International Journal of Engineering Research and Science & Technology

IJERST

www.ijerst.org

ISSN : 2319-5991

Vol. 20 No. 4 (2024)

ijerst.editor@gmail.com

editor@ijerst.com

ISSN 2319-5991 www.ijerst.com
Vol. 20, No.4, 2024

Research Paper

AI BASED SURVEILLANCE SYSTEM FOR DETECTION OF VEHICLES WITHOUT HELMETUSING YOLO TECHNOLOGY

VELISHALA GANESH
velishalaganesh2@gmail.com

Vennela Srikanth
vennelasrikanth2727@gmail.com

V Eswar Vankata Sai Ravi Krishna
eswernaidu52@gmail.com

Wagmare Sailu
218R1A04C7@gmail.com

CMR Engineering college, Kandlakoya, Hyderabad-50140

ABSTRACT

The project focuses on developing a machine learning-based surveillance system designed to enhance traffic safety by detecting bike riders without helmets and identifying triple riders in real-time.Leveragingadvancedcomputervisiontechniques,thesystemutilizesConvolutional Neural Networks (CNNs) and state-of-the-art detection algorithms such asYOLO (You Only Look Once) and Faster R-CNN to analyse live video feeds from traffic cameras.

Withhighaccuracy(96.66%)andalowfalsealarmrateof0.5%,thesystemreliablyidentifies violations,evenincomplextrafficscenarios.Itprocessesvideofeedsframebyframe,detecting helmet-less riders and triple riding through automated classification and object detection. Integration with pre-trained models like ResNet and EfficientNet further enhances its performance.

The adaptive learning mechanism enables continuous improvement through training on new datasets, ensuring the system remains robust across diverse environments. Designed for seamless integration into existing traffic management systems, this solution offers real-time monitoring, automated detection, and scalable deployment, significantly contributing to safer roadways and improved traffic regulation.

Inadditiontodetectinghelmetviolationsandtripleriding,thesystemcanbefurtherenhanced by integrating license plate recognition to automate fine generation. By leveraging Optical CharacterRecognition (OCR)techniques, the system can extract vehicle registration numbers from detected violators, streamlining law enforcement and reducing the need for manual intervention.Thisfeatureenablesauthoritiestoissueautomatedpenaltynotifications,ensuring a more efficient and transparent traffic monitoring process. Moreover, the system's scalability allowsittobedeployedacrossmultipleurbanlocationswithvaryingtrafficdensities,adapting to different lighting conditions and environmental factors for consistent performance.

Received: 03-11-2024 Accepted: 09-12-2024 Published: 16-12-2024

INTRODUCTION

The project focuses on developing a Machine Learning-Based Surveillance System designed to improve traffic safety by automatically detecting bike riders who are not wearing helmets and identifying instances of triple riding in real-time. With the increasing number of two-wheeledvehiclesontheroads,safetyviolationssuchasr idersnotwearinghelmetsorcarrying more passengers than allowed are common causes of accidents. The goal of this project is to create an efficient, automated system that can address these issues without relying on manual intervention..

Toachievethis,thesystemutilizesadvancedmach inelearningalgorithmsandcomputer visiontechniques.TheprimarytechnologiesusedareC onvolutionalNeuralNetworks(CNNs) andobject detectionmodelssuch asYOLO (You OnlyLookOnce)and FasterR-CNN.These models arecapableofprocessing videofeeds to identifyviolations in real-time.Thesystem is designed to analyze live footage from surveillance cameras placed at traffic hotspots or along highways, ensuring comprehensive monitoring of road safety.

By continuously analyzing traffic, the system can quickly detect bike riders without helmetsandidentifyifavehicleiscarryingmorethanthe allowednumberofpassengers(triple riding).Theautomateddetectionprocesseliminatesth eneedformanualmonitoring,reducing the burden on traffic authorities while ensuring consistent enforcement of traffic rules. The systemprocessesvideofeedsframebyframe,classifyi ngobjectsanddetectingviolationswith high accuracy.

The system operates with a remarkable accuracy rate of 96.66% in detecting helmet-lessridersandhasalowfalsealarmrateof0.5%,ensurin greliableandprecisedetection.With thehelp of adaptive learning, thesystem continuously improves its performanceby collecting new data and retraining the models. This feature allows the system to adapt to different environmental conditions, such as varying lighting and traffic densities, maintaining its efficiency across diverse locations.

Designedforseamlessintegrationwithexist ingtrafficmanagementsystems,thissolution offers a scalable and flexible approach to traffic law enforcement.

OBJECTIVE

The objective of this project is to develop an advanced machine learning-based surveillance system that can automatically detect bike riders without helmets and identify triple riding in real-time video feeds. The goal is to create a fully automated system capable of monitoring traffic and detecting these violations without requiring manual intervention, significantly improving road safety. With the increasing number of two-wheeled vehicles on the road, particularly in densely populated areas, this system aims to enhance safety by identifying violations related to helmet use and overcrowding on motorcycles.

Akeyobjectiveoftheprojectistoachievehighaccuracy inviolationdetection,withthesystem designed to identify helmet-less riders and triple riders with an accuracy of 96.66%. Additionally, it aims to minimize false positives, ensuring the reliability and efficiency of the system. By using machine learning models likeYOLO (You Only Look Once) and Faster R- CNN, the system processes real-time video feeds to detect violations quickly, allowing for prompt enforcement actions.

Ultimately, the project aims to provide a cost-effective, efficient, and real-time solution to traffic monitoring, helping authorities enforce traffic laws more effectively and reduce accidents caused by helmet non-compliance and triple riding. By automating the detection process,thesystemnotonlysavestimeandresourcesbu talsohelpsimprovetheoverallsafety and regulation of roads, contributing to safer communities.

PROPOSED SYSTEMS

The proposed system leverages machine learning and advanced computer vision techniques to develop an automated surveillance solution capable of detecting bike riders without helmets and identifying triple riders in real-time. Unlike traditional methods, which rely on manual monitoring, this system integrates state-of-the-art object detection algorithms such as YOLO (You Only Look Once) and Faster R-CNN to process live video feeds from surveillance cameras.Byanalyzingvideoframesinreal-time,thesystem accuratelyidentifies violations, ensuring effective enforcement of traffic laws without human intervention.

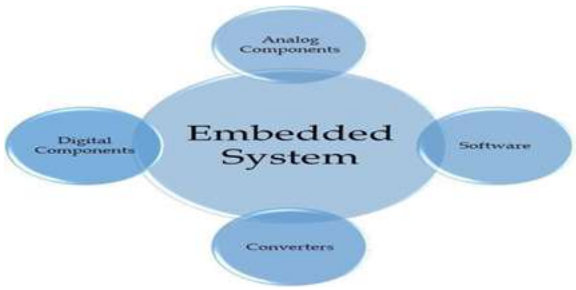
To enhance accuracy and reliability, the system employs Convolutional Neural Networks(CNNs) andpre-trainedmodelslikeResNetandEfficientNet,achievin gadetection accuracy of 96.66% with a false alarm rate as low as 0.5%. Additionally, the system incorporatesadaptivelearningmechanisms,allowingi ttocontinuouslyimprovebytrainingon newdatasets.Thisensuresrobustnessandadaptabilityt odiversetrafficenvironments,lighting conditions, and varying vehicle densities, making it a scalable and efficient solution.

Oneofthekeystrengthsoftheproposedsystemisitssea mlessintegrationwithexisting trafficmanagementinfrastructure.Thesystemisdesig nedtohandlemultiplecamerainputsand can be deployed across high-traffic zones for broader coverage.Automated reporting further enhances its efficiency by flagging violations and generating alerts for traffic authorities, reducing the dependency on manual monitoring. This automation enables a streamlined approach to law enforcement, ensuring prompt action against violations.

The system offers several advantages, including real-time operation for immediate violationdetection,highscalabilitytomonitorlargeareas,andenhancedaccuracytominimize falsedetections.Additionally,itsautomationreducestheneedforhumanoperators,improving efficiency,whileitsversatilityensuresreliableperformanceundervariedlightingandweather conditions. By integrating cutting-edge machine learning algorithms with adaptive technologies,theproposedsystempresentsahighlyreliable,efficient,andscalablesolutionfor improving traffic safety and compliance.

Embedded system

An embedded system is a combination of computer hardware and software designed for a specificfunctionorfunctionswithinalargersystem.Thesystemscanbeprogrammableorwith fixed functionality.



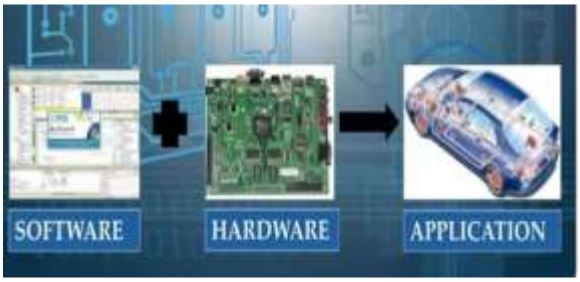
EMBEDDEDSYSTEM

Characteristics of embedded systems

The main characteristic of embedded systems is that they are task specific. They perform a singletaskwithinalargersystem.Forexample,amobilephoneis notanembeddedsystem,it is a combination of embedded systems that together allow it to perform a variety of general- purpose tasks.

CHARACTERISTICS OF EMBEDDED SYSTEMS

- **Hardware.** The hardware of embedded systems is based around microprocessors and microcontrollers. Microprocessorsareverysimilartomicrocontrollers,andgenerallyrefer to a CPU that is integrated with other basic computing components such as memory chips and digitalsignalprocessors(DSP).Microcontrollershavethosecomponentsbuiltintoone chip.
- **Software.** Software for embedded systems can vary in complexity. However, industrial grademicrocontrollersandembeddedIoTsystemsgenerallyrunverysimplesoftwarethat requires little memory.



EMBEDDED SYSTEM

DESIGN APPROACHES ARCHITECTURE

A system designed with the embedding of hardware and software together for a specific function with a larger area is embedded system design. In embedded system design, a microcontroller plays a vital role. Micro-controller is based on Harvard architecture, it is an important component of an embedded system. External processor, internal memory and i/o components are interfaced with the microcontroller. It occupies less area, less power consumption. The application of microcontrollers is MP3, washing machines.

Critical Embedded Systems (CES) are systems in which failures arepotentiallycatastrophic and, therefore, hard constraints are imposed on them. In the last yearsthe amount of software accommodated within CES has considerably changed.

Forexample,insmartcarstheamountofsoftware hasgrownabout100timescomparedtopreviousyears. Thischangemeansthatsoftwaredesignforthesesystemsisalsoboundedtohard constraints (e.g., high security and performance). Along the evolution of CES, theapproaches for designing them are also changing rapidly, so as to fit the specialized needs ofCES. Thus, a broad understanding of such approaches is missing.

StepsintheEmbeddedSystemDesignProcess

Thedifferentstepsintheembeddedsystemdesign flow/flowdiagramincludethefollowing.s

EMBEDDEDDESIGN-PROCESS-STEPS

Hardware–SoftwareArchitecture

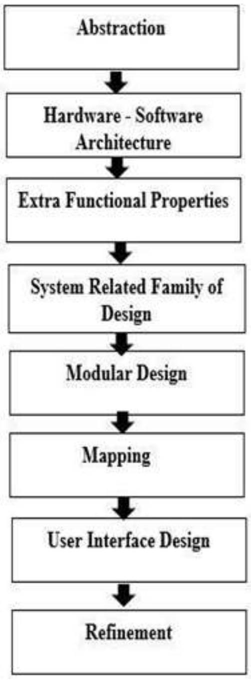
Properknowledgeofhardware andsoftwareto be knownbeforestartinganydesign process.

ExtraFunctionalProperties

Extrafunctionsto beimplementedaretobe understoodcompletelyfrom themain design.

SystemRelatedFamilyofDesign

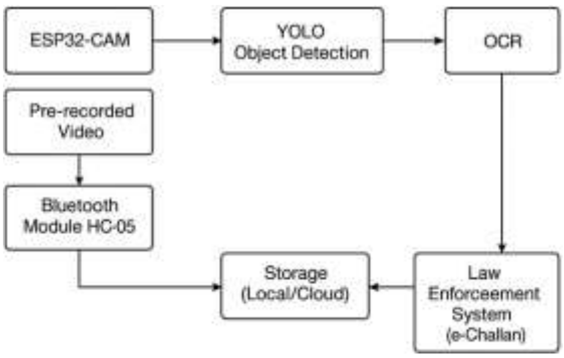
Whendesigningasystem,one shouldrefertoaprevioussystem-relatedfamilyof design



WORKING

The Non-Helmet Rider Detection System is designed to identify motorcyclists who are not wearing helmets and extract their license plate number for further action. The system utilizes ESP32-CAM, Bluetooth Module HC-05, YOLO-based object detection, and OCR (Optical CharacterRecognition)toachieveitsobjectives.Theworkingofthesystemisexplainedinthe following step

BLOCKDIAGRAM



1. **VideoCapture**

Thesystem takes input in theform ofareal-timevideofeed fromtheESP32-CAMmoduleor a pre-recorded video file. The ESP32-CAM continuously captures frames of the traffic, focusing on motorcycles and their riders.

2. **ObjectDetectionusingYOLO**

EachvideoframeisprocessedusingtheYOLO(YouOnlyLookOnce)objectdetectionmodel to identify key objects such as:

- **Motorcycle**(toconfirmthepresenceof atwo-wheeler).
- **Person** (toidentifytherideronthe motorcycle).
- **Helmet**(tocheckwhethertherideriswearinga helmet).
- **LicensePlate**(toextractthe numberifaviolationisdetected).

Ifariderisdetectedwithoutahelmet,thesystemproceedsto thenext step.

3. **LicensePlateRecognitionusingOCR**

Onceanon-helmet rider is detected,thesystem focuses on themotorcycle's licenseplate.The Optical Character Recognition (OCR) algorithm is applied to extract the alphanumeric characters from the plate.This extracted license plate number is stored for further processing

4. **DataTransmissionviaBluetooth(HC-05)**

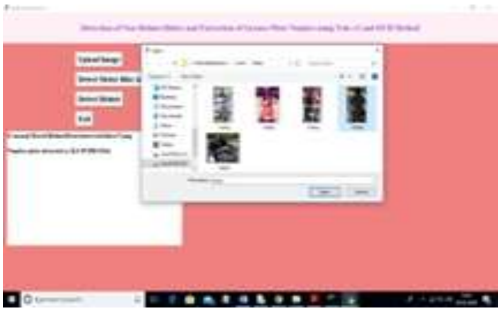
The extracted license plate number and violation details are sent wirelessly using the HC-05 Bluetooth module to a nearby monitoring device, smartphone, or police enforcement system. This ensures real-time communication with traffic authorities or law enforcement officers. If required, the data can also be uploaded to a centralized cloud server for record-keeping and analysis.

SystemTesting

Testingthebehaviorofthewholesoftware/systemasdefinedinsoftwarerequirements specification(SRS) is known as system testing, its main focus is to verify that the customer requirements are fulfilled.

RESULT

Aftersetting pathdoubleclickon‘run.bat’filetorun projectandto getbelowscreen



1.Inabovescreenapplicationdetectedthatpersonisnotwearinghelmetanditsextractednumber from vehicle and display in beside text area. Now we will check with helmet image

2.InabovescreenIamuploading4.pngwhichiswearinghelmetandnowclickon'DetectMotor Bike & Person'button to get below result

In above screen application detected person is wearing helmet and that label is displaying around his head and application stop there itself and not scanning number plate.

Note:Toimplementthisprojectandtoextractnumberplatewehavetrainedfewimagesandif uwanttoextractfornewimagesthensendthosenewimagestous,soweincludethoseimages in yolo model to extract new images number plate also.

APPLICATIONS

1. TrafficLawEnforcement

Thesystemcanbedeployedbytrafficpoliceandroadsafetyauthoritiestomonitorandpenalize riders who violate helmet laws. By automating the detection and fine issuance process, this system reduces the burden on law enforcement officers and ensures fair and consistent rule enforcement without requiring physical intervention.

2. SmartCitySurveillanceSystems

Many modern cities are adopting smart surveillance technologies to improve traffic management. This system can be integrated with existing CCTV networks in smart cities to provide real-time helmet violation detection, enhancing road safety and ensuring better compliance with traffic regulations.

3. HighwayandTollBoothMonitoring

Onhighwaysandattollbooths,thissystemcanbeusedtoidentifyhelmet-lessridersandstore their details for future reference. It can help authorities track repeat offenders and implement strict traffic discipline in high-speed zones where accidents are more likely.

4. VehicleRegistrationandInsuranceVerification

Insurance companies and transport departments can use this system to check whether a motorcyclistcomplieswithhelmetregulations.Repeatedviolationscanbelinkedtoinsurance premiumadjustmentsorrestrictionsonvehicleregistration,encouragingriderstofollowsafety rules.

5. AccidentPreventionandRoadSafetyAwarenessCampaigns

This system can serve as a preventive measure by deterring riders from violating safety laws. GovernmentagenciesandNGOscanusethedata collectedfromthesystemtoanalyzehelmet usage trends and run awareness campaigns promoting road safety.

REFRENCES

[1] J.Chiverton, "Helmet Presence Classification with Motorcycle Detection And Tracking",IETIntelligentTransportSystems,Vol.6,Issue3,pp.259–269,March2012.

[2] RattapoomWaranusast, NannaphatBundon,VasanTimtongandChainarongTangnoi, "Machine Vision techniques for Motorcycle Safety Helmet Detection", 28th International Conference on Image and Vision Computing New Zealand, pp 35-40, IVCNZ

2013.

[3] Romuere Silva, Kelson Aires, Thiago Santos, Kalyf Abdala, Rodrigo Veras, Andr´e Soares, “Automatic Detection Of Motorcyclists without Helmet”, 2013 XXXIX Latin America Computing Conference (CLEI).IEEE,2013.

[4] Romuere Silva, “Helmet Detection on Motorcyclists Using Image Descriptors and Classifiers”, 27th SIBGRAPI Conference on Graphics, Patterns and Images.IEEE, 2014.

[5] ThepnimitMarayatr,PinitKumhom,“Motorcyclist‟sHelmetWearingDetectionUsing ImageProcessing”,AdvancedMaterialsResearch Vol931-932,pp.588-592,May-2014.

[6] Amir Mukhtar, Tong Boon Tang, “Vision Based Motorcycle Detection using HOG features”,IEEEInternationalConferenceonSignalandImageProcessingApplications (ICSIPA).IEEE, 2015.

[7] Abu H. M. Rubaiyat, Tanjin T. Toma, Masoumeh Kalantari-Khandani, “Automatic Detection of Helmet Uses for Construction Safety”, IEEE/WIC/ACM International Conference on Web Intelligence Workshops(WIW).IEEE, 2016.

[8] XINHUA JIANG “A Study of Low-resolution Safety Helmet Image Recognition Combining Statistical Features with Artificial Neural Network”.ISSN: 1473-804x.

[9] KunalDahiya,DineshSingh,C.KrishnaMohan, “AutomaticDetectionof Bike-riders withoutHelmetusingSurveillanceVideosinReal-time”,Internationaljointconference on neural network(IJCNN). IEEE, 2016.

[10] MaharshDesai,ShubhamKhandelwal, LokneeshSingh,Prof.ShilpaGite,“Automatic Helmet Detection on Public Roads”, International Journal of Engineering Trends and Technology (IJETT), Volume 35 Number 5- May 2016, ISSN: 2231-5381.