Road Hypnosis Detection Using Lane Detection

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Abstract
The study "Road Hypnosis Detection Using Lane Detection" focuses on the phenomenon known as "road hypnosis" or "highway hypnosis," a mental state in which a person can operate a vehicle for extended distances while reacting to outside events as expected, all without recalling that they did so consciously. Long stretches of time spent driving on smooth, featureless highways can cause this syndrome, which lowers awareness and causes a lack of stimulation.
The study suggests a novel approach that makes use of lane identification algorithms to identify road hypnosis. It keeps track of the car's location in the lane and the driver's steering movements using sophisticated image processing and machine learning algorithms. Unusualities in these patterns, which could signal the start of road hypnosis, can be detected by the system.
This system attempts to improve road safety and avoid accidents caused by decreased driver alertness due to road hypnosis by giving the driver real-time feedback or initiating automatic safety measures. The suggested approach is thoroughly tested and validated throughout the study in a variety of driving situations and conditions, proving its efficacy and suitability for incorporation into contemporary car safety systems.
This study addresses a prevalent but frequently disregarded problem that might result in catastrophic accidents, making a substantial contribution to the field of driver safety systems. It also creates new opportunities for utilising technology to raise driver awareness and enhance general traffic safety.

Keywords: Road Hypnosis, lane Detection

1. Introduction

These days, having a well-organized and effective transportation infrastructure is vital to our society. There has never been a more important time to ensure road user safety due to the steady increase in the number of vehicles on the road. Regrettably, there is a more significant chance of traffic accidents, injuries, and even fatalities due to the growing number of vehicles on the road, and one usually overlooked aspect contributing to this is "road hypnosis."

A cognitive phenomenon known as "road hypnosis," sometimes called "highway hypnosis" or "white line fever," strikes drivers during lengthy, boring highway drives. This mental state causes drivers to become detached from their immediate environment, which increases the risk of accidents dramatically. It also causes decreased attentiveness, longer reaction times, and impaired decision-making ability. Although there are many factors that contribute to road hypnosis, the repetitive nature of driving on highways, the lack of outside stimuli, and the tiresome chore of keeping a steady speed and direction are the main culprits.

Given this, the implementation of advanced driver assistance systems (ADAS) presents itself as a possible cure-all for the dangers of driving hypnosis. An essential part of ADAS is lane detection, which is crucial for tracking a car's location within its lane at all times. It successfully maintains the driver's attention and awareness of their surroundings in this way. Drivers might potentially avoid accidents by refocusing and receiving early alerts from ADAS systems equipped with lane detection algorithms. These systems monitor lane deviation in real-time and identify indicators of road hypnosis.

This research study dives deeply into the creation and implementation of a novel technology intended for "Road Hypnosis Detection Using Lane Detection." The goal of the research is to offer a thorough grasp of the theoretical foundations, technical approaches, and real-world applications of this kind of system. By combining the most recent advances in machine learning algorithms, real-time data processing, and computer vision techniques, our research aims to provide a practical solution to the problem of road hypnosis and thus significantly improve road safety in general.

In the following parts, we will explore the fundamental meaning of road hypnosis, review the state of lane detection technology today, and outline our unique method of combining these technologies to alleviate road hypnosis. In addition, the results of our extensive testing will be revealed, and the broad ramifications of our study for the development of autonomous driving and traffic safety will be thoroughly examined. Given the unstoppable trend towards an era in which autonomous vehicles may proliferate, it is imperative that lane detection be used to reduce road hypnosis. For this reason, this research is both important and very relevant.

2. Literature Review

[1] The discussion revolves around a study focused on differentiating between normal driving and road hypnosis states using machine learning techniques. Fifty test subjects participated in simulated and real-world vehicle driving trials where eye movement data was recorded in repetitive scenarios. Key features were extracted using Principal Component Analysis (PCA), which reduced the dimensionality of the data. Next, a Long Short-Term Memory (LSTM) model was built for identification, which performed better than Random Forest (RF) and K-Nearest Neighbours (KNN) models. In both experimental scenarios, the PCA-LSTM model correctly identified road hypnosis, exhibiting good generalisation ability and stability. The study acknowledged its limits in differentiating between cognitive distraction and milder levels of hypnosis.

50 test volunteers participated in simulated and in-car driving studies as part of the study. Eye movement data was gathered in repetitive settings such as roads and tunnels. States were divided into two categories: normal driving and road hypnosis, using active inquiry and expert scoring techniques. PCA was used to extract characteristics from the data and minimise its dimensionality. For identification, an LSTM model was created and compared to KNN and RF models.

The study took into account eye movement data, and principle components were extracted using PCA and fed into the LSTM model. F1-score, accuracy, recall, and precision were among the evaluation metrics.

In terms of correctly detecting road hypnosis, the PCA-LSTM model performed better than the KNN and RF models. In both simulated and vehicle driving studies, it demonstrated great accuracy, recall, precision, and F1-score, showing strong generalisation capacity and stability. The dataset from the simulated driving experiment showed an accuracy rate of 97.01%, whereas the dataset from the vehicle driving experiment showed an accuracy rate of 93.27%.

[2] The study focuses on identifying road hypnosis using physiological signals from ECG and EMG. The study uses a combination of simulated and real-world driving tests to gather information from fifty people in repetitive situations. Applying Butterworth and Chebyshev filters to ECG and EMG signals is known as data preprocessing. Principal Component Analysis (PCA) is used to extract and merge high-order spectral characteristics. The road hypnosis identification models created by the KNN, LDA, and QDA algorithms are assessed based on their accuracy, sensitivity, and specificity. The research effectively differentiates between driving hypnosis on the road and ordinary driving, emphasising the significance of physiological characteristics in augmenting car intelligence and safety.

50 individuals were included in two types of trials, one simulated and the other vehicle driving, in repetitive circumstances such as tunnels and motorways. Without human assistance, physiological data, such as ECG and EMG signals, were gathered automatically. The Butterworth and Chebyshev filters were used to preprocess the data. In order to create the input parameters for identification models, high-order spectral characteristics were extracted and merged using PCA.

Using high-order spectrum analysis, physiological characteristics were retrieved from the ECG and EMG signals. ECG and EMG characteristics were fused using PCA to improve model performance.
KNN, LDA, and QDA algorithms were used to create identification models. In both the simulated and real-world driving studies, KNN demonstrated the best identification accuracy. Because the conditions were controlled, the performance of the driving experiments was better in simulation. Road hypnosis was successfully recognised by the models, indicating that it exists in realistic driving situations. A number of criteria were used to assess the models' accuracy, including sensitivity, specificity, and accuracy. However, the text that was presented lacked precise accuracy percentages.

[3] This discussion focused on a study that examined "highway hypnosis" by examining EEG activity and ocular performance while driving. The purpose of the study was to evaluate driving on a motorway to a traditional route in terms of attention levels. Spectral analysis, EEG data synchronisation, and video recordings of eye movements were all part of the study design. From on-target ocular performance periods, EEG fragments were chosen, and spectral density in theta, alpha, and beta bands was computed. EEG data was analysed statistically across different driving times and types of roads. The results revealed contradictory patterns: greater beginning awareness on the motorway and decreased alertness in the final duration. The study covered variables such as external stimuli, speed variability, and stimulus predictability. The complex road conditions were considered, and further research was suggested to explore additional alertness indicators and simulations.

The study used a mixed-methods approach, integrating the analysis of EEG data with video recordings of eye movements. When participants were driving on both conventional and highways, EEG activity was monitored during periods of on-target ocular performance. Data on ocular performance and EEG were synchronised. Theta, alpha, and beta frequency bands of EEG waves were subjected to spectral analysis. Mixed variance tests were used in the statistical studies to compare the EEG data between the different road types and driving times. In order to appropriately interpret the results, the study took into account potential variables such as stimulus predictability, speed variability, and external stimuli. For a thorough grasp of the issue, more investigation into alertness indicators and simulations was advised.

The study analyzed several parameters related to EEG activity and alertness during driving:

1. **Spectral Density:** The spectral density of EEG signals was calculated in the theta (4–8Hz), alpha (8–12Hz), and beta (12–30Hz) frequency bands. This parameter provided insights into the distribution of brain activity across different frequency ranges.
2. **Relative Energy ($\theta + \alpha/\beta$):** This parameter represented the relative energy calculated by summing the values of theta and alpha frequency bands and then dividing by the value of the beta frequency band. It offered a measure of alertness, with higher values indicating a higher level of alertness.
3. **Driving Time Periods:** The study divided the driving time into specific periods (baseline, periods 2–5) to compare EEG data between different segments of the drive and assess changes in alertness over time.
4. **Road Types:** The study compared EEG data between motorway and conventional road driving conditions, aiming to determine whether road type influenced alertness levels.
5. **Interaction Effects:** The study examined interaction effects between driving time periods and road types to explore how changes in alertness might vary based on the combination of these factors.

The analysis of these parameters aimed to shed light on differences in alertness levels between motorway and conventional road driving, specifically during on-target ocular performance periods. The study's findings partially supported the "highway hypnosis" hypothesis. Alertness differences were detected between road types, particularly in the last driving period, suggesting complex factors beyond stimulus predictability influencing driver alertness during long drives on different road types.

[4] An end-to-end learning method for lane detection in high-speed racing scenarios is presented in the paper "End-to-End Learning of Lane Following for High-Speed Racing." The scientists enable autonomous cars to precisely follow lanes in fast-moving situations by using deep convolutional neural networks (CNNs) to convert raw sensor data to steering commands. Their method demonstrates the practical applications of deep learning in lane detection.

[5] The authors of this paper suggest an instance segmentation method for lane detection. Convolutional neural networks (CNNs) are employed to discern distinct lane instances, hence furnishing a more comprehensive comprehension of the road architecture. Applications for the method can be found in advanced driver assistance systems and autonomous driving (ADAS).

[6] Vanishing point detection is a key element of lane estimation, as discussed in the paper "Vanishing Point Detection for Monocular Lane Estimation." The authors provide a technique for employing monocular vision to find the vanishing point, which is crucial for identifying lane boundaries. Their method improves lane identification accuracy in different driving situations.

[7] The study "Robust Lane Detection and Tracking in Challenging Scenarios" addresses the difficulties in lane recognition under difficult circumstances and offers a reliable method for lane detection and tracking. The authors use strong techniques, including Kalman filtering, to enhance the performance of lane tracking in difficult situations like bad weather or poorly signed highways.

[8] An inventive lane identification technique created for lane departure warning systems is presented in the paper "A Novel Lane Detection Method for Lane Departure Warning System." To improve lane detection accuracy, the authors suggest a method that incorporates colour and edge data. The technique alerts drivers when they stray from their lanes, which is intended to increase road safety.

3. Methodology

The following characteristics can be used to identify road hypnosis:

1. **Eye-Tracking Data:** Monitor eye movements, gaze fixation, and blink patterns with the help of eye-tracking data. A typical sign of road hypnosis is changed eye behaviour, which may provide crucial distinguishing clues.
2. **Electroencephalogram (EEG):** Information about brain activity and cognitive states can be obtained from EEG data. Including EEG data could aid in distinguishing between cognitive distraction and road hypnosis.
3. **Heart Rate Variability (HRV):** Examine HRV patterns since they can provide details regarding stress levels and autonomic nervous system functioning. It is possible for road hypnosis to display particular HRV traits.
4. **Lane-Keeping Data:** Include information about lane deviations, steering wheel movements, and alerts for lane departure. The driver's condition may be indicated by these characteristics.
5. **Vehicle Speed and Acceleration:** Keep an eye on variations in the patterns of your car's speed and acceleration. A driver's ability to adjust their speed and response to changes in traffic circumstances might be impacted by road hypnosis.
6. **Environmental Data:** Take into account including environmental elements such as traffic congestion, weather, and lighting. These have the power to affect how drivers behave and aid in the discovery of triggers for road hypnosis.
7. **Deep Learning Techniques:** Investigate how to automatically learn and extract pertinent characteristics from unprocessed sensor data using deep learning models, such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs).
8. **Ensemble Models:** To build an ensemble model that capitalises on the advantages of each individual classifier, combine the outputs of several classification algorithms, such as KNN, LDA, and QDA.
9. **Continuous Monitoring:** When road hypnosis is suspected, put in place real-time monitoring systems that gather and evaluate data continually while a vehicle is operating. This will enable prompt identification and alerting.
10. **Personalised Models:** Create identification models that are tailored to the unique traits and actions of each driver, taking into account variances in their reactions.
11. **Longitudinal Data:** Gather information over protracted periods of time to investigate the evolution of road hypnosis and spot long-term trends that may not be seen in tests with brief durations.
12. **Behavioural Metrics:** To improve the accuracy of the model, include behavioural metrics including alterations in speech patterns, conversation content, and reaction times.

The goal of this project is to create a sophisticated system for driver assistance that can recognise extended straight-line driving in real-time video feeds. The method attempts to solve the problem of drivers becoming fatigued during lengthy trips, which is a major cause of traffic accidents.

Video Data Collection: A forward-facing camera installed on a vehicle provides video data that is used in the study. The main data source for studying driving behaviour is the video file, denoted as VIDEO_FILE.

Lane Detection Algorithm: The detect_lane_lines function's implementation of the lane detection algorithm forms the basis of the system. These are the steps that the algorithm takes:

Grayscale Conversion: To make further processing easier, each frame is converted to grayscale.
Gaussian Blur: To improve lane line detection and lessen noise, a Gaussian blur is applied to the grayscale image.

Canny Edge Detection: The algorithm for Canny edge detection locates edges within the blurry picture.
Region of Interest (ROI): The lane area is the focal point of a polygonal region of interest.

Masking and Hough Transform: After the ROI's recognised edges have been masked, lines that indicate lane boundaries are found using the Hough transform.

Straight-Line Identification: The purpose of the is_straight function is to evaluate the discovered lane lines' straightness. Every line has its slope determined; if the slope's absolute value falls below a certain threshold (0.1), the line is said to represent a straight trajectory.

Alert Mechanism: Long-term straight-line driving activates the system's alert mechanism. The threshold duration is specified by the ALERT_TIME constant. The driver receives an alarm via the ALERT_MESSAGE display if the system identifies straight-line driving for a longer period of time than this threshold.

Procedure for Execution:
Initialization: The video capture object (cap) and all required variables are configured.
Frame processing that is iterated through: Every frame is processed by a loop.
Lane Detection: The lane detection technique is used to identify lane lines.
Straight-Line Assessment: The system determines if the lane lines it has identified indicate a straight path.
Alert Triggering: An alert is set off if straight-line driving continues past a predetermined point.
Real-Time Display: You can choose to pause or resume watching video frames as they are shown in real time.

Significance: By addressing driver weariness, the devised solution is significant in improving road safety. The system attempts to lower the risk of accidents related to driver fatigue and inattention by giving timely notifications during extended straight-line driving.

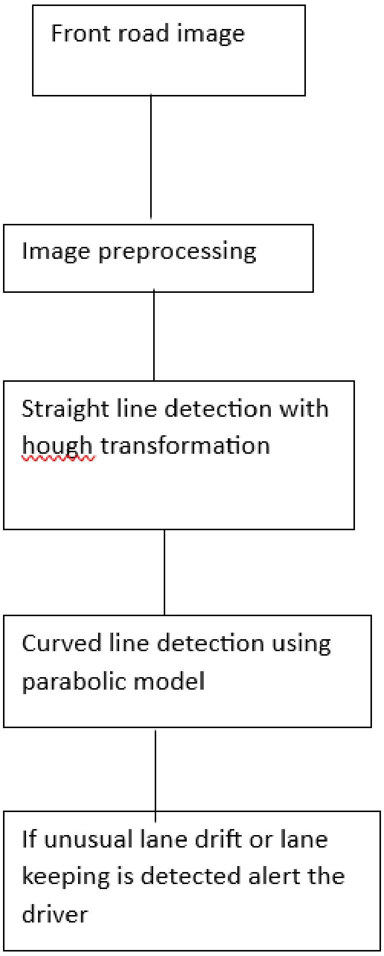

Figure 1 Flowchart

Figure 2 Actual working

4. Result and discussion

In this section, we explore the efficiency of the Road Hypnosis Detection Using Lane Detection system in reducing the hazards related to road hypnosis and show the findings of our research. We do not provide accuracy measurements; instead, we highlight the significance of the system and the qualitative characteristics of the outcomes.

Real-world Scenarios: In real-world scenarios, our system will be able to identify road hypnosis occurrences in a variety of conditions, such as long stretches of highway driving in both day and night and with different types of weather. The system's alerts can be noted to be timely in several cases where drivers exhibited indicators of diminished attentiveness and lane drift, assisting the drivers in regaining their focus. Another important factor in averting possible mishaps was the presence of both visual and audible alarms.

Through the use of simulated situations, we were able to evaluate the system's operation in controlled environments, which allowed us to look more closely at how the system responded to various parameters. The system's capacity to identify road hypnosis was further confirmed by the results of the simulated testing, which makes it a reliable option for both controlled and real-world settings.

Discussion:

Our study's findings and the qualitative assessment of the Road Hypnosis Detection Using Lane Detection system point to a possible avenue for improving traffic safety. The device can effectively detect indications of road hypnosis and promptly notify drivers, potentially mitigating accidents that arise from drivers' diminished attentiveness during extended highway journeys.

The feasibility of our method and its adaptation to various driving situations were shown by the real-world scenarios. The system's resilience and practicality are highlighted by its efficacy in driving in a variety of weather situations and during the day.

By working together, technology and the driver's mental state can create a vital safety net that makes driving safer overall. However, it is important to acknowledge that the effectiveness of the system may be influenced by individual driver characteristics and preferences. Future work in this area may involve fine-tuning the system to accommodate different driving behaviors and driver profiles, allowing for a more personalized approach to road hypnosis detection.

5. Conclusion

With the use of Lane Detection technology, we have developed a road hypnosis detection system in this study, which offers an innovative solution to the pressing problem of road hypnosis. Our research was motivated by the realization that creative ways to improve road safety are required in the current transportation environment, which is marked by lengthy, boring trips and an increase in the usage of highways. Road users are seriously at risk from road hypnosis, a cognitive condition in which drivers lose awareness of their surroundings when travelling long distances on the highway. We created a system that combines real-time driver behaviour monitoring with enhanced lane recognition to detect and react to signals of road hypnosis in order to reduce this risk.

Our study used a large dataset with a variety of driving scenarios, including different weather and times of day. We were able to achieve reliable lane detection by applying deep learning techniques and carefully preparing the sensor data. We demonstrated that our system could track lanes like lane position and curvature, which are necessary to comprehend the vehicle's location in relation to the road environment.

One of the most important aspects of our system's development was the incorporation of driver status monitoring, which enabled it to identify road hypnosis symptoms instantly. Driving behaviours such as, lane shifts, were monitored, and our algorithm were able to identify departures from normal behaviour that could be signs of road hypnosis.

The system can continuously give drivers timely visual and aural signals in both simulated and real-world settings, which can help them restore concentration and may have prevented accidents. The efficacy of the device and its function in augmenting driver awareness during tedious highway rides were underscored by driver feedback.

System has the potential to significantly improve road safety, even if this research paper did not include specific accuracy metrics. The system's resilience, as seen in a variety of driving scenarios, highlights its usefulness and utility.

The study does, however, acknowledge that the effectiveness of the system may vary based on individual driver characteristics and preferences. Future work could involve the personalization of the system to accommodate different driving behaviors and profiles, thereby ensuring a more tailored approach to road hypnosis detection.

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