Road Condition Classification and Optimized Speed Acquisition

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***Abstract*—Every day more than 4 million people in India drive two-wheelers. Most of them who drive it are either rushing to the workplace, making deliveries etc. More than 20% of the people who drive two-wheelers in the age group of 20-34 years have reported having back pain mostly due to the bad road conditions that they face almost everyday. Our proposed system uses accelerometer, gyroscope and pressure sensors to detect the condition of the road and classify it according to the intensity of how bad the road condition is currently. The system will not only detect the bad and good roads but it will also classify it in a range according to how severe the condition of the road is after analysis. We use physical components of the sensors and calibrate it according to a particular vehicle. In the end, we acquire the optimized speed to travel from that particular road to reduce the impact on the user.**

Keywords—Classification, Data Analysis, Human Impact Analysis, Machine Learning, Optimized Speed Acquisition, Predictive Analysis, Road Condition

I. INTRODUCTION

Nowadays with the growth in the automobile industry, there has been an increase in motorcycle daily use. In India, many individuals like to drive two-wheelers to avoid traffic and reach to their daily workplaces or destinations in time. But due to uneven road conditions, many users face discomfort while driving. Keeping track of bad road conditions and also the speed bumps that are purposely laid down is not an easy task. Maintenance of roads gets delayed due to this issue. While coming back to the users, the users aren't aware of what optimal speeds they should drive to experience the lowest amount of impact or discomfort. If a user is aware of the situation then that person can be prevented from various back-related issues.

The system that we are proposing will classify the roads according to the severity of the condition into a given range of categorical variables. The system will also acquire a speed at which a user should drive on a particular road so that the person experiences the least impact on the body as well as the vehicle.

The system will also help the authorities to keep track of the uneven road conditions and plan the maintenance process beforehand. On the other hand when the user's vehicle maintenance costs can also be reduced due to the reduction of the impact that the vehicle will experience on a daily basis.

II. RELATED WORK

Jakob Eriksson, Lewis Girod, Bret Hull, Ryan Newton, Samuel Madden and Hari Balakrishnan[1] proposed the idea about how the sensors equipped on a vehicle can classify the road conditions. Various holes can be classified such as potholes, manholes etc. This can help the government to determine which road needs more maintenance.

Artis Mednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs and Leo Selavo[2] suggested that the accelerometer on the smartphone can help to detect a pothole in the road. The detection is done using the value of the z-axis threshold value with true positives as high as 90 per cent.

Umang Bhatt, Shouvik Mani, Edgar Xi and J. Zico Kolter [3] came up with a way by which we can classify the road conditions more efficiently based on the number of potholes present. Using the standard deviation of the accelerometer, the severity of the potholes can easily be determined. The SVM, when used with RBF kernel, can classify the road condition up to an accuracy of 83 per cent. Due to this, the best road can be found out from one point to another.

Shivakumara BS and Sridhar V [4] performed experiments and discovered how the Hand Arm Vibrations (HAV) and Whole Body Vibrations (WBV) due to the motorcycle played adverse effects on the human body. They also mentioned the correlation between the frequency of vibration and the types of effects that can be caused on the body.

Jaimon Dennis Quadros, Suhas P and Vaishak N. L. [5] studied the variation of displacement of various body parts for different terrains amplitudes and mentioned that terrain amplitudes become ineffective above 8Hz frequency. By analysing the data they stated that the ideal operating speed for the head, back, torso and thorax is 31 km/h and for diaphragm, abdomen and pelvis is 49.60 km/h.

Hsieh-Ching Chen, Wei-Chyuan Chen, Yung-Ping Liu, Chih-Yong Chen, Yi-Tsong Pan [7] evaluated the predictions of various health risks of motorcycle riders. They stated that alongside WBV other factors like ageing

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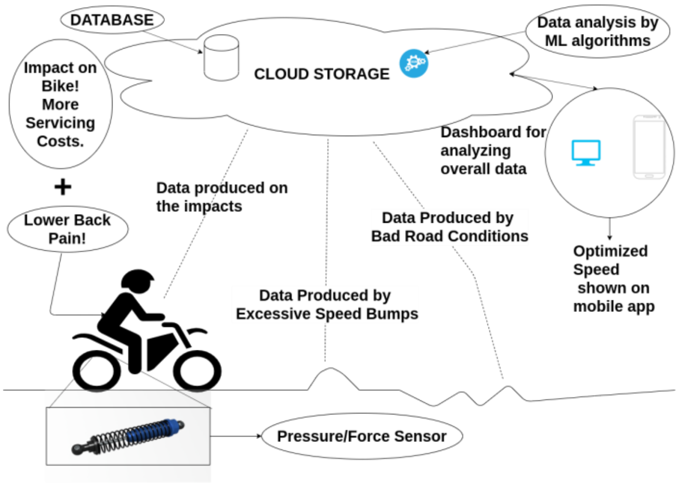
also constitute for health issues. Vibration peak distributions are the result of vehicle speed.

III. PROPOSED SYSTEM



The unit consisting of the hardware components will be mounted onto the motorcycle. The data will be collected and will be posted to the cloud storage for further analysis. The cloud will be consisting of the algorithm that will analyse and predict the various deliverables that are promised by our system. The deliverables mean the analysis of the impact that the human's body undergoes and also the road condition classification. The optimal speed will be shown for a particular road onto the mobile application when it is under drive mode.

We have divided the working of the system into 3 different phases, namely: Data Sensing Phase, Data Analysis Phase and User Interaction Phase.

A. DATA SENSING PHASE:

Here we gather the data from the physical components that we assemble together and mount it onto the motorbike. The physical components consist of Raspberry Pi, Accelerometer sensor, Gyroscope sensor, Pressure/Force sensor, GSM card and a casket to cover the Raspberry Pi. The power supply to the Raspberry Pi will be given through the battery of the motorbike.

The data collected from the accelerometer and gyroscope is a 3-axis data and the force/pressure sensor will be a time-series impact on the bike while driving.

The need of using hardware components for this project is that it will be calibrated according to the vehicle as we are installing a pressure/force sensor onto the suspension of the vehicle and also in future many more components can be added to this module to proceed in the direction of smart bikes/vehicles.

B. DATA ANALYSIS PHASE:

The data collected from the raspberry pi module will then be transferred to the cloud through the GSM card that will be installed on it. Algorithms will be deployed onto the cloud for the purpose of the analysis of the data sensed from the first phase. The algorithm we are planning to use is the Support Vector Machine algorithm which will help us to classify the data into a range of categorical variables.

The SVM will make the classification easier and provide better results as compared to other supervised algorithms. The Kernel that we decided as of now to use is the Gaussian Kernel , but we will keep on looking for other optimal kernels.

The disturbances on the road can be sensed through the 3-axis data provided by the gyro-accelerometer sensor. The pressure sensor will detect the intensity of the impact on the bike. These will provide the algorithm variables to extract knowledge from the data and put data points into classes accordingly. After acquiring the classes of the data points we will map it according to the latitude and longitude parameters onto a map. This will also help the user by providing the best route available to their destination.

Then we move onto the next outcome of our system that is the acquisition of optimized speed from another algorithm that will also be present onto the cloud. Once a user is travelled from a particular road we can analyse at what speed the user was driving and how much impact the user experience. Then whenever any other user tries to go from the same road we can calculate at which speed that user should drive to stay inside the speed limit and experience the lowest amount of impact. We will look for the most optimal classification algorithm for determining the most optimal speed for the given road.

This algorithm will keep on updating the optimized speeds for a particular span of the road as many users will be driving on it. As the road conditions will change from time to time so the algorithm will adapt through new road conditions and provide the optimized speed accordingly. This will be done by continuously collecting the data from the users. This data will constantly keep on updating on the cloud.

C. USER INTERACTION PHASE:

Now coming to the final phase of our system, here we provide an android application to the user to see the analysis of how the user drive and also while driving acquire the optimized speed to experience minimal impact.

A dashboard will be provided for the authorities to analyze the road conditions and where the actual need for maintenance is required. The dashboard will contain a map with road condition colour coded and the analysis of various users.

This app will constantly fetch the updated data from the cloud and make it easily available to the user.

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Also visualizations will make it easier for the user to take proper measures and decisions.

IV. OPTIMIZED SPEED ACQUISITION

This is an algorithm that our system uses to acquire the optimized speed to keep the Whole Body Vibration(WBV) under a certain range to avoid fatal injuries. The algorithm first analyzes the user's historical data to predict the optimized speed for a particular road.

The requisite for this algorithm to determine the optimized speed for a particular road or portion of road is that any user should have at least travelled the road once to generate the historical data that is required for the prediction. It will first analyze how much WBV takes place on that particular road and then find the speed for lowest WBV observed.

V. ANALYSIS OF IMPACT ON HUMAN

The human who drives the vehicle undergoes vibrations due to various components which include the bad road conditions and also it causes many types of effects on the human body as stated by Shivkumara BS and Sridhar V[4] . This can be used for predicting the effects of a frequency of vibration to predict the types of effects that can be used for further analysis of the impact caused on humans.

Also as Jaimon Dennis Quadros, Suhas P and Vaishak N. L[5] gave the relation between the displacement and frequency while driving and its effect on various body parts.

They also provided an ideal operating speed for a two-wheeler to experience minimum vibrations is 8Hz. We are trying to improve this by giving ideal speeds for various roads according to their conditions.

VI. CONCLUSION

In this paper, we have proposed a system to analyse the discomfort experienced by the user while driving a two-wheeler on the road and also predict the optimal speed at which the user should drive to avoid any effects from the WBV i.e Whole Body Vibrations experienced by the user.

This system will help the user to drive optimally and also the authorities can monitor the road conditions due to the classification provided by the system.

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