International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-13 Issue-6, May 2024

Driver Distraction and Drowsiness Detection Based on Object Detection Using Deep Learning Algorithm

T. Nandhakumar, S. Swetha, T. Thrisha, M. Varunapriya

Abstract: ***Distracted driving is a major global contributing factor to traffic accidents. Distracted drivers are three times more likely to be involved in an accident than non-distracted drivers. This is why detecting driver distraction is essential to improving road safety. Several prior studies have proposed a range of methods for identifying driver distraction, including as image, sensor, and machine learning-based approaches. However, these methods have limitations in terms of accuracy, complexity, and real-time performance. By combining a convolutional neural network (CNN) with the You Only Look Once (YOLO) object identification method, this study suggests a unique way to driver distraction detection The two primary phases of the suggested paradigm are object identification utilizing Yolo and classification of the identified things. The YOLO algorithm is used to identify and pinpoint the driver's hands, face, and any other objects that might draw their attention away from the road. The objects that have been observed are then categorized using a CNN to determine whether or not the driver is distracted. When evaluated on a publicly available dataset, the proposed model shows good performance in detecting driver preoccupation. Utilize the CNN algorithm in addition to ocular features to determine the driver's level of fatigue. The proposed method might be incorporated into advanced driver assistance systems with real-time environment to improve road safety.***

Keywords: ***Convolutional Neural Network, Driver distraction, Drowsiness Detection, Object Detection, Yolo Algorithm.***

I. INTRODUCTION

A driver monitoring system (DMS) is a piece of technology that follows a driver's movements and uses sensors and cameras to look for signs of exhaustion, inattention and impairment. Technology aims to improve road safety by warning drivers or by taking corrective action.

Manuscript received on 30 April 2024 | Revised Manuscript received on 11 May 2024 | Manuscript Accepted on 15 May 2024 | Manuscript published on 30 May 2024.
*Correspondence Author(s)

Mr. T. Nandhakumar, Assistant Professor, Department of Computer Science and Engineering, Mahendra Engineering College, Namakkal (Tamil Nadu), India. Email: nandhakumartm93@gmail.com, ORCID ID: 0009-0006-6009-9876

Ms. S. Swetha*, UG Scholar, Department of Computer Science and Engineering, Mahendra Engineering College, Namakkal (Tamil Nadu), India. Email: swethasundaresan583@gmail.com, ORCID ID: 0009-0005-2211-6076

Ms. T. Thrisha, UG Scholar, Department of Computer Science and Engineering, Mahendra Engineering College, Namakkal (Tamil Nadu), India. Email: thrishathangaraj@gmail.com, ORCID ID: 0009-0001-6010-1642

Ms. M. Varunapriya, UG Scholar, Department of Computer Science and Engineering, Mahendra Engineering College, Namakkal (Tamil Nadu), India. Email: varunmvp7@gmail.com, ORCID ID: 0009-0006-9580-5726

DMS is becoming more common in automotive sector as safety component of advanced driver assistance systems (ADAS) and driverless vehicles. Two of the main causes of traffic accidents are driver fatigue and inattentiveness. According to the National Highway Traffic Safety Administration (NHTSA), 3,142 accidents involving distracted driving claimed lives in 2019. Furthermore, fatigue is believed to be contributing up to 20% of all traffic accidents. Therefore, detecting and reducing fatigue along with distraction is necessary for improving road safety. DMS track the driver's movements using a range of cameras and sensors, including biometric sensors, head position, facial recognition, and eye tracking. These sensors are able to detect signs of fatigue like drooping eyelids or changes in head position, as well as evidence of distraction, such as looking away from road or using a phone. The system can then issue visual or auditory cues to the driver, or it can fix the situation by adjusting the seat position or reducing the speed of the vehicle. DMS is useful in detecting impairments relates to driving, such as drunk driving. This system may detect irregularities in driver's behavior, such as slurred speech, impaired motor function, which will alert them or take action by telling them to go to the side of the road. In conclusion, DMS is a crucial piece of equipment that enhances safety on the road by spotting and preventing driver fatigue, inattention, impairment. The technology is being increasingly commonly used in the automotive industry as an ADAS and autonomous vehicle safety feature. As technology advances, it might significantly decrease the number of road accidents caused by careless driving.

Among the most eminent applications of intelligent transportation systems are the enhancement of public safety and the reduction of accidents (ITS). Particularly on rural roads, one of the main causes of accidents is fatigued driving. Fatigue impairs a driver's insight and ability to make decisions that will keep the car under control. Tiredness and drowsiness impair a driver's ability to handle the car, react instinctively, recognize, and perceive their surroundings. Consequently, it is imperative that driver assistance systems that identify driver weariness and drowsiness be incorporated into the current automotive industry trend. This study presents a non-intrusive prototype computer vision system for tracking a driver's concentration in real time. Eye tracking is a crucial technology for future driver assistance systems since human eyes carry a wealth of information about a driver's state, including gaze, attention span, and level of weariness. Reducing the frequency of collisions and facilitating safe driving for all drivers are the objectives.

The real-time eye tracking and detection method outlined in this study functions in lighting situations that fluctuate realistically. It is based on a software system that records a driver's perspective in real time using a camera and incorporates eye monitoring to stop collisions.

The increased circulation of huge vehicles at night has made driving risky, resulting in numerous accidents and concerns for the public and transportation authorities. The drivers are forced to travel without stopping after a few days of constant driving, which impairs their ability to drive and slows down their reflexes, increasing the likelihood of accidents. Fatigue is identified as the primary cause of drowsiness in the majority of accident instances. The word "fatigue" describes a group of symptoms that include subjective feelings of sleepiness and diminished performance. Notwithstanding the extensive study conducted, there is still no consensus definition for the term "fatigue." Figure 1 shows the driver drowsiness detection.

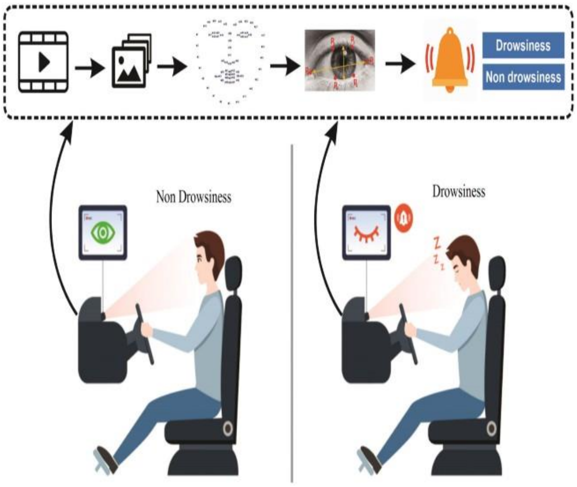

Fig. 1. Drowsiness Analysis

II. LITERATURE SURVEY

Narayana Darapaneni, et.al [1][6][7][8][9][10]. designed to keep drivers and passengers safe in the event of an accident by providing tools that warn of possible issues and serve as a deterrent to collisions. However, even the most recent autonomous cars nonetheless require the driver to be vigilant and ready to regain control of the car in an emergency. In May 2016, the first fatal autonomous car event happened in Florida's Williston when a Tesla autopilot and a white truck trailer collided. In March 2018, an Uber self-driving car with an emergency backup driver at the wheel struck and killed a pedestrian in Arizona. In both of these accidents, the safety driver had the chance to stop the collision, but the evidence shows that he was visibly distracted. This means that detecting inattentive driving is also a crucial component of self-driving automobiles. We think that identifying distracted drivers is crucial for developing more preventative strategies. The purpose of this study is to determine the reason of driver distraction and to concentrate on identifying manual distractions when the driver is not focusing on the road. We present a convolutional neural network-based solution to this problem. Additionally, we strive to reduce the memory and computational costs while maintaining an accuracy high enough for real-time applications. Global traffic accident rates have been steadily rising over the last few years. A National Highway Traffic Safety Administrator research states that nearly one in every five car accidents are caused by inattentive driving. Our objective is to develop a dependable and precise system that can recognize distracted driving and notify the driver when it happens. Inspired by Convolutional Neural Networks' remarkable abilities in computer vision, we introduce a CNN-based system that can identify the source of attention in addition to detecting distracted driving.

Monagi h. Alkinani, et.al, [2] anything that causes one to become distracted or lose focus while driving is regarded to be, when a driver is not paying attention to driving, it's referred to as inattentive driving. Distractions cause human drivers to become less skilled drivers, which finally results in auto accidents when the vehicle loses control and starts to drift outside of lanes or change speed suddenly. Two things might cause a driver to get distracted: first, when he begins engaging in activities other than driving; second, when someone else causes the distraction; and third, when something unexpected happens and diverts the driver's focus. Depending on their degree and nature, human driver distractions can take many various forms. Distractions include using a cell phone, taking calls, reading or sending texts, glancing at other drivers and objects outside the car, smoking, drinking, and eating. Additionally, using smart devices like infotainment systems in cars or smart watches, together with any entertainment or navigation apps, might divert drivers' attention from operating a motor vehicle. Human driver distractions come in six flavours: physical, optical, cognitive, olfactory, gustatory, and auditory. A driver engaging in manual distraction is one who removes their hands from the steering wheel. Drivers who divert their attention from the road are committing the sort of distraction known as visual distraction. When a motorist takes their eyes off the road to think about something other than driving, this is known as cognitive distraction.

Md. Uzzol hossain, et.al [3]. A study on deep learning is applied to idea drift and multitasking. With the enormous resources required to train deep learning models or the large and challenging datasets used to train deep learning models, one popular deep learning method is move learning. Profound learning move learning works best when the model highlights that are first gotten are enormous. To prepare a subsequent objective organization on an objective dataset and task, the learnt highlights are first moved to a base organization that has been prepared on a base dataset and task. This technique is more likely to work if the attributes are generic, meaning they can be applied to both the base and goal duties, rather than being job-specific. Transfer learning is a useful tool for solving predictive modeling problems. The two most widely used transfer learning techniques are the develop model method and the pre-trained model approach. for the purpose of classifying picture data on the ILSVRC (ImageNet Huge Scope Visual Acknowledgment Challenge), various high-performing models have been formed and placed into utilization.

Retrieval Number: 100.1/ijitee.F988813060524
DOI: 10.35940/ijitee.F9888.13060524
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

ImageNet, the wellspring of the opposition picture, has helped with the creation and preparing of convolutional brain organizations. Moreover, a large number of the models utilized in the rivalries were dependent upon lenient licenses. These models can be utilized as the establishment for PC vision applications that utilization move learning. The supportive learning highlights let the models distinguish the conventional characteristics from the photographs. The models accomplish cutting edge execution for a few picture recognizable proof errands and keep on turning out successfully for the undertakings for which they were planned.

Mustafa aljasim, et.al,…[4] Emergence of new technologies and modes of transportation is necessary to provide effective and efficient services to people. The economy, the environment, and people's physically and mental health can all benefit from the construction of a reliable and secure transport network. One of the main problems with our present transportation system is the rising incidence of accidents. The World health Association positions auto collisions as the 10th most normal reason for mortality internationally. An expected 50 million individuals are harmed and 1.35 million individuals pass on in car crashes yearly. Because this, transportation protection is a huge global concern. Distracted driving, which includes chatting on the phone, smoking, and using a mobile device, is to blame for more than 80% of traffic incidents. As a result, driver action analysis and monitoring have received increasing focus. Many attempts have been made to use effective strategies that use countermeasures for distracted driver actions to address the issue of driver distraction. The three types of measures are: (1) preventing distractions before they happen; (2) detecting distracting actions (by being vigilant) after distractions happen; and (3) avoiding collisions when one is anticipated. To reduce the frequency of accidents brought on by distracted driving, government legislation, strong fines, and public awareness campaigns are utilized to stop distraction sources before they occur. The performance of numerous cutting-edge picture deep learning classification techniques is initially examined in this research.

Abeer. A. Aljohani, et.al,..[5] According to studies, using a phone while driving raises the risk of an automobile accident four times higher than normal driving. With a basic camera and a clear view of drivers, dangerous behavior can be observed and prevented. Artificial Intelligence (AI) is one of the most crucial instruments for tracking these drives patterns. Profound learning (DL) and AI (ML) are the two essential and popular subfields of man-made intelligence. Convolutional Brain Organizations are among the best profound learning calculations (CNN). Specialists have been focusing on making reliable structures to recognize unsafe way of behaving and stop mishaps in the consequence in recent years. The goal of this project is to create a hybrid model that monitors the driver's behavior and minimizes distractions by utilizing the most recent advances in computer vision and text categorization technology. The performance of CNN for identifying potentially risky behavior is influenced by many hyperparameters. CNN can be used by researchers for a range of computer vision problems with these parameters. Nevertheless, the cost of confusion in creating the optimal model is associated with versatility. Because AI capabilities have advanced significantly, researchers can now quickly train complicated models on powerful computing processors. The real-time performance of the algorithms for detection and classification was enhanced by this capability. This study uses cutting-edge deep learning techniques to create a fully functional standalone system for tracking and identifying driver behavior.

III. EXISTING METHODOLOGIES

Several techniques have been distributed in the writing to decide driver interruption. These frameworks can be separated into three fundamental classes: frameworks in light of AI, frameworks in view of pictures, and frameworks in light of sensors. Picture based frameworks use cameras or different sensors to catch pictures of the driver, which are then analysed to check for signs of distraction. Typically, computer vision algorithms are used by these systems to recognize the driver's face, eyes, and hands and to follow their movements. The Face and Eyes Activity Detection (FEAD) system is an illustration of an image-based system. It employs a camera to identify the driver's face and eyes and examines them for indications of distraction. Another illustration is the Face LAB system, which records the driver's face using several cameras and analyzes their expressions for indications of distraction. Sensor-based systems monitor driver behavior and identify indicators of distraction or fatigue using sensors including electroencephalography (EEG), gyroscopes, and accelerometers. For instance, Volvo's Fatigue Detection System monitors the driver's grip strength and looks for indicators of fatigue using sensors in the steering wheel. The problem of false positives, in which the system reports distraction when the driver is not genuinely distracted, is one of the major obstacles. Many things, including variations in the lighting, other occupants in the car, or the actions of the driver, can result in false positives. Real-time performance is another difficulty, especially for independent vehicles where the framework should have the option to answer quick to potential dangers. This requires the framework to have low inertness and great precision, which can be difficult to do, especially in complex driving settings. Fig 2 shows the existing hardware based implementation framework.

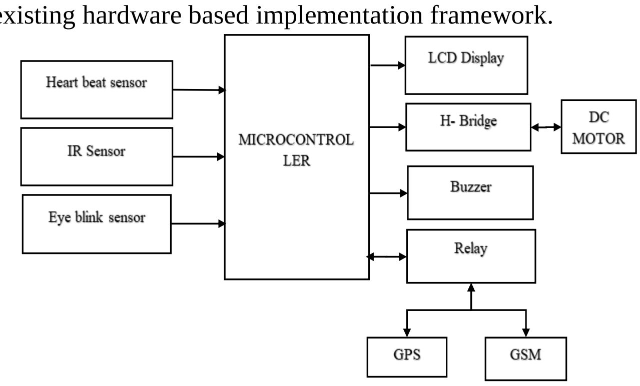

Fig. 2. Existing Framework

IV. PROPOSED METHODOLOGIES

Using a range of sensors and algorithms, a system known as driver distraction detection monitors a driver's activities and searches for signs of diversion. The technology may detect whether a driver is not paying enough attention to the road, regardless whether the distraction is coming from an external source like using a phone or an internal one like tiredness. Comparing the suggested approach to current driver monitoring systems, there are a number of benefits. Firstly, it combines machine learning and object detection algorithms to detect indicators of tiredness and distraction with a high degree of accuracy and consistency. Secondly, the system is engineered to function in real-time with minimal latency, guaranteeing prompt detection and resolution of potential threats. Lastly, the device is an affordable way to increase road safety because it is simple to include into current cars. In any case, there are a few limitations and hardships with the recommended framework too. The YOLO algorithm's requirement for high-quality camera photos in order to correctly identify the driver's face and eyes is one of the primary obstacles. This can be especially difficult when it's cloudy or dark outside. Furthermore, the CNN algorithm's correctness in the training set of data is crucial to the system's operation. As a result, it is crucial to guarantee that the dataset used to train the CNN algorithm accurately represents actual driving situations. The suggested YOLO and CNN algorithm-based method for detecting driver distraction and tiredness has the potential to increase traffic safety. Nonetheless, additional investigation and advancement are required to tackle the constraints and difficulties linked with the system and guarantee its efficacy in actual driving situations. The suggested system architecture for tiredness and driver distraction is depicted in Fig.3.

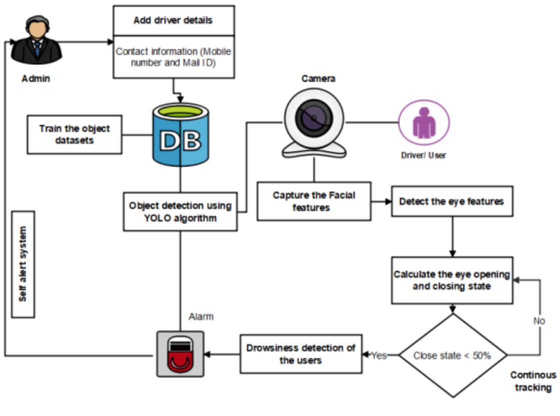

Fig. 3. System Architecture

The eye aspect ratio (EAR), which is the ratio of eye width to eye length, can be used to determine how often an eye opens and closes. The EAR value is bigger while the eye is open and goes to zero when the eye is closed. This value is dependent on the size of the eye. The eye contour is located initially, the EAR value is computed using the eye key point, and the variation in the EAR value represents the state of the found person's eyes. The positioning of the left eye key points is $p60-p67$ The formula for EAR calculation is as follows:

$$EAR = \frac{||P_{61} - P_{67}|| + ||P_{63} - P_{65}||}{2||P_{60} - P_{64}||} \quad (1)$$

The threshold was set to 0.15 after numerous experiments and data checks revealed that setting the EAR value to 0.15 increased detection accuracy and stability. When EAR is less than 0.15, it can be judged that the eye's state is closed.

A. Yolo Algorithm Steps

Step 1: An input image is divided into a S × S grid by YOLO.
Step 2: A grid cell is responsible for detecting an object when its center is inside it.
Step 3: For every grid cell, the B bounding boxes and their corresponding confidence ratings are estimated. These confidence scores show how much the model thinks the box contains an object and how much it thinks the predicted box is correct.
Stage 4: YOLO predicts numerous jumping boxes for every framework cell. During preparing, we just need one bouncing box indicator to be responsible for every thing. Just go for it doles out an indicator the title of "mindful" indicator for an item founded on whose expectation has the most elevated current IOU with the ground truth.
Step 5: Each predictor boosts the total recall score by improving its capacity to predict particular object sizes, aspect ratios, or classes.

V. EXPERIMENTAL RESULTS

Real-time datasets were used in this chapter. The sleepiness detection approaches were applied on this framework. After then, exact measurements can be use to assess performance. The accuracy metric was evaluated as

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} *100 \quad (2)$$

The proposed algorithm provides improved exact rate than machine learning algorithms. Accuracy table shown in table 1.

TABLE I. Accuracy Table

Algorithm	Accuracy (%)
Naives bayes	20
SVM	50
CNN	70

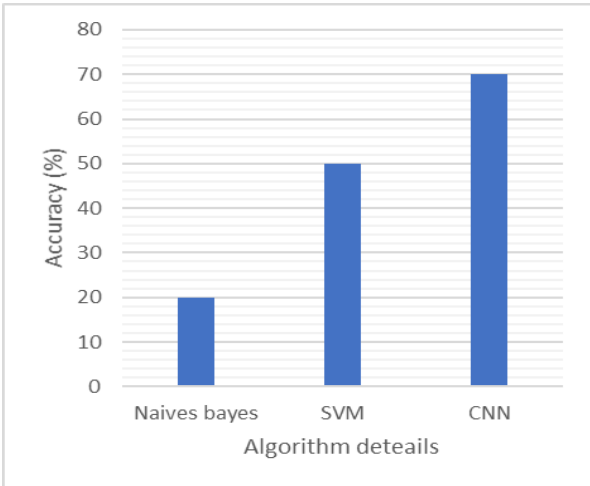

Fig. 4. Performance Report

Based on the performance chart, CNN outperforms the current machine learning algorithms in terms of accuracy. The suggested method lowers the amount of false positives.

VI. CONCLUSION

In conclusion, as driver distraction detection has the ability to prevent crashes and save lives while driving, study into the technology is crucial. The proposed technique for using CNN and YOLO algorithms to identify driving distraction and fatigue may be a helpful way to identify potential hazards and promptly alert drivers to them. The COCO dataset is used to train the YOLO model, and the camera is utilized to capture images of the driver and assess their behavior. The YOLO model is used to detect objects, while the CNN algorithm is used to study the driver's behavior and identify signs of fatigue and distraction. Moreover, improving the accuracy of the object identification algorithm can benefit the proposed system. This can be achieved by increasing the size of the training dataset or by using a pre-trained model that has been trained on a larger dataset. Combining the system with other state-of-the-art technologies, such as artificial intelligence, machine learning, and computer vision, can also improve it. Incorporating distraction detection methods other than visual ones is another topic of future investigation for driver distraction detection. For example, machine learning algorithms that examine the sounds in the car or the speech patterns of the driver can be used to identify auditory distraction. Sensors that detect movement, like as accelerometers or gyroscopes, can be used to identify tactile distractions, such as when a driver uses a phone.

DECLARATION STATEMENT

Funding	No, I did not receive.
Conflicts of Interest	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material	Not relevant.
Authors Contributions	All authors have equal participation in this article.

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AUTHORS PROFILE

Mr. T. Nandhakumar, M.E., is an Assistant Professor, in the Department of Computer Science and Engineering at Mahendra Engineering College, Namakkal, Tamil Nadu, India. He completed his Bachelor of Engineering in the Department of Computer Science and Engineering at Muthayammal Engineering College, Rasipuram under Anna University, Coimbatore. He completed his Master of Engineering in the Department of Computer Science and Engineering at Gnanamani College of Technology, Pachal, under Anna University, Chennai. His research interest is Deep Learning, and so he completed the Deep Learning course in NPTEL.

Ms. S. Swetha, is a UG Scholar in the Department of Computer Science and Engineering at Mahendra Engineering College, Namakkal, Tamil Nadu, India. She won Third prize in the idea presentation conducted at Rajalakshmi Engineering College, Chennai, Tamilnadu, for her paper titled Challenges of 5G Technology. She secured 85% in the Cloud Computing course and 82% in the Introduction to Internet of Things course in NPTEL. She acquired Microsoft Azure Fundamentals certification in 2022. She had been an Automation Intern at NextWealth from August 8, 2022, to November 7, 2022. She has handled Robotic Process Automation projects in 2023. Her area of interest is Deep Learning.

Ms. T. Thrisha, is a UG Scholar in the Department of Computer Science and Engineering at Mahendra Engineering College, Namakkal, Tamil Nadu, India. She did a full stack development internship in ICT Academy in Virtual mode. She completed the Internet of Web Technology-5 course. Her area of interest is Deep Learning.

Ms. M. Varunapriya, is a UG Scholar in the Department of Computer Science and Engineering at Mahendra Engineering College, Namakkal, Tamil Nadu, India. She completed the Cloud computing course in NPTEL securing 65%. She had undergone the Virtual internship program by ICT academy. She accomplished her activeness in a paper presentation at Govt Engineering College, Salem. She is good at articulation and performed in a hackathon conducted at Mahendra Engineering College. Her area of interest is Deep Learning.