

Road Speed Violation Prediction Using Machine Learning with Route-Based Weather Forecasting.

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Abstract : Road accidents are widely increasing due to over-speed and weather conditions. So maintaining road safety is the first and most important thing. In order to address this issue this project develops a system which checks the speed of vehicle in real time and alerts the drivers to maintain smooth driving.

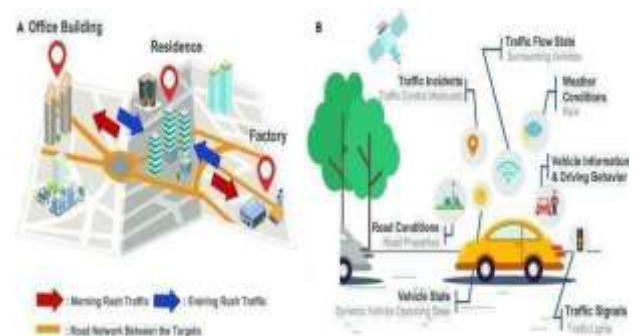
Extension to this the driver can also know the weather condition in the selected route. The user can able to see the whether at the particular route and identify whether it is sunny, foggy, rainy, low visibility or any other weather conditions. By knowing the weather conditions before the journey begins user can identify the pre-situations and adjust themselves according to their weather and maintain safety.

Keywords-Machine Learning, GPS data, Speed-Limit Violation Prediction, Route Analysis, Real-Time Alerts, Road Safety.

I. Introduction

Road accidents is the major issue faced by all over the world. And the main reason for the road accidents is over-speeding and driver unable to identify the danger zones. Many drivers do not follow speed limits because they cannot notice them properly, alerts and limits are setup only at constant places where most possible accidents happen. At the same time weather changes constantly. These unexpected situations can be risky and dangerous at the same time. When the over speed is integrated with the bad weather condition this leads to increase the accidents even more when compared to regular situations.

Even many road safety technologies has been improved and developed yet there is no device or a app which can warn the user to control their speed and sends a pop up message to reduce their speed. Example when there is a school nearby and the driver is over speeding the road limit they will get notified with a message like “Go Slow” or “Reduce Speed”. Such that the driver can adjust according to the road situations and prevent accidents. In some cases the alerts arrive late or do not consider the weather conditions due to sudden changes on the road. Drivers may misunderstand the signs that is the message which is being displayed or not knowing about the upcoming weather conditions.



-1a. Alert System

The above picture 1a describes about a driver alert System that shows the real-time data such as current speed, weather conditions and all possible danger zones. It gives clear and complete information about the chosen route and alerts the users based on the driving.

Over speeding is still a major issue on road safety. It causes many accidents and can also injuries, and sometimes even loss of life including damage for vehicles. Even there are many number of resources available yet many drivers still fail to exceed the speed limit and also fails to reduce the speed irrespective to danger zones, road type or neither weather conditions. To address this issue our project presents Road speed violation predictor integrated with selected route weather prediction. It is a data driven system which alerts drivers about all the possible risks and danger zones.

II. Literature Review

Machine Learning to predict user driving:

Machine learning plays key role in analyzing the driver behavior and reasons for the unsafe driving. Machine Learning uses models like Random Forest and Gradient Boosting work because they use the large number of inputs at the same it also focuses on the speed, road type, weather conditions and give the accurate results. These models helps to find the patterns which show when a driver might over speed the limit in the particular route. Studies that machine learning can handle large amounts of data and sort different driving conditions correctly, making it useful for predicting speeding risks using real- world information like the data in this project.

Weather-Aware Driving and Risk Analysis:

Research in smart transportation shows that weather has a big effect on driving safety. Conditions like fog, rain, snow and low visibility make it harder to control a vehicle and can lead to speeding problems. Many studies say that using weather data along with driving information-like speed and road type-helps predict unsafe situations more accurately. When weather details are added to driving -assistance systems, drivers can better understand the risks ahead and adjust their speed . This is especially helpful on roads where weather changes quickly. Studies also show that weather-based prediction models can lower accident rates by warning drivers before danger occurs. Integrating with weather insights make road safety systems more dependable and also improves driving conditions in real time.

Engineering Solutions:

Engineering studies that the smart transportation to use the data along with the sensors and communication along with networks to make roads safer. New transport tech can forecast the weather conditions in the selected route up to 10kms furtherly. Notifies them with the upcoming rain, fog or poor visibility. It also warns when a vehicle exceeds the permitted speed on a particular route. This system enables that spot speeding risks along with the guiding system to the users.

Policy Frameworks:

Research on road safety shows that well-organized policies can boost transport systems by the data-base monitoring tools with the flexible speed controls. Such that systems assist users in improving road safety and act according to the conditions which helps to reduce road accidents.

Community Resilience:

Studies on road safety indicate that communication between the user and the real time data along with weather predictions become safer3w when the driver receive quick updates about the road conditions.

Environmental Considerations:

Studies in smart transportation show that adding weather awareness to road-safety systems helps reduce risks and improves how drivers respond to changing conditions. By using route-based weather information in predicting speed-violation risks, this project encourages safer driver choices and contribute to a secure driving.

III. PROPOSED MODEL

A data-driven safety system operates by continuously collecting real-time driving information, such as the vehicle's speed, current road type and weather condition. The collected data I processed to evaluate the level of risk on the road. In this system, the dataset features act like sensors, and the machine learning model works like a transducer that turns raw driving data into useful safety predictions.

The inputs from the dataset are handled by the trained prediction model, which has been programmed to interpret different combinations of speed, road conditions, traffic and weather patterns. Using this information, the model produces results that show how likely a speeding violation is to happen. The processing unit evaluates each feature and produces a corresponding warning level for the driver. These operations are performed using machine learning algorithm coded in Python and executed through relevant data-processing command.

After the prediction model generates the result, the system immediately shows an alert to the driver through the dashboard or app display. The driver receives different kind of warnings like “Go slow” or “Reduce speed”. It is quite different from SMS-based systems, this model provides real-time alerts directly on the maps, so that user will not face any network issues. It can also process and display data, ensuring safe reliable monitoring of the driver’s behavior.

The working principle of the system is it shows the a visual model that access the real-time driving inputs like road type, weather, and the vehicle current path. When it senses the driver is approaching a specific zone. The warning appears directly on the route, promoting the driver to adjust speed according to the situation.

The system also assesses upcoming environmental conditions along the selected route. It monitors up to 10kms whether it is sunny, rainy, foggy or low visibility. So the user can act accordingly based on the situations.

Both alerts work simultaneously as part of a continuous monitoring process. The system tracks alerts, checks road conditions, and forecasts weather up to 10kms of the journey. By placing warnings directly at the navigation path, the system make sure that the driver receives timely, and also location-specific guidance to maintain safe driving conditions throughout the journey.

IV. DESIGN DESCRIPTION

The chosen project Road Speed Violation Predictor with Route Weather Prediction, a combination of real time data processing and a machine learning technologies which are used to create safe and secure road safety system. This system is designed to monitor the driving behavior in real time and warn drivers when there is a risk of over speed-limit violation on the selected route.

To make use of this system, a Python-based technologies and machine learning libraries are used for building the prediction model and also processing driving data. Python provides an efficient environment for handling datasets, performing feature analysis based on the data, and running machine learning algorithms such as XG Boost to detect patterns. These models analyze multiple features like vehicle speed, speed limits, road type, weather condition, and traffic level, to determine whether a speeding violation is likely to occur.



For data handling and processing, we make use of tools such as Pandas and NumPy which are used to clean, format, and analyze the dataset. These tools help convert raw data into clean structured format that can be used by the machine learning model for the prediction. The system will also integrate with the GPS and digital map data to identify the current road segment along with the speed limits, and route information, ensuring that alerts are according to the location-specific and relevant to the drivers' chosen path.

The system connects with the weather data sources or APIs to get the real-time weather conditions along with the selected path. By analyzing weather factors the system can also predict how environmental changes may affect driving safety. This combination allows the model to generate early warnings regarding the weather along with the alert notifications.

To send the real time alerts to the driver, the system uses a map that is similar to other existing navigation applications. The map displays the vehicle's current speed, the allowed speed limit for the specific road, and any possible risks based on the current driving conditions. If the system detects that the vehicle is exceeding the safe speed more than limited speed or else entering into a sensitive road segment such as school zone, a warning message like "Go Slow" or "Speed Limit Ahead" appears directly on the screen.

The system includes many different modules. The Data module collects real-time information such as vehicle speed, road type, GPS location, and also weather data. The Preprocessing module prepares this data by removing irrelevant information and extracting meaningful features such as the difference between vehicle speed and the road's speed limit. The modified data is passed to Machine Learning Prediction module, where it analyses the inputs and estimates the probability of a speed violation.

It evaluates the output of the speed-violation prediction model to decide whether the driver should be warned or not. When a risk is identified, the system sends an alert message to the driver using user interface.

Overall, the system mainly focuses on combining machine learning, GPS-based route monitoring, and also weather prediction to create a road safety solution to avoid accidents. By analyzing multiple driving environmental factors the system can provide immediate or early warnings to the drivers and help reduce the accidents caused due to over speeding and weather conditions.

V. EXPERIMENTAL RESULT

After testing the developed Road Speed Violation Prediction System using the dataset and the real-time alert model, several outputs were obtained as part of functional, performance, and accuracy.

1. Functional Testing Outputs

- Verification that GPS-derived data including vehicle speed, speed limit, road type and weather condition is properly captured and processed reliably.

- Confirmation that the system correctly compares the vehicle speed with speed limit to identify the risk levels and possible dangers.

- Validation that alerts like "Go Slow-School Zone", "Go slow Immediately", and weather warnings appear accurately at the intended map locations for the drivers nearby.

- Evaluation of the model ability to classify driving conditions into Safe, Moderate Risk, and High Risk using combined factors effectively.

2. Performance testing Outputs

- Measurement of the system response time for real-time prediction and alert generation during route navigation to ensure timely warnings for drivers.

- Evaluation of system efficiency while processing large datasets that include multiple driving factors such as weather conditions, traffic levels, road types and vehicle speed data.

- Alert display on the navigation of the interface when the vehicle is moving continuously along the route.

3. Accuracy Testing Outputs

-Compares the predicted violation labels and actual violation values in the dataset to examine the classification accuracy of the model.

-The model is evaluated against ground truth using precision, recall, and F1-score to measure its predictive and output quality.

-The models ability to detect over-speeding is tested under different weather conditions and various road types.

4. Robustness Testing Outputs

-The system is assessed for handling irrelevant or missing inputs, such as unknown weather entries or irregular speed values, to make sure effective performance despite any of the data gaps.

-The model is checked for the managing sudden speed changes, unexpected route diversions, and irrelevant GPS signals, as well as overall reliability in all the challenging conditions.

5. Scalability Testing Outputs

-The System's capacity is to process growing volumes of driving records-including more vehicles, frequent weather updates.

-Testing whether the prediction model and map-based alert system continue to perform effectively as the dataset grows, and make sure that the system can support long-term deployment and real-time requirements.

V.CONCLUSION

The proposed Road Speed Violation Prediction System Integrated with selected Route weather prediction works effectively and also integrates with the real-time road speed, road type and weather conditions to identify unsafe driving situations with high speed in danger zones. Based on this prediction, the system generates route-based alerts as "Go slow" on the navigation interface to warn the driver.

These alerts improve driver safety by informing them about changing road and environmental conditions, allowing them to adjust their speed and driving behavior according to the road type. Experimental observations tells that the system works effectively in different driving areas such as school zones, and highways. Another important feature of the system is that the ability to update warnings automatically according to the driver's real-time location during journey. This ensures that the alerts remain relevant throughout the journey. In addition, the model can be integrated easily with existing platforms, making practical and solution for supporting safer driving practices, reducing the chances of speed-related accidents, and improving overall road safety in everyday transportation scenarios.

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