METHODOLOGY

The system uses Raspberry Pi to control all of the components. It is using software Python as a platform to make the coding.

The main theme of this application is to detect the helmet and number plate of bicycle rider.

Here continuously camera captures the images. If image detects the bike rider without helmet it will immediately process for number plate detection.

For Helmet and number plate detection, system will use YOLOv8 algorithm.

The methodology is divided into three parts.

The first part is on the design structure, followed by hardware description and the finally on the programming design.

All these three parts were assembled together and experiments were then performed to build a system.

IV. SYSTEM DESIGN

Our helmet-detecting solution makes sure riders wore headgear by utilizing cutting-edge technology and sensible design. Our solution relies on the Raspberry Pi 3 Model B+, a compact yet powerful computer that handles data and tasks for helmet detection. The economic feasibility of using the Raspberry Pi is validated by its selection for system deployment. Since it is dirt cheap, the gadget allows it to be used in even the lowest-income areas while scaling up for mass consumption.

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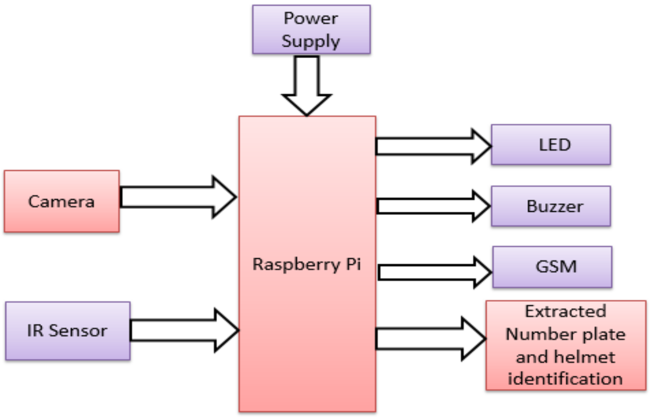

Figure 1: Block Diagram

This makes the proposed approach to monitor helmet compliance a light wallet method of ensuring this can be done without a heavy financial weight on users to advance urban safety. Here is a more detailed look at each component of the system.

Central Processing Unit: Raspberry Pi 3 Model B+, It manages the data and computations necessary to detect helmets. We chose this model because it provides an excellent balance of computing power, energy efficiency, and connectivity with other devices. It uses the YOLOv9 object identification model, which is highly accurate and can process photos quickly.

Camera Module for Real-Time Image Capture: To capture live video of motorcyclists, we use a Raspberry Pi-connected camera. The camera is positioned to plainly see the rider's head and sends the video to the Raspberry Pi for analysis. The camera's quality is vital since accurate helmet detection requires clear images.

GPIO Interface: These are the pins on the Raspberry Pi that send control signals directly to the system.

GSM Module: To send notification to authorized person regarding detected number plate without helmet.

Power Supply: To keep everything running smoothly, we have a reliable power supply unit. This unit makes sure that all parts of the system get the power they need. Since the system will be used on the move, the power supply needs to provide stable and sufficient power to the Raspberry Pi, the camera, GSM and the control interface.

V. YOLOV8 ALGORITHM

YOLOv8 stands out for its efficient single-stage architecture, making it well-suited for real-time object detection tasks. Here's a concise overview of its key components:

Backbone Network: The foundation is a Convolutional Neural Network (CNN) backbone, often a modified Darknet variant (e.g., CSPDarknet53). This network extracts features from the input image at various levels of detail, providing a rich representation for object detection.

Neck Networks: Some YOLOv8 variants might include a neck network. This network refines the feature maps extracted by the backbone at different stages, combining them to create a more comprehensive image representation that incorporates information from various resolutions.

Head Network: The head network takes the processed feature maps (from the backbone and optionally the neck) and performs the final detections. It typically consists of several convolutional layers followed by fully connected layers. These layers predict bounding boxes for potential objects and classify them into predefined categories.

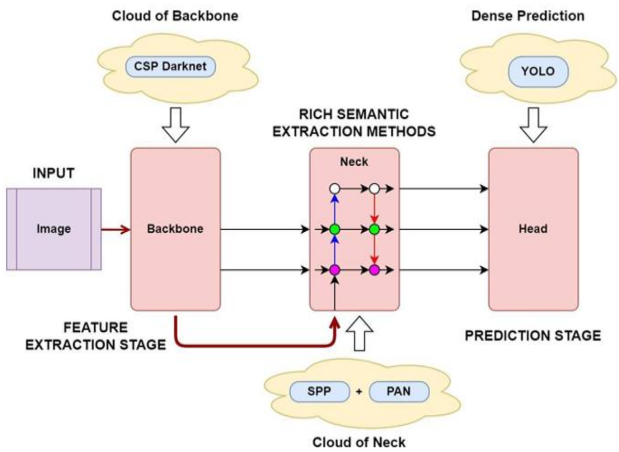

Figure 2: YOLO V8 Architecture

Thus, YOLOv8 takes an input image, feeds it through the backbone network for feature extraction optionally refines the features through the neck network, and finally utilizes the head network to predict bounding boxes and classify objects.

1. Training

From the described dataset, 800 images were used for training a YOLOv8s pre-trained model. The dataset includes motorcycle riders with and without helmets.

To increase model generalizability and prevent over-fitting, the image size was fixed. The model was trained with the parameters. The model was initially trained for 100 epochs but the best result was considered at the 48th iteration. Thus, to remove and redundancy and over-fitting introduced, the following train model was considered best: epochs=100: This parameter sets the number of cycles the entire training dataset will be trained and validated through the model. batch=16:

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This defines the number of images processed by the model in each training iteration. imgsz=640: This specifies the size (resolution) to which the training images will be resized before feeding them into the model.

optimizer=SGD: This indicates the optimizer algorithm used to update the model's weights during training. SGD (Stochastic Gradient Descent) is being used here.

lr=0.01: This is the initial learning rate, which controls the magnitude of updates to the model's weights.

momentum=0.937, weightdecay=0.001: These are additional hyper-parameters used with the SGD optimizer to improve convergence and stability.

2. Testing

To evaluate the generalizability and real-world applicability of the trained YOLOv8 model, we conducted testing on unseen images not included in the training or validation sets. A single test image was processed, providing insights into the model's processing speed for each stage:

Pre-processing (0.6ms per image): This initial stage involves tasks like image resizing and normalization. The relatively fast preprocessing time indicates efficient handling of image data preparation.

Inference (16.3ms per image): This core step encompasses passing the pre-processed image through the YOLOv8 model to generate detections.

The inference speed is similar to the validation speed suggests potential consistency between controlled and real-world scenarios. Post-processing (98.3ms to under 2ms): This final stage varies depending on the image complexity and the specific post-processing tasks performed. It often involves decoding detections from the model's output format and applying non- max suppression (NMS) to remove redundant bounding boxes.

VI. CONCLUSION AND FUTURE SCOPE

Conclusion:

The objective of the project is to study and resolve algorithmic and mathematical aspects of automatic helmet and number plate detection systems.

This project successfully developed a system that combines YOLOv8 object detection with a Raspberry Pi for real – time processing. The system's performance exceeded expectations, proving its effectiveness in diverse traffic conditions. The synergy between YOLOv8 and Raspberry Pi presents a compelling solution for vehicle number plate recognition. YOLOv8's realtime object detection capabilities, combined with Raspberry Pi's affordability and compact form factor, create a powerful and versatile platform for ALPR applications. The combination of YOLOv8 and Raspberry Pi offers a promising approach for developing efficient and cost-effective ALPR solutions.

Future Scope:

Future work could include enhancing the system's capabilities to recognize plates from different countries, improving its performance in extreme weather conditions, and integrating it with larger traffic management systems. The synergy between YOLOv8 and Raspberry Pi presents significant potential for the future of vehicle number plate recognition. Additionally, with ongoing enhancements in hardware capabilities and edge AI frameworks, the integration of YOLOv8 on Raspberry Pi could extend to other domains, enabling comprehensive and scalable smart surveillance solutions.

REFERENCES

[1] Aishwarya Agrawal &Nikita Pardakhe,"Automatic License Plate Recognition Using Raspberry Pi", International Interdisciplinary Conference on Science Technology Engineering Management Pharmacy and Humanities Held on 22nd – 23rd April 2017,4, in Singapore ISBN: 9780998900001.

[2] M. Sarfraz, M.J. Ahmed, S.A. Ghazi, Saudi Arabian license plate recognition system, in: 2003 International Conference on Geometric Modeling and Graphics, 2003. Proceedings, 2003, pp. 36–41.

[3] P.I. Reji, V.S. Dharun, License plate localization: A review, Int. J. Eng. Trends Technol. 10 (13) (2014).

[4] Gisu Heo, "Extraction of Car License Plate Regions using Line grouping and density methods," IEEE International Symposium on Information Technology Convergence (ISITC 2007).

[5] Chen, Chao-Ho, et al. "License plate recognition for moving vehicles using a moving camera." 2013 Ninth International Conference on Intelligent Information Hiding and Multimedia Signal Processing. IEEE, 2013

[6] Dr. Rama Abirami K, Aishwarya Rani, Atul Kumar, Ayush Bhardwaj, and Ayush Rungta. (2023).MovingVehicle Registration Plate Detection. ijariie-issn(O)-2395-4396.vol-9 issue-3 2023.

[7] Chirag Patel, Dipti Shah, and Atul Patel. (2014). Automatic number plate recognition system(ANPR).intwrnational journal of computer applications(0975 – 8887). Volume 69- no.9, may 2013.

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[8] J.M. S. V. Ravi Kumar, B. Sujatha, and N. Leelavathi. (2012). Automatic Vehicle Number Plate Recognition System Using Machine Learning. conf.ser .:Mater. sci. Eng. 1074 012012. doi:10.1088/1757-899X/1074/1/012012.

[9] Anubha Jain, Kamlesh Kumawat, and Neha Tiwari. (2023). Relevance of automatic number plate recognition system in vehicle theft detection.engproc2023059185.18 january 2024.

[10] Asma Iqbal, Mohammed Mujataba Maaz, Syed Amaan Fayaz, and Mohd Sohaib Hussain. (2022). Real -Time Number plate recognition using raspberry pi. Volume 10, issue 2.

[11] Vaishnav A, Mandot M, Arrospide, Salgado L, and Mohedano R. (2021).Automatic number plate recognition.: A Detailed survey of Relevenat Algoritms./doi.org/ 10.3390/s21093028. 26 April 2026.

[12] Zhang, Cheang, Varma, Zhu, and Tejas. (Year). Vehicle number plate and Detection and Recognition. issn 2415-6698.7 march 2021. ASTESJ ISSN: 2415-. 10.25046/aj060249.

[13] Charith Perera, Jithmi Shashirangana, Heshan Padmasiri, and Dulani Meedeniya. (2020). Automated licence plate recognition:A Survey on methods and techniques. IEEE international conference .December 29, 2020.

[14] P. Shah, S. Karamchandani, T. Nadkar, N. Gulechha, K. Koli and K. Lad, "OCR-based chassis-number recognition using artificial neural networks," 2009 IEEE International Conference on Vehicular Electronics and Safety (ICVES), 2009, pp. 31-34, doi:10.1109/ICVES.2009.5400240.

[15] S. Huang, H. Xu, X. Xia and Y. Zhang, "End-to-End Vessel Plate Number Detection and Recognition Using Deep Convolutional Neural Networks and LSTMs," 2018 11th International Symposium on Computational Intelligence and Design (ISCID), 2018, pp. 195-199, doi:10.1109/ISCID.2018.00051.

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