ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 11, Issue 3, March 2024

Comprehensive Analysis and Implementation of a Multi-Factored Detection System for Accident and Risk Analysis in Smart Cities

[1] Divleen Kaur Chugh, [2] Tripti Jain, [3] Aryan Birla, [4] Dr Sandeep Tayal, [5] Mr. Ashish Sharma

[1] [2] [3] [4] [5] Department of Computer Science and Engineering, Maharaja Agrasen Institute of Technology, Affiliated to G.G.S.I.P. University, Delhi, India

Corresponding Author Email: [1] dchugh121@gmail.com, [2] jaintripti59@gmail.com, [3] b.birla167@gmail.com

Abstract— ***Road safety is a paramount concern worldwide. Enhancing road safety remains a critical societal concern, prompting the need for innovative solutions to reduce accidents and enhance transportation security. This research aims to propose a system that utilizes an affordable and accessible multi-factored detection approach, diverging from prevalent single-factor detection methods.***

By examining the intricate web of factors contributing to road mishaps and harnessing advanced technologies, this study aims to tackle the diverse factors contributing to accidents. Employing a deductive and confirmatory research approach, this study systematically investigates crucial factors that intensify the risks of accidents, encompassing over speeding, rash driving, DUI, driver fatigue, and distractions while driving.

This study combines a range of advanced technologies to reinforce its methodology, incorporating OpenCV-based object detection, machine learning models specifically designed for distraction recognition, facial and pose detection systems, sensor-based technologies, and GPS. These technological facets collectively work to identify, classify, and mitigate multiple aspects, including over speeding, inattention, physical fatigue, and rash driving, forming the bedrock of the research approach.

The proposed system, marked by ease of use, budget-friendliness, and multifactor detection capabilities, stands as a potential frontier in road safety technology. The implications of this study underscore the feasibility and effectiveness of integrating these technologies to not only enhance road safety but also significantly reduce accidents, thereby saving lives and fostering a more secure transportation environment. This comprehensive approach paves the way for a paradigm shift in mitigating road accidents, highlighting the significance of technology-driven solutions for ensuring a secure transportation landscape.

Keywords: Driver's Fatigue Analysis, DUI and distraction detection, GPS-Based Velocity Detection, Machine Learning Models, Overspeeding Mitigation, Rash Driving Identification.

I. INTRODUCTION

India, a nation of diverse cultures, landscapes, and flourishing technological advancements, grapples with a pressing concern that casts a shadow on its progress: the widespread severity of accidents. The sheer scale and gravity of accidents across the Indian landscape have emerged as a formidable challenge, impacting lives, livelihoods, and the socio-economic fabric of the nation.

Statistics paint a distressing narrative, revealing a stark reality that cannot be overlooked. India ranks first globally in road fatalities, accounting for 11% of such incidents worldwide. According to the 'Road Safety in India' report by the Economic Times, the country witnesses the loss of 1.5 million lives annually due to road crashes. As per the World Health Organization (WHO), road crashes are the 8th leading cause of death, with more than 1.3 billion deaths and 50 million serious injuries. It is the leading cause of death among youths and kids aged 5 to 29 years. The WHO identifies India as one of the countries bearing the highest burden of road traffic accidents globally, with an alarming toll on human lives. Recent reports show India witnessing a staggering number of fatalities and injuries due to road accidents, placing it among the top-ranking countries for road accident-related casualties.

Mitigating road accidents is a persistent challenge demanding a focused approach in risk detection and prevention. Prevailing methods for analysing road accidents often rely on singular factors such as traffic violations or road conditions. However, these limited approaches fail to encapsulate the multitude of variables contributing to accidents, hindering the development of comprehensive preventative measures. The complexity of road accidents, shaped by diverse factors like driver behaviour, distractions behind the wheel, instances of driving under the influence, driver fatigue, speeding, reckless driving, and vehicle conditions, underscores the need for a comprehensive and inclusive analytical approach.

Addressing the limitations of current methods is crucial to devise a nuanced and multidimensional detection system that amalgamates various data sources and technological advancements. Such an integrated approach holds the promise of substantially enhancing road safety measures and reducing the alarming frequency and severity of accidents on Indian roads. As India embarks on a trajectory of growth and

ISSN (Online) 2394-2320
International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 11, Issue 3, March 2024

development, the need to address this specter of accidents becomes an urgent imperative.

Addressing the severity of accidents demands a comprehensive, multi-faceted approach that amalgamates innovative technologies, robust policies, public awareness campaigns, and strategic interventions across various domains. This study investigates the severity and root causes of accidents in India, advocating for a comprehensive multi-factored detection system.

Our innovation integrates GPS for over speeding detection and advanced image analysis for identifying DUI, distractions, and driver fatigue. Through rigorous analysis and strategic proposals, this research aims to significantly reduce accident severity, paving the way for a safer and more resilient India.

Table I

PARAMETER	2020	2021	% Change
Number of Accidents	3,66,138	4,12,432	12.6
Number of people killed	1,31,714	1,53,972	16.9
Number of Injury	3,48,279	3,84,448	10.4
Accident Severity (People killed in 100 accidents)	36	37	

Data source- (Ministry of Road Transport & Highways 2023) *[29]*

II. LITERATURE SURVEY

Recent research addresses driver distraction in intelligent transportation systems [2] by proposing a driver distraction detecting and inattentive driving behaviours, employing machine learning and deep learning algorithms for accurate measurement and classification [1]. Comprehensive detection of driving fitness issues, such as drowsiness and alcohol influence, is proposed using facial landmark detection and motion analysis [8] Further research includes fatigue detection through facial analysis [12]. Also, IoT-based systems [11] can be integrated for obstacle detection, alcohol sensing, and over-speeding detection for comprehensive accident prevention and response. A solution for effective speed control using Zigbee and GPS technology is proposed, emphasising cost-effectiveness and ease of installation [15]. An economical vehicle tracking system merging Smartphone technology with GPS and GSM/GPRS is introduced for real-time tracking [7], [16]. Machine learning's role in estimating stress levels using bio-signals is explored, demonstrating Random Forest's superiority [21]. Enhanced vehicle safety through non-intrusive eye tracking for driver fatigue detection is demonstrated [23]. YOLO, a novel object detection approach, achieves real-time processing speeds with impressive accuracy [18]. Additionally, research endeavours focusing on fatigue detection [9], [23] using eye state analysis and facial landmark detection underscore the significance of real-time monitoring in preventing accidents due to driver fatigue.

These studies collectively contribute to a comprehensive understanding of the multifaceted nature of road safety concerns and highlight the potential of combining various technological interventions, ranging from distraction detection systems and fatigue monitoring to overspeeding detection and object recognition, in diminishing road accidents and improving overall safety measures.

III. METHODOLOGY

This study employs a deductive and confirmatory research approach, utilizing a research framework to derive conclusions. Our research philosophy revolves around proposing a solution that is not only the most feasible and convenient but also cost-effective, easily implementable, and budget-friendly. The primary goal is to enhance road safety through the implementation of a multi-factored detection system, meticulously analyzing various aspects. Our method seeks to build a comprehensive understanding of accident risk factors by closely examining driver behaviour, environmental factors, and vehicle dynamics. This will open the door to successful preventive measures.

The innovative aspect of our solution is its comprehensive approach to road safety. It provides an integrated, one-stop system that addresses distractions, alertness, fatigue, rash driving, DUI, and more by taking into account a number of factors. This solution is affordable and easily available, democratizes sophisticated safety technology, and guarantees broad advantages for people, organizations, and governmental bodies. It not only enhances road safety but also significantly reduces the loss of lives by addressing diverse factors contributing to accidents, creating a safer and more secure transportation environment.

The 5 major factors that influence and increase accidents on road are:

1. Over speeding

Over speeding refers to going over the safe speed limit for a particular road or area. It has been found to be a significant cause of traffic accidents. This careless driving worsens collisions and impairs the driver's capacity to respond to unforeseen circumstances.

Recent national statistics indicate that in India, overspeeding is the cause of about 30% of traffic accidents. This concerning statistic emphasises how important it is to enforce speed limits and encourage safe driving practises. Also, studies highlight over speeding not only causes collisions but also more serious injuries and fatalities.

2. Rash Driving

In simpler terms, reckless driving refers to operating a vehicle erratically, such as zigzagging or making sudden jerky movements while exceeding speed limits. This includes driving disregarding red lights or stop signs, leading to collisions with other vehicles or pedestrians, abnormal turns,

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 11, Issue 3, March 2024

particularly wide ones, which significantly alter the vehicle's lateral acceleration and unpredictably weaving through traffic. Rash driving induces sudden changes in the vehicle's sideways movement, often caused by abrupt shifts in steering direction. Such driving poses heightened risks of accidents due to aggressive driving tactics like tailgating, abrupt lane changes, ignoring traffic signals, and flouting traffic regulations. These actions seriously jeopardise public safety by substantially elevating the likelihood of accidents.

Studies show that reckless driving incidents account for almost 20% of traffic accidents that are reported in urban areas. These results highlight how crucial it is to encourage a cautious and patient driving culture in order to reduce the frequency of these kinds of collisions.

3. Driving Under Influence (DUI)

Driving under the influence involves operating a vehicle after intoxication or drug use puts public safety at serious risk. Accidents are more likely when there is intoxication-related impairment to judgement and coordination. Due to the deterioration of a driver's cognitive functions, including reaction times and decision-making abilities, the likelihood of preventable accidents increases.

According to research findings, drunk drivers are suspected of being involved in almost 15% of fatal traffic accidents in India. This emphasises how urgently strict policies, like sobriety checkpoints and public awareness campaigns, are needed to reduce DUI-related accidents.

4. Driver's Fatigue

Driver attention and reaction time are hampered by driver fatigue, which results from long driving hours or from not getting enough sleep. Drivers who are fatigued are more likely to lose focus, have reduced alertness, slower reaction times, and impaired judgement, raising the possibility of collisions.

Based on reports, 10% of road accidents in the country are attributed to driver fatigue. To address this issue, it is imperative to implement regulations regarding driving hours, encourage regular breaks, and raise awareness about the risks associated with fatigue.

5. Distractions While Driving

Driving distractions, such as using a phone or engaging in other activities inside the car, divert attention away from the road. These distractions make it harder to perceive the surroundings and increase the risk of accidents. Distractions can be categorized into three types: visual, manual, and cognitive. Anything that diverts a driver's attention from the road, such as using a smartphone or adjusting in-car technology, constitutes a visual distraction. Cognitive distractions, such as daydreaming or conversing, divert mental focus, while manual distractions, such as texting or eating, require taking one's hands off the wheel. When drivers engage in other tasks or distractions, they lose focus on driving, potentially leading to accidents that could have been prevented.

Recent surveys show that distracted drivers are much more likely to be involved in accidents. Drivers of all ages report nearly 25% of their accidents as a result of distractions while operating a vehicle. This underscores the importance of enforcing laws that prohibit specific forms of distraction while driving and launching public awareness campaigns about the risks associated with distracted driving.

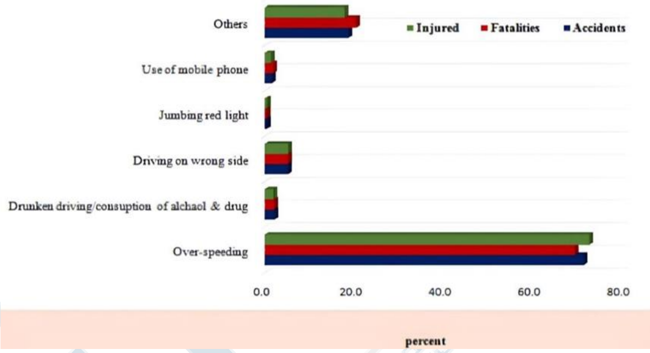

Figure 1: Graph showing various factors responsible for injury, fatality and accidents

Source- (Ministry of Road Transport & Highways 2023) [29]

Each factor outlined in figure1 plays a pivotal role in the occurrence and severity of road accidents in India, as supported by empirical data and national statistics. Understanding the significance of these factors forms the basis for our comprehensive approach in addressing road safety issues through a multi-factored detection system.

This approach seeks to integrate various methodologies, including qualitative and quantitative techniques, to effectively capture and mitigate these contributing factors, ensuring a more holistic and informed strategy toward road accident prevention.

3.1. Proposed Solution

Our study proposes the following solutions:

A. Using OpenCV Object Detection Model

The proposed object detection model, leveraging OpenCV, is designed to meticulously analyse physical distractions within a driving scenario and violation of traffic rules like lack of seatbelt and not looking on the road with a keen focus on unauthorised objects like alcohol bottles and the presence of mobile phones, particularly in the hands of drivers. With representations from every ethnicity included in its vast dataset, this model demonstrates the ability to identify and categorise different types of distractions into ten different classes. The model's inclusivity, which takes into account a range of ethnicities in its dataset, guarantees that it will work well in a variety of demographic scenarios.

This object detection model is at the forefront of technological advancements aimed at reducing the risks associated with distracted driving. The working looks like:

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 11, Issue 3, March 2024

- Efficient Distraction Recognition: Utilises pre trained models like YOLO (you only look once) or SSD (Single shot multibox) for real-time capture and labelling of distractions, including unauthorised objects and mobile phone use by drivers. These tools have shown accuracy in identifying and localising objects within images or videos. Studies done in [17],[22] have leveraged OpenCV's functionalities to implement object detection algorithms with efficiency. In, [18] concluded that YOLO can detect objects almost immediately while maintaining a high degree of accuracy, which makes it appropriate for applications that need fast reactions. SSD's capacity to effectively recognise objects at distinct scales was demonstrated by Liu et al. (2016) [19], providing reliable detection even for smaller or concealed items. Therefore, the use of OpenCV with pretrained models would be an efficient and user-friendly approach.
- You Only Look Once (YOLO): YOLO is an object detection algorithm that divides an image into a grid and predicts bounding boxes and class probabilities for each grid cell. It is known for its speed and ability to detect multiple objects in real-time.
- Single Shot Multibox Detector (SSD): SSD is another object detection algorithm that generates bounding box proposals and class scores for these boxes at multiple scales. It provides a good balance between accuracy and speed. The implementation includes:

- Real-time Distraction Recognition:

1. Input Image or Video Frame: The model takes an input image or video frame from the driving scenario.
2. Preprocessing: The input is pre-processed, typically by resizing and normalising the image to a format suitable for object detection.

- Model Loading:

1. Loading Pre-trained Model: The pre-trained model is loaded using OpenCV. This model has been trained on a diverse dataset containing representations from every ethnicity.
2. Class Labels: The model comes with a set of class labels that define the different types of distractions, as explained in detail in section 2.

- Forward Pass:

Running the Model: The pre-processed image is passed through the loaded model using a forward pass. This involves passing the image through various layers of the neural network to obtain predictions.

- Post-processing:

1. Extracting Detections: The model provides predictions in terms of bounding boxes, class probabilities, and class labels for each detected object in the image.
2. Thresholding: a confidence threshold is applied to filter out detections with low confidence.

- Categorization into Distraction Classes:

Labelling Distractions: The model categorises the detected objects into different distraction classes, as explained in detail in section 2.

- Inclusivity and Demographic Scenarios:

1. Ethnicity Inclusivity: The model's training data includes representations from every ethnicity, ensuring that it can accurately recognize distractions across a diverse range of demographic scenarios.
2. Versatile Road Safety Applications: Enhances road safety by offering immediate feedback to drivers and providing valuable insights for authorities to address and mitigate distraction-related risks.
3. Inclusive Dataset Across Ethnicities: Ensures effectiveness across diverse demographics by incorporating a dataset that represents various ethnicities in distraction analysis.
4. Data-Driven Decision Support for Authorities: Equips authorities with crucial distraction insights, enabling targeted interventions and policies to improve overall road safety.
5. Cutting-Edge Technological Frontline: Stands at the forefront of technological advancements, setting a new standard for real-time distraction analysis and promoting safer driving habits. As depicted in figure2 and figure3.

Figure 2: Calling using right hand

Figure 3: Driver drinking while driving

- This Efficient Distraction Recognition feature demonstrates how the model leverages pre-trained object detection models to identify and categorise distractions in a driving scenario, offering a practical and real-time solution for improving road safety. [17] used a dataset containing coloured pictures showing people driving safely or engaging in different types of distraction and trained models using CNN and could derive efficiency of about 99%.

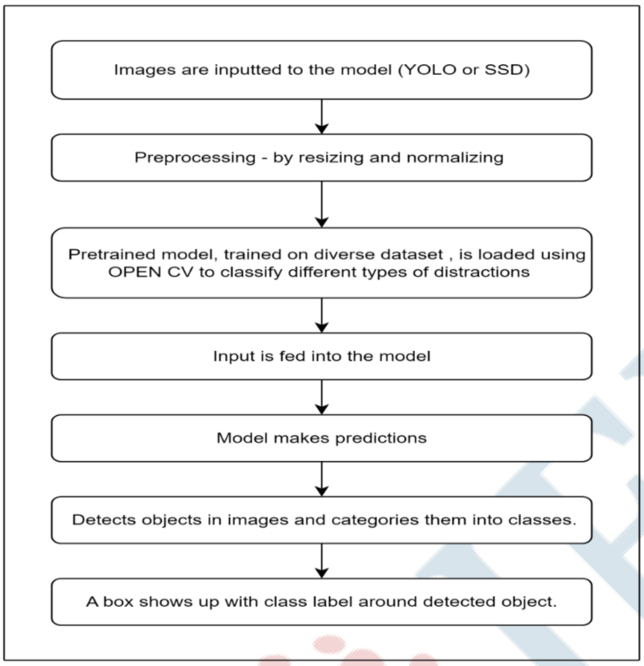

Figure 4: Workflow for object detection model

B. Driver Inattention Assessment

Inattention, arising from fatigue, drowsiness, or various distracting activities like texting, talking on the phone, or applying makeup, is a significant concern. S Arun et al. identified four key measures to identify driver inattention levels: subjective ratings from the driver i.e. evaluating driver's opinion on his/her level of inattention; vehicle-based measures like steering wheel movement, speeding which is covered in section 6; physiological measures like Heart rate, EEG and Skin conductance to detect inattention and behavioural measures that are covered in section 3 and 4 respectively.

- The Machine Learning model employs Convolutional Neural Networks (CNNs) to not only detect distracted drivers but also discern the specific causes of their distraction by analyzing images captured through an in-vehicle camera module. Leveraging the spatial feature-learning capabilities of CNNs, these images are processed and categorized using fully connected neural networks.
- The neural network is fed images from a dashboard camera, and the model identifies different distraction categories. To optimize the training process without compromising classifier accuracy, an active sensor, Kinect, is employed. The dataset, provided by State Farm, consists of 2244 RGB images depicting individuals driving safely or engaging in various distractions. Training and testing are performed with 75% and 25% of the images, respectively, ensuring a diverse representation of all ethnicities.
- Ten distraction classes are defined, including safe driving, texting with the right or left hand, calling with the right or left hand, operating the radio, drinking while driving, reaching behind, doing makeup while driving, and talking to a passenger. Also, shown in figure5, figure6, figure7 and figure8. To enhance the dataset's robustness, image augmentation and resizing are employed, generating new image sets with alterations in shear, zoom, and horizontal and vertical shifts for each epoch.

Figure 5: Calling with left hand

Figure 6: Operating the radio

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 11, Issue 3, March 2024

Figure 7: Talking to someone while driving

Figure 8: Getting something from backseat

- VGG19 and VGG16 models, with pre-trained weights to reduce training time, are utilised through the Keras API with Tensorflow as the backend. Four models inspired by VGG16 and VGG19 architectures are trained on the dataset, offering a comprehensive approach to distracted driver detection and classification.

C. Face Detection Model

The face detection model of open CV can be leveraged as it accurately identifies and locates facial features, serving as the foundation for following subsequent analyses. Using the identified face as a starting point, the system examines the eyes to identify sleepiness. It evaluates elements like eye closure, counting the number of times and how long it lasts to spot possible sleepy states.

- Yawning: a typical indicator of sleepiness involves tracking facial expressions to identify instances of yawning. The system detects and tallies yawns based on observed mouth movements. When the count of yawns surpasses a set threshold, an alert is triggered for the driver. Yawning signifies not only tiredness but also changes in bodily conditions. Consistent yawning throughout a journey serves as an indicator of driver fatigue.
- Closed-eyes analysis: Continuous monitoring of closed-eye activity assists in identifying drowsiness by distinguishing between prolonged eye closure and intentional blinking. Blinking typically follows a regular pattern, differentiating between regular blinks and those indicating drowsiness is essential. The usual duration of a blink is around 400ms, with a minimum duration of 75ms. Hence, if the driver's eyes remain closed for more than 400ms, it is flagged as a sign of drowsiness.

In [24], authors combined OpenCV with a feature detector to discern indications of driver fatigue or drowsiness by analysing images. Their method revolved around employing computer vision to scrutinise facial features and eye movements from images or video frames taken within the vehicle to analyse yawning, rubbing eyes due to fatigue, and drowsy eye blinking.

- Head Motion Recognition: Through monitoring head movements, the system evaluates minor head movements or nods, adding to a more thorough examination of drowsiness than just eye-related cues. V. Krishna and the team utilised an OpenCV-based face detection model to analyse head movements. The model identifies safety when a person's head remains within the frame and alerts potential danger if the head moves outside the frame. This method harnesses computer vision for assessment, and the integration of OpenCV boosting precision and effectiveness of head movement analysis. Such an approach could serve as a valuable tool within driver monitoring systems to evaluate head movements and safety.

D. Pose Detection Model

Utilizing the OpenCV pose detection model into practice, we expand the analysis to detect lateral movements and evaluate whether the driver is acting oddly or suspiciously. The emphasis is on identifying patterns, like excessive fidgeting, which may indicate discomfort or possible distraction or rash driving. Through captured images or video frames taken inside the vehicle, changes in the driver's lateral position such as sudden leaning to one side or erratic body movements while driving can be analysed. OpenCV's pose detection is capable of tracking human body key points, including the driver's position, using techniques like the OpenPose algorithm. By continuously analysing these key points over time, erratic movements or changes in the driver's posture can be analysed. Moreover, combining this data with other factors such as vehicle speed, GPS information (which has been discussed in detail in section 6), and steering wheel movements could enhance the accuracy of detecting reckless driving patterns. Study in [25], employed OpenCV and MediaPipe to assess live webcam images, estimating body landmarks and assisting users with accurate workout

ISSN (Online) 2394-2320
International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 11, Issue 3, March 2024

postures. This model's application could extend to correcting a driver's posture as well.

The pose detection model can incorporate extra (bnm 2001)distractions in the following ways:

- Detection of Lateral Movement: The pose detection model tracks the driver's body position concerning the vehicle to identify lateral movements. Abrupt or unpredictable sideways movements may be interpreted as possible indicators of diversion or inattention.
- Analysis of Excessive Fidgeting: The system detects instances of excessive fidgeting, such as restless hand or body movements, by examining body poses and movements. Unusual fidgeting levels could indicate discomfort or distraction, which would help to provide a more thorough evaluation of the driver's behaviour. Jupalle et al did Human Pose Estimation (HPE) utilising computer vision methods to identify and locate key body joints like shoulders, elbows, wrists, hips, knees, and ankles in images or videos for this purpose.
- Identification of Hand Motions: The pose detection model now includes hand gesture recognition, which makes it possible to identify potentially distracting gestures like pointing, waving hands, and making other gestures that take focus away from driving.
- Recognition of Head Turns: When a head turn is detected outside of its typical range, the model can identify it as a possible distraction. A driver may not be entirely focused on the road if their head movements are unusual.
- Posture Evaluation: By examining the driver's posture as a whole, the model can detect uncomfortable or unusual positions that could indicate discomfort or distraction, helping to provide a more comprehensive assessment of the driver's condition.
- How to Detect Occupancy: By identifying various body positions, the system can determine how many people are inside the car, taking into account factors like the presence of passengers and possible distractions from other drivers.

E. Physical Fatigue Detection System

Fatigue analysis focuses on thorough examination of driving behaviour, utilising physical detection systems that assess various aspects such as the frequency of the steering wheel, irregular turns, and lag in gear changes. [6] examined human driver behaviours like fatigue, and aggression, employing deep learning algorithms and emphasising the need for advanced sensor-based systems such as steering wheel angle and acceleration sensors for accurate detection and understanding of these behaviours.

The study employs a combination of sensors, including those in the steering wheel, gear shift, clutch, brake, and driver's seat, to comprehensively analyse the driver's physical state and behaviour.

Table II

Fatigue driving characteristics	Count	Percentage (%)
Frequency of steering wheel drop	66	37.5
Grip of steering wheel drop	88	50.0
Frequency of accelerate change	34	19.3
Shift timing change (Early or Late)	85	48.3
Turn irregular suddenly	88	50.0
Match of accelerate and clutch uncoordinated	65	36.9

Proportion of Fatigue Driving Characteristics
Data Source- [12]

Specifically, the following sensors are considered in this research:

1. Gear Shift Sensors (Limit Switch): These sensors monitor the gear shifting process, providing insights into the driver's interaction with the gearbox.
2. Steering Wheel Angle Sensor (Photoelectric Angle Sensor): Monitoring the angle of the steering wheel, this sensor detects sudden and unexplained changes in steering patterns, which may indicate drowsiness or fatigue.
3. Acceleration Pedal Sensor (Potentiometer): This sensor tracks the driver's acceleration pedal usage, revealing patterns of acceleration and potential fatigue-related variations.
4. Brake Pedal Sensor (Potentiometer): Monitoring the brake pedal, this sensor provides information on braking patterns, helping to identify irregularities that may be associated with driver fatigue.

The integration of these sensors allows for a comprehensive evaluation of the driver's actions, including acceleration, braking, shifting, and steering. The study aims to identify continuous changes in these driving aspects that may be indicative of increasing driver fatigue.

[17] presented a fatigue detection algorithm utilising facial features and driver characteristics, achieving 95.10% accuracy in simulated driving scenarios. It underscores the importance of sensors like steering wheel angle and acceleration-based sensors, emphasising their role in enhancing driver state analysis and contributing to improved traffic safety through precise fatigue detection methods.

Therefore, by leveraging a multi-sensor approach, the research seeks to enhance the accuracy and reliability of fatigue detection systems, ultimately contributing to improved road safety.

F. Overspeeding Detection

A Global Positioning System (GPS) is a satellite-based navigation system that precisely determines location and tracks vehicle movements. The GPS system communicates with a network of orbiting satellites, each broadcasting signals containing location and timestamps. These signals, travelling at the speed of light, are received by a GPS receiver on Earth. The receiver calculates distances from multiple satellites, employing trilateration to determine the exact location. GPS is integral to modern vehicles, contributing to efficient transportation through navigation, route optimization, traffic management, and emergency response. The aim of this research is to leverage GPS data to promptly identify instances of vehicles exceeding predefined speed thresholds, enhancing road safety and compliance with speed limits.

Overspeeding is intricately linked to rash driving, as exceeding speed limits often results in reckless behaviour. (Bevly 2004) [5] provided evidence supporting the integration of GPS technology for accurate vehicle velocity detection and demonstrates how a standard, costeffective GPS receiver can effectively address. By leveraging GPS velocity measurements, this method precisely determines various crucial vehicle parameters, including course, velocity, road grade, and rectifies errors in inertial sensors, affirming its importance in vehicle velocity detection and state monitoring.

The propensity for erratic manoeuvres increases with higher speeds, emphasising the critical correlation between overspeeding and the emergence of dangerous driving practices on the road.

The methodology involves:

- Data Collection:

GPS data is collected using pre-installed GPS receivers in vehicles.

- Data Preprocessing:

The collected data undergoes preprocessing to filter out noise, improving accuracy.

- Threshold Definition:

1. Road Type Classification: Categorising roads based on characteristics like traffic density, infrastructure, and urban planning.

- Data is collected from government databases and analysed to classify roads and associate speed limits with road segments.
- Dynamic adjustment of overspeed thresholds based on road types ensures contextual relevance.

2. Traffic Density:

- Analysing traffic density using GPS data to influence threshold speeds.
- Higher traffic density may lead to lower threshold speeds for safe braking distances.

3. Geofencing:

- Defining virtual boundaries for specific areas (e.g., school zones, hospital zones) to customize threshold speeds.
- Lower threshold speeds are set in sensitive areas identified through geofencing.

- Generating Alerts for Authorities:

Employ geofencing techniques to define areas of particular concern, such as school zones.

1. Generate real-time alerts for authorities when vehicles exceed predefined speed thresholds.
2. Geofencing can be extended to include additional areas like construction zones in future implementations.

The research aims to design algorithms capable of processing live GPS data streams for real-time overspeed detection, providing timely alerts to users and relevant authorities. Also summarised in figure9. In, [16] implemented an affordable vehicle tracking system utilising GPS and GSM/GPRS technologies, affirming GPS's role in precise vehicle velocity detection and can be integrated with a Smartphone app offering real-time vehicle tracking and location updates.

The workflow for the GPS based system is as follows:

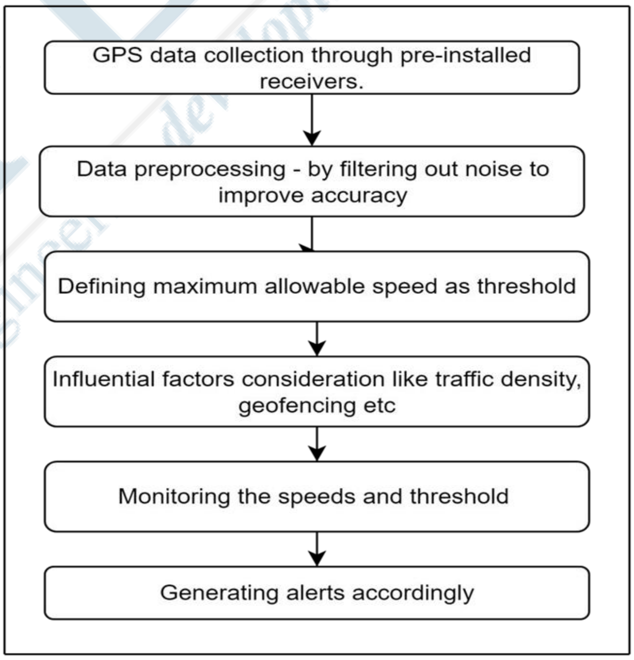

Figure 9: Workflow for over speeding detection model

This study introduced a pragmatic solution prioritising feasibility, affordability, and effectiveness to improve road safety. Highlighting five primary factors— Overspeeding, Rash Driving, DUI, Driver's Fatigue, and Distractions— it integrates OpenCV, machine learning algorithms, and sensor technologies for in-depth analysis. The proposed solution leverages OpenCV for distraction identification, machine learning for behaviour analysis, and various sensors, including steering wheel and acceleration-based sensors, for

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 11, Issue 3, March 2024

detecting physical fatigue and rash driving.

Additionally, facial, pose, and head motion detection models contribute valuable insights into driver attentiveness. The study underscores GPS's role in precise vehicle velocity detection, crucial for addressing overspeeding. This integrated approach demonstrates practical means to enhance road safety by facilitating real-time alerts and aiding authorities in mitigating critical issues while promoting safer driving habits.

IV. DISCUSSION

The findings of this study shed light on the critical factors contributing to road accidents in India and propose a comprehensive, technologically advanced solution. Through the meticulous examination of Overspeeding, Rash Driving, DUI, Driver's Fatigue, and Distractions, this research underscores their pivotal roles in escalating accident rates. Statistical data and empirical evidence showcased the alarming prevalence of these factors in contributing to vehicular collisions, emphasising the urgency of addressing them holistically.

The integration of OpenCV object detection, machine learning models, sensor technologies, and GPS systems offers a promising avenue for effective detection and mitigation of these accident-inducing elements. Moreover, the user-friendly nature and cost-effectiveness of these proposed systems democratise access to advanced safety measures, ensuring broader implementation and impact across diverse demographics and driving environments. These findings hold substantial implications for policy-making, technological advancements, and societal well-being. The proposed system's ability to analyse and mitigate accident-causing factors offers a significant stride towards enhancing road safety.

The results advocate for the integration of such advanced systems into transportation policies, encouraging the adoption of technology-driven solutions for accident prevention.

V. CONCLUSION

In conclusion, the mixed-methods approach presented in this research paper offers a groundbreaking solution to address the intricate challenges surrounding road safety in India and was pivotal in capturing the multifaceted nature of driver behaviour and its correlation with road accidents. By employing a deductive and confirmatory research methodology, this study focuses on leveraging technological advancements to detect and mitigate factors contributing to accidents. The multi-faceted detection system proposed encompasses OpenCV object detection, machine learning models, sensor technologies, and GPS systems. This integration enables a meticulous analysis of Overspeeding, Rash Driving, DUI, Driver's Fatigue, and Distractions, crucial elements significantly impacting road safety.

Our proposed system distinguishes its multifaceted approach, which holistically addresses various aspects influencing accidents on Indian roads. By using OpenCV object detection and machine learning models, our solution identifies and categorises potential hazards in realtime, offering an easily implementable yet sophisticated safety system. Notably, the system's user-friendly interface and cost-effective nature democratise access to state-of-the-art safety technologies. This accessibility ensures a broad impact, benefiting individuals, organisations, and governmental bodies alike, while promising substantial reductions in accident rates and associated fatalities.

Furthermore, the proposed system's incorporation of sensor technologies like steering wheel angle sensors and GPS systems enhances its adaptability across diverse driving scenarios and demographics. By accurately analysing driver behaviours, environmental factors, and vehicle dynamics, this system empowers authorities with data-driven decision-making tools to proactively mitigate risks. Ultimately, this research not only contributes to enhancing road safety but also paves the way for a more secure transportation environment by addressing a spectrum of contributing factors to accidents prevalent on Indian roads.

VI. FUTURE SCOPE

In future endeavours, assessing cognitive alertness could be integrated by innovative approaches alongside traditional subjective methods. A cognitive alertness quiz, featuring tasks such as hands-free mobile-based mental arithmetic, seems promising. Methods involving manipulating cognitive distraction, such as answering prerecorded questions, can be another avenue for exploration. Going beyond established practices, the inclusion of monitoring skin temperature during cognitive tasks should stand out as a means to glean novel insights. These advancements offer the potential to significantly enhance our understanding of cognitive inattention on the road, ultimately contributing to the development of more effective safety measures and interventions. Specifically, they enable the evaluation of the driver's mental alertness, a critical factor in ensuring sustained driver attention.

REFERENCES

[1] Aksjonov, Andrei, Pavel Nedoma, Valery Vodovozov, Eduard Petlenkov, Martin Herrmann. 2019. "Detection and Evaluation of Driver Distraction Using Machine Learning and Fuzzy Logic." doi:10.1109/TITS.2018.2857222

[2] Alkinani, Monagi H., Wazir Z. Khan, and Quratulain Arshad. 2020. "Detecting Human Driver Inattentive and Aggressive Driving Behavior using Deep Learning: Recent Advances, Requirements and Open Challenges". https://doi.org/10.1109/ACCESS.2020.2999829.

[3] Arun, S., Kenneth Sundaraj, and M. Murugappan. 2012. "Driver Inattention Detection Methods : A Review." https://doi.org/10.1109/STUDENT.2012.6408351.

[4] Balasubramanian, Venkatesh, and Sathish K. Sivasankaran. 2019. “Analysis of factors associated with exceeding lawful speed traffic violations in Indian metropolitan city.” Journal of Transportation Safety & Security. https://doi.org/10.1080/19439962.2019.1626962

[5] Bevly, David M. 2004. “Global Positioning System GPS A Low Cost Velocity.” doi:126/2/255/461695.

[6] Bi, Xiaojun, Zheng Chen, and Jianyu yue. 2021. “A Novel One-step Method Based on YOLOv3-tiny for Fatigue Driving Detection.” doi:10.1109/ICCC51575.2020.9345278.

[7] Binal, Vasant, Vaishali Shardul, Priyanka Solankar, Sneha Sharma, and Prof. Namrata D. Ghuse. 2020. “Over Speed Detection on Highway.”

[8] Chatterjee, Ipshita, Isha, and Apoorva Sharma. 2018. “Driving Fitness Detection: A Holistic Approach For Prevention of Drowsy and Drunk Driving using Computer Vision Techniques.” https://doi.org/10.23919/SEEDA-CECNSM.2018.8544944.

[9] Chen, Peijiang. 2017. “Research on driver fatigue detection strategy based on human eye state.” https://doi.org/10.1109/CAC.2017.8242842.

[10] Dong, Zhening, Meiyan Zhang, Jinwei Sun, Tianao Cao, Runqiao Liu, Tianao Cao, Runqiao Liu, Qisong Wang, and Dan Liu. 2022. “Detection, Prevention and Emergency Solution of Road Accidents in Bangladesh using IoT.” doi: https://doi.org/10.1109/ISITDI55734.2022.9944436.

[11] M. S. Fakir, N. Sakib, M. S. Mia and N. S. Sizan, "Detection, Prevention and Emergency Solution of Road Accidents in Bangladesh using IoT," 2022 International Symposium on Information Technology and Digital Innovation (ISITDI), Padang, Indonesia, 2022, pp. 86-91, doi: 10.1109/ISITDI55734.2022.9944436.

[12] Hailin, Wang, Liu Hanhui, and Song Zhumei. Fatigue Driving Detection System Design Based on Driving Behavior.” (January), 4. 2011. “Fatigue Driving Detection System Design Based on Driving Behavior.” https://doi.org/10.1109/ICOIP.2010.101.

[13] Hansen, John H., Carlos Busso, Yang Zheng, and Amardeep Sathyanarayana. 2017. “Driver Modelling for Detection and Assessment of Distraction.” doi:13.10.1109/MSP.2017.2699039.

[14] Joshi, Madhura, Harini Sankar, Adarsh K. Singh, Harshad Dharmadhikari, and Pushkar Sathe. 2018. “Car Overspeeding Detection.” https://www.ijrte.org/wpcontent/uploads/papers/v8i2/B1082078219.pdf.

[15] Kochar, Pallavi, and M. Supriya. 2016. “Vehicle Speed Control Using Zigbee and GPS.” https://doi.org/10.1007/978-981-10-3433-6_101.

[16] Lee, SeokJu, Girma Tewolde, and Jaerock Kwon. 2014. “Design and implementation of vehicle tracking system using GPS/GSM/GPRS technology and smartphone application.” https://doi.org/10.1109/WF-IoT.2014.6803187.

[17] Masood, Sarfaraz, Abhinav Rai, Aakash Aggarwal, M.N. Doja, and Musheer Ahmad. 2017. “Detecting Distraction of drivers using Convolutional Neural Network.” https://doi.org/10.1016/j.patrec.2017.12.023.

[18] Redmon, J., et al. 2016. “You Only Look Once: Unified, Real-Time Object Detection.” https://doi.org/10.1109/CVPR.2016.91.

[19] Liu, W., et al. (2016). SSD: Single Shot MultiBox Detector. European Conference on Computer Vision. 2016. “SSD: Single Shot MultiBox Detector.” doi:1512.02325.

[20] Pham, Hoang D., Micheal Drieberg, and Chi C. Nguyen. 2014. “Development of vehicle tracking systems using GPS and GSM modem.” https://doi.org/10.1109/ICOS.2013.6735054.

[21] v, Sasikala, Rajeswari T, Sk Naseema Begum, Ch Divya Sri, and M Sravya M. 2022. “Stress Detection from Sensor Data using Machine Learning Algorithms.” https://doi.org/10.1109/ICEARS53579.2022.9751881.

[22] Zhang, Xiaoying, Ruosong Chang, Xue Sui, and Yutong Li. 2022. “Influences of Emotion on Driving Decisions at Different Risk Levels: An Eye Movement Study.” https://www.frontiersin.org/articles/10.3389/fpsyg.2022.788712.

[23] Krishnasree, V., N. Balaji, and P. Sudhakar Rao. 2014. “A Real Time Improved Driver Fatigue Monitoring System.” https://www.wseas.org/multimedia/journals/signal/2014/a325714-161.pdf.

[24] R. Manoharan, and S. Chandrakala. 2015.

[25] Kwon, Yejin, and Dongho Kim. 2022. “Real-time Workout Posture Correction using OpenCV and MediaPipe.” http://dx_d01ug/lM.llNll,"ki:t_ZlC?_?il.1.199.

[26] Li, Kening, Yunbo Gong, and Ziliang Ren. 2020. “A Fatigue Driving Detection Algorithm Based on Facial Multi-Feature Fusion.” doi:10.1109/ACCESS.2020.2998363.

[27] Wesley, Avinash & Shastri, Dvijesh & Pavlidis, Ioannis. (2010). A novel method to monitor driver's distractions. 4273-4278. 10.1145/1753846.1754138.

[28] Itoh, Makoto. (2009). Individual Differences in Effects of Secondary Cognitive Activity during Driving on Temperature at the Nose Tip. 10.1109/ICMA.2009.5246188.

[29] Ministry of Road Transport & Highways, Government of India. 2023. *ROAD ACCIDENTS IN INDIA*. Government of India. https://morth.nic.in/.