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Driver Fatigue and Obstacle Detection System

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ABSTRACT

The increasing occurrence of accidents attributed to driver drowsiness and fatigue poses a significant threat to transportation safety. In response to this critical issue, we propose a novel Driver Drowsiness Detection System that employs image processing techniques to monitor drivers continuously. The core focus lies in the analysis of the driver's face and eyes for early detection of signs of drowsiness. The system utilizes a Raspberry Pi processor for efficient image processing. The proposed system consists of three main phases: Face Detection, Eye Detection, and Drowsiness Detection. The integration of these phases creates a comprehensive Driver Road Safety System, aimed at reducing accidents caused by driver drowsiness. The system's efficacy in improving road safety is attributed to its real-time monitoring capabilities, capacity to adjust to changing circumstances, and compatibility with warning systems. The results demonstrate the potential ofthissystemtosignificantlycontributetothereductionofaccidentscausedbydrowsy driving, thereby enhancing transportation safety.

Key words: Night Vision Camera, Alcohol Sensor, GSM Module, Ultrasonic Obstacle Sensor, GPS Module and GPS Antenna, Seatbelt Sensor, Raspberry pi, USB to TTL Module.

Abbreviations: GSM, Global system for Mobile communication; GPS, Global Positioning System; USB, Universal Serial Bus; TTL, Time to Live.

I.INTRODUCTION

Driverdrowsinessposesasignificantriskonroadsafety,contributingtoaround 30 percent of accidents, as identified in various surveys. The deteriorating attention levels of drivers, often due to insufficient sleep, prolonged driving, or medical conditions like brain disorders, underscore the need for effective drowsiness detection systems.Thisprojectaimstoaddressthisissuethroughanintelligentdriverassistance system utilizing image processing techniques.Theinitialsectionexploresvariousmethodsformeasuringdriverdrowsiness,including vehicle-based, physiological, and behavioral measures. An intelligent system is proposed to integrate these methods for timely driver alerts, preventing accidents. Advantages and disadvantages of each method are discussed, leading to the selection of the most suitable approach. The system's development approach is outlined using a flow chart, emphasizing continuous real-time image capture, face and eye detection, and drowsiness condition assessment.

Detaileddiscussionsonobjectdetection,facedetection,andeyedetectionareprovided. As faces are a type of object, object detection studies are conducted. Various approaches for face and eye detection are proposed and explained to form the foundation for the system.

Thetheoreticalfoundationforsystemdesignisestablished,highlightingthecomplexity of face structure. Facial mapping using harr-cascade algorithm is introduced as a method to recognize faces by projecting images onto a face space representing significant variations. Eigen face approach, incorporating Eigen values and vectors, face image representation, mean-centred images, covariance matrix, and Eigen face space, is explored for effective face recognition.[1]The hardware chosen for implementation is the Raspberry Pi, and the theoretical approach to drowsiness detection is detailed. Techniques such as Integral Image formation, Adaboost, and Cascading are employed. Code is developed to implement the proposed algorithm, and the Raspberry Pi is set up accordingly.[2] The system's responseisrecordedusingsubjects,withvisualindicationsofeyeopeningandclosure, demonstrating the algorithm's functionality.

II.RELATED WORK

In recent times, there has been a growing focus on researching remote access models for detecting driver drowsiness and monitoring health parameters. Previous studies havedelvedintounderstandingthecausesoffatigue.OmkarDharmadhikari'sresearch paper titled "Survey on Driver’s Drowsiness Detection System" [1] introduced a method based on measuring yawning and analyzing the driver's head position for detecting drowsiness. In the research paper titled "Drowsy Driver Detection Through Facial Movement Analysis" [2], EsraVura and Mujdat Cetin proposed a system based on the Facial ActionCodingsystem.Theymaintainedadatabaseusingmachinelearningtechniques to analyze facial movements for drowsiness detection. On the contrary, a system that recognizes a driver's sleepiness making use of physiological movements, behavior- based methods, and vehicle-based methods had been developed in research titled "Detecting Driver Drowsiness using Wireless Wearables" [3].

Inastudynamed“AMulti-Stage,Multi-FeatureMachineLearningApproachtoDetect Driver Sleepiness in Naturalistic Road Driving Conditions” [4] demonstrates how machine learning combined with deep learning is capable of precisely recognizing a weary driver. The paper titled "IoT-Based Driver Alertness and Health Monitoring System" [5] by T. Shwetha, J. Panduranga Rao, and B. Sreenivasu presented a model based on the Internet of Things (IoT). This system utilized a webcam to detect the driver's eye state and incorporated temperature and pulse rate sensors for monitoring the driver's health.

III.METHODOLOGY

In our real-time applications, we've successfully implemented a unique Haar cascade technique to pinpoint the area associated with a driver's face.[7] This technology enablesustoidentifyfacialexpressionsbyfocusingsolelyonfacialstructures,ignoring otherobjects.Ifthesystemdetectsanintoxicateddriver,ittriggersabuzzerandutilizes a GSM module to send alert messages to the driver's mobile device while tracking the vehicle'slocationthroughaGPSmodule.Ouralcoholsensor,connectedtoaRaspberry Pi,efficientlydetectsethanolintheairwhenadriverexhales,providingaquick response to determine alcohol levels. This sensor activates the GSM module to send SMSalertstoanemergencycontactaftersoundingthebuzzer.Thesystemaidsdrivers by addressing issues like alcohol consumption, recognizing hazards, ensuring seatbelt usage, and preventing drowsiness.

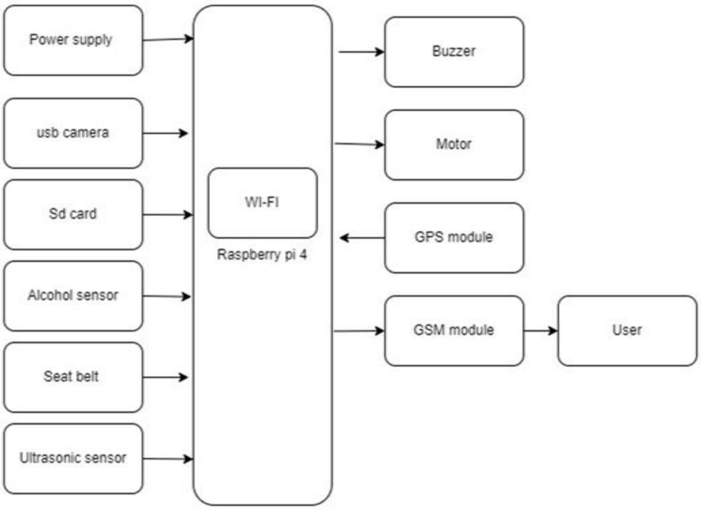

Figure 1:Shows block diagram of the Driver Fatigue andObstacle Detection System using Raspberry Pi

ThearchitectureofaDFODSencompassesvariouscomponents,includingsensors,data processing units, alerting mechanisms, and connectivity interfaces. Cutting-edge technologies such as computer vision, machine learning, and IoT play pivotal roles in realizing the system's functionality. SensorIntegration:Cameras:High-resolutioncamerascapturereal-timevideofeedof thedriver's face,allowingforthedetectionofdrowsinesscuessuchas eyeclosureand head nodding. Infrared Sensors: Infrared sensors monitor the driver's eye movement and blink rate, providing additional inputs for fatigue detection. Seatbelt Sensors: Seatbeltsensorsdetectthepresenceandproperusageofseatbelts,ensuringcompliance with safety measures.

Data Processing: Image Processing Algorithms: Advanced algorithms analyse the video feed to identify patterns indicative of driver fatigue or distraction. Machine Learning Models: Machine learning models trained on extensive datasets enable the system to recognize specific fatigue indicators with high accuracy. Real-time Processing: Processing units with sufficient computational power ensure timely detection of fatigue and obstacle detection.

Itisacapablelittledevicethat enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It’s capable of doing everything you’d expect a desktopcomputertodo,frombrowsingtheinternetandplayinghigh-definitionvideo, to making spreadsheets, word-processing, and playing games. What’smore,theRaspberryPihastheabilitytointeractwiththeoutsideworldandhas been used in a wide array of digital maker projects, from music machines and parent detectorstoweatherstationsandtweetingbirdhouseswithinfra-redcameras.Wewant to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work.

TheRaspberry Pi 4 Model B+is asingle-board computerdevelopedby theRaspberry Pi Foundation. It is an upgraded version of the Raspberry Pi 3 Model B+ and offers improved performance and features. Here are the key features of the Raspberry Pi 4 Model B+.

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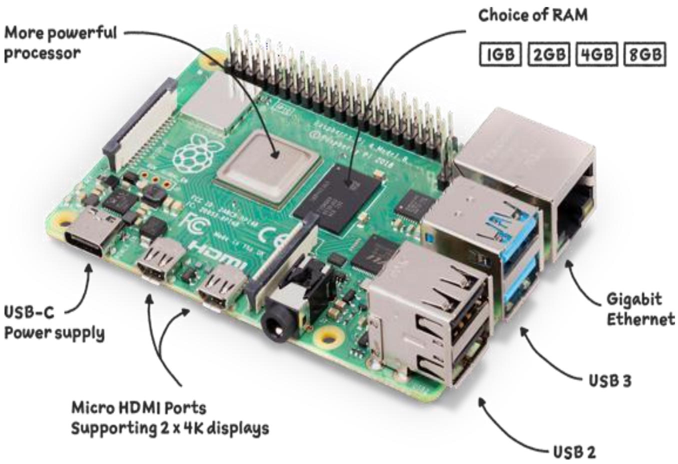


Figure 2: Shows Raspberry PiModel4 B+

PYTHON IDLE: IDLEStandsforIntegratedDevelopmentandLearningEnvironment.Thestorybehind thenameIDLEissimilartoPython.GuidoVanRossumnamedPythonaftertheBritish comedy group Monty Python while the name IDLE was chosen to pay tribute to Eric Idle,whowasoneoftheMontyPython'sfoundingmembers.IDLEcomesbundledwith the default implementation of the Python language since the 01.5.2b1 release. It is packagedasanoptionalpartofthePythonpackagingwithmanyLinux,Windows,and Mac distributions.

HAAR-CASCADESOFTWARE: AdetaileddescriptionofHaarclassifierscanbeseeninPaulViolaandMichaelJones's paper "Rapid Object Detection using a Boosted Cascade of Simple Features", linked overhere.Notethatthearticlegoesintosomemathematics,andassumesknowledgeof machine learning terminology.

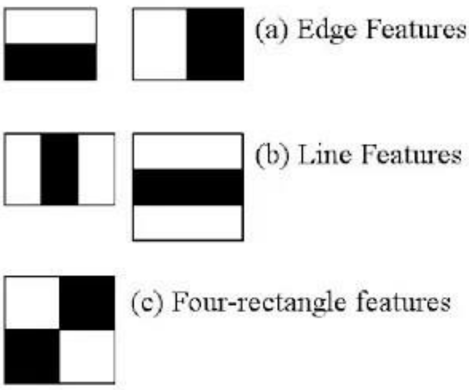


Figure 3:Shows Types of Haar Features

CreatingIntegralImages: Withoutgoingintotoomuchofthemathematicsbehindit (check out the paper if you're interested in that), integral images essentially speed up the calculation of these Haar features.

Instead of computing at every pixel, it instead creates sub-rectangles and creates array references for each of those sub-rectangles.

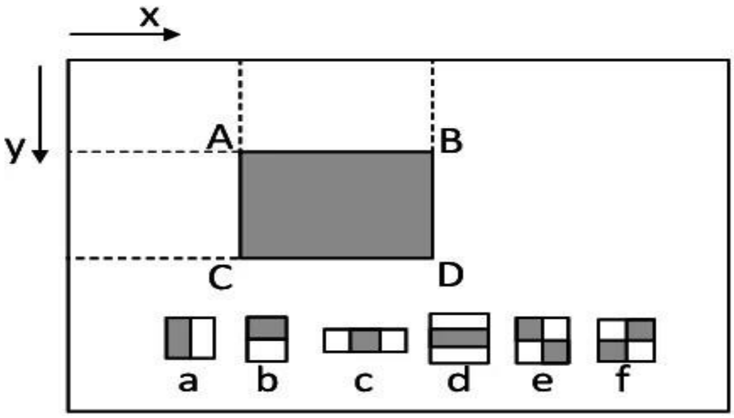
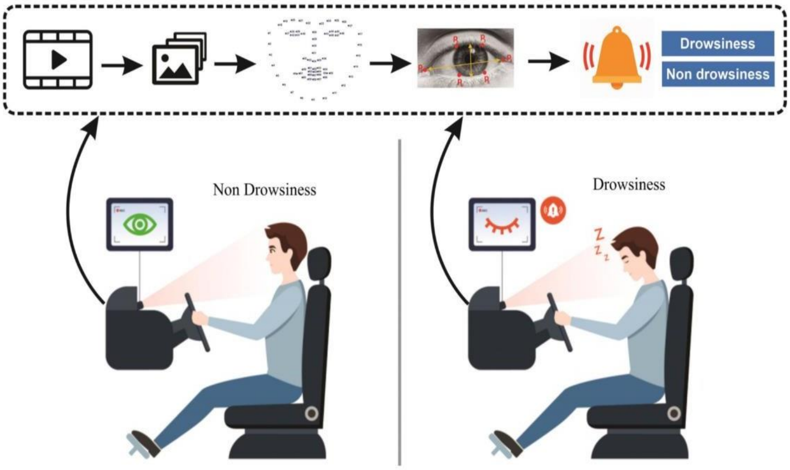


Figure 4:Shows Illustration for how an integral image works.

IV.RESULTS

Theillustrationoftheexperimentalconfigurationfortheproposed"DriverFatigueand Obstacle Detection System using Raspberry Pi" is presented in Figure 7.2. This setup comprisesallthedesignatedsensors,eachofwhichhasundergonethoroughtestingand functionsseamlessly.Thehardwareisdesignedforeffortlessintegrationwithadvanced devices or any forthcoming technological enhancements. Additionally, it offers seamlessintegrationintoautomobiles,allowingforstraightforwardconnectiontotheir powersupply and system. Thesystem is adaptable and canbeeasily incorporatedinto future advancements or integrated into various automotive setups



. **Figure 5: Shows the Working of the driver fatigue detection system.**

In real-time video feeds, the shape predictor predicts the face and eye regions. The EAR, calculated as the Euclidean distance between the two eyes, determines the level of drowsiness. Face landmark identification is performed by referencing the created dataset.ThealgorithmcalculatestheEARacrossmultipleframes,displayingoneblink at a time. If the Raspberry Pi module detects driver fatigue, it triggers a high-pitched alarm throughthebuzzer as theinitial safety measure. As asecondarysafety measure, the GSM module is activated to establish communication with an operator or an emergency contact in a remote location.

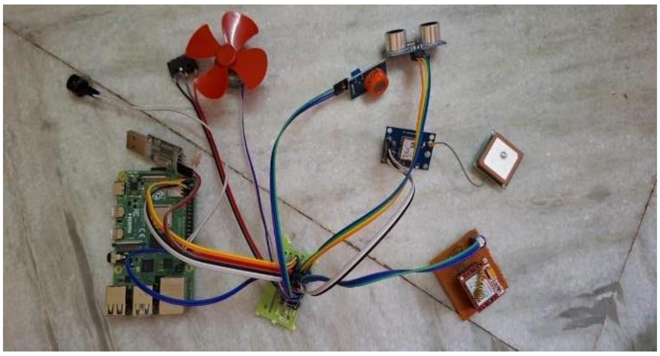


Figure 6:Shows the Experimental proposed system

The console output serves as a system-specific display appearing on the screen of the systemexecutingthePythonprogram,anditistransmittedtotheRaspberryPimodule.

Withintheframeworkoftheproposedproject,thesystemgeneratesvariousemergency messages and console outputs. Examples of these messages include prompts such as "Please reduce speed, vehicle detected ahead," "Driver in abnormal condition," and "Driver under the influence of alcohol," among others. These messages are triggered based on the inputs received by the system, enhancing the overall functionality and safety features of the project.

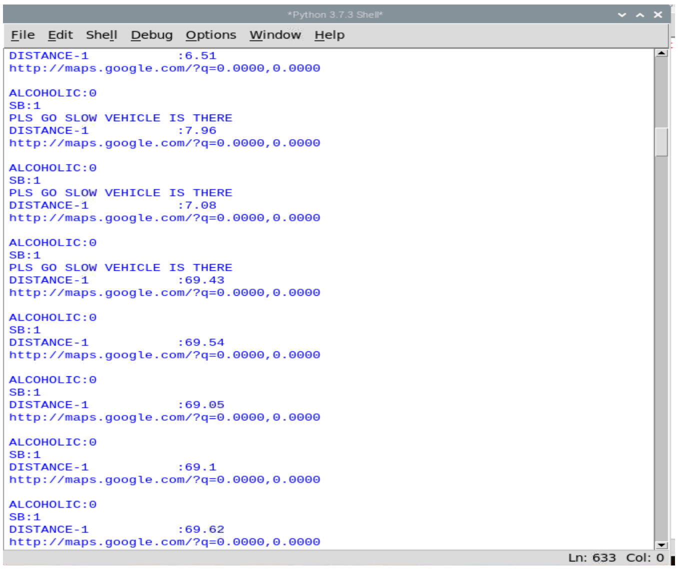


Figure 7:Shows the Console output

V.CONCLUSIONS

The primary objective of driver fatigue detection is to prevent accidents caused by drowsinessbyensuringdriversremainalertwhileoperatingavehicle.Toachievethis, abuzzeremits an alertsignal to awaken thedriver ifsigns offatiguearedetected. The Raspberry Pi, in conjunction with a USB camera, continuously assesses the driver's fatiguelevelinreal-time.TheassessmentinvolvesutilizingtheHaarCascadeClassifier to identify facial features, with a focus on the eyes. Facial landmarks are pinpointed usingashapepredictor,andtheEyeAspectRatio(EAR)iscomputedbymeasuringthe Euclidean distance between the eyes. Precise identification of facial and eye features in each image enables the calculation of the driver's level of sleepiness. The system accurately records frequent head tilting and eye blinking, providing valuable indicators of drowsiness. Additionally, the inclusion of a seat belt sensor, an alcohol sensor, and an obstruction sensor adds an extra layer of precaution for the driver. In the event that the driver's sleepiness approaches a critical threshold, a loud warning is triggered to rouse them from their drowsy state.

VI.DISCUSSIONS

In the future, the implementation may be done in a well-lit space with constant illumination, for various lighting scenarios, and it can also be taken into consideration for those with dark skin. The future scope of driver drowsiness detection holds significantpotentialforfurtheradvancementsandimprovementsinroadsafety.Several avenues can be explored to enhance the effectiveness and features of such systems.

AdvancedSensing Technologies: Integration of more advanced sensors, such as EEG (Electroencephalogram) sensors or advanced computer vision systems, can provide a more comprehensive analysis of the driver's physiological and behavioural indicators of drowsiness.

MachineLearning andAI Integration: Utilizing machine learning algorithms and artificial intelligence (AI) can enhance the system's ability to adapt and learn from diverse driving scenarios, making it more accurate in detecting subtle signs of driver fatigue.

Biometric Authentication: Incorporating biometric authentication methods, such as facial recognition or fingerprint scanning, could add an additional layer of security, ensuring that the detected drowsiness is associated with the authorized driver.

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