SMART ROAD TRANSPORTATION SYSTEM

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Abstract : ***Road transport system is an essential mode of transport system all around the world. However, it is also important to understand that majority of the transportation related accidents are caused on the roads itself, especially in nations like India where the road infrastructure has been poorly developed. Another reason for the increase in the number of road accidents can be attributed to the 'static' conditions of the transportation system in general. With the rise in technical developments in the fields of Internet of Things(IoT) and Machine Learning(ML), the road transportation system can be improved from a static system to a dynamic system. The proposed paper aims to provide various dynamic solutions to enhance the road transportation system through smart solar street lighting systems, smart road dividers, machine learning techniques to determine potholes and bumps on the roads and elastic speed breakers. With these methods, we aim to increase the safety and ease of usage of the road transportation system, thus reducing the rate of road accidents and traffic congestion problems effectively.***

Key Words: ***Internet of things, machine learning, smart divider, pothole and bump detection, elastic speed breakers, non-Newtonian fluids.***

I. INTRODUCTION

According to the report published by the Indian Govern-ment[1] on the road accidents in India for the calendar year 2016, the National Highways constituted for 29.6% of road accidents even though the network of the National Highways is just 2% of the nationwide road network. Similarly, the State Highways accounted for 25.3% of road accidents in India although their network is just 3% of the total road network. Figure 1 illustrates the data related to accidents on various types of roads in India for the year 2016.

Also, the same report has stated that 84% of the road accidents had been caused due to the fault of the driver of the motor vehicle, in which 66.5% of the accidents had been due to over-speeding, 7.3% of the accidents were due to overtaking, 4.4% of the accidents were due to driving on the wrong side of the road and 1.1% of the accidents were caused due to jumping of the traffic signal. Other reasons like the defects in road conditions or improper light system accounted for 2.3% of the accidents. Thus, the majority of the accidents could be prevented if we could improve on providing the proper infrastructure for curbing these same faults. Also, it should be noted that though the conditions of the National Highways and the State Highways are much better than the majority of the roads in India, a huge portion of accidents(around 50%) are happening on these highways. Hence, measures are required to prevent the number of accidents happening on such types of roads in the future.

Road Classification	National Highways	State Highways	Other Roads
No. of Accidents	1,42,359 (29.6)	1,21,655 (25.3)	2,16, 638 (45.1)
No. of Persons Killed	52,075 (34.5)	42,067 (27.9)	56,643 (37.6)
No. of Persons Injured	1,46,286 (29.6)	1,27,470 (25.8)	2,20,868 (44.6)

Note: Figures within parentheses indicate share in total accidents, killed and injured in the respective road categories.

Fig. 1 Number of Road Accidents, Persons Killed & Injured as per Road Category (2016)

II. EXISTING SYSTEM

The existing system[2] describes the implementation of smart street lighting system and automated speed breakers system. The paper aims to provide the energy optimization through both these systems. The street lighting system is im-plemented through piezo sensors and LDR sensors. The piezo sensors are required for customization of lighting systems through which we can alter the brightness of the street lights. The LDR sensor is used to turn on or turn off the street light, depending upon the external environment conditions. For instance, the street lights will automatically get turned off during the daytime since the LDR sensor detects the ample amount of sunlight in the surroundings. As the day proceeds to the darkness, the street lights automatically get turned on. Thus, the system ensures that no manual intervention is required to control street lights.

The other part of the paper describes the implementation of automated speed breakers. Here, piezo sensors and actuators are used. The piezo sensors is used to detect the speed of the moving vehicle. If the speed of the vehicle is recorded higher than the recommended speed limit, Then the actuators placed around 10 meters ahead of the piezo sensors lift up the rumble strips to prevent the over speeding of the vehicle and thus, The probability of the vehicle facing accident is reduced.

However, The existing system has flaws. Although the smart street lighting system could have successful implementation, The same cannot be said for the automated speed breaker system. Some of the reasons why the automated speed breaker system could fail are given as follows:

1. The existing road infrastructure would not be able to modify from the static speed breakers to the dynamic auto-mated speed breakers. There would be high maintenance cost since large number of sensors will be required

2. If multiple number of vehicles are passing through the same portion of the road where the piezo sensors are placed, then there will be decision-making problem whether to lift the rumble strips or not. For instance, If one vehicle is passing at a speed of 40km/hr and the other vehicle is passing at a speed of 80km/hr and if the recommended speed limit is 60km/hr then lifting up the rumble strip would unnecessary cause fuel consumption for the former vehicle.

III. PROPOSED SYSTEM

(A)Smart Divider

The idea of smart divider[2] can be used to reduce traffic congestion on roads, especially during the rush hour where there is heavy traffic on one side of the road and little to no traffic on the other side of the road. The existing system uses the Raspberry Pi and the pi camera to detect the movement of the vehicles, along with sensors placed along the side of the dividers. However, the increased use of sensors increases the cost of implementation.

The proposed system will try to eliminate the rising cost by using Deep Learning techniques to detect the number of cars on each side of the road respectively. The divider will be moved through the following mechanism- the smart dividers will have multiple wheels placed below them to facilitate the movement accordingly.

We use the Matlab Deep Learning platform for detecting the cars on the road through the camera from the top at the main junction/ traffic signals and accordingly, the number of vehicles will be counted. If the number of one side of the road is less than half than that on the other side of the road, then the divider will be shifted by one lane to the former side. If the number of vehicles on one side of the road is less than quarter the number of vehicles on the other side of the road, then the divider will be shifted by 2 lanes. Before shifting the divider, a message will be displayed onthe sign board so that the drivers will be warned.

(B) Pothole and Bump Detection System

In developing countries like India, the road conditions are very poor. The unexpected potholes and bumps on the roads constitute to the huge number of accidents on the roads. According to the report[1], potholes accounted for a massive 6424 road accidents and 2324 lives during the calendar year 2016. However, there hasn't been any tracking system to detect these anomalies on the road and thus, the work on developing the roads remains incomplete. The proposed solution is that we can track the potholes on the roads through various Machine Learning Techniques. The most suitable technique would be a supervised learning approach which includes various methods like k-nearest neighbors, decision tree classifier, supervised neural networks, Bayesian trees, etc. In the supervised learning approach, we train the data points so that they could be classified into common and uncommon data points, which we could label them effectively. As the training data increases over a period of time, the accuracy for anomaly detection also increases.

We could apply the same techniques for the detection of the potholes and bumps on the roads. Firstly, the cameras will be paced on the street lights which will send the real time images on the cloud. We can use many platforms to detect such anomalies like the Matlab Deep Learning platform or the Darknet image detection platform, etc. for this purpose. If any anomalies are tracked on the road, then their locations will be mapped through the GPS system set up on the camera. Hence, the municipal authorities will be immediately notified about the prevailing anomalies present currently on that certain patch of the road. Thus, the manual intervention is removed in the pothole and bump detection. The following diagram helps us to visualize how potholes and other anomalies can be detected in real time through this concept. Figure 2 shows the original snapshot of a pothole-ridden patch of a road, while Figure 3 shows the detection of potholes.

Fig. 2. Original photo captured.

Fig. 3. Probabilistic detection of anomalies

(C) Elastic Speed Breakers

As given in the existing system, the smart automated speed breakers still has certain flaws. To eliminate these flaws, elastic speed breakers can be implemented. The elasticity of the material for the speed breakers can be achieved with the help of a non-Newtonian fluid. A non-Newtonian fluid is the fluid which does not follow Newton's law of viscosity. It is a fluid whose applied viscosity varies on applied stress or force. For example, if one punches a container full of non-Newtonian fluids, then your hand would not go through the fluid. The reason is that the particles of the fluid arrange as a solid state material such that even a huge force at that level would not penetrate through it. On the other hand, if you put your hand into the fluid slowly, it will penetrate successfully.

Fig. 4. The world's first liquid speed bump designed by the Spanish company Badennova SL.

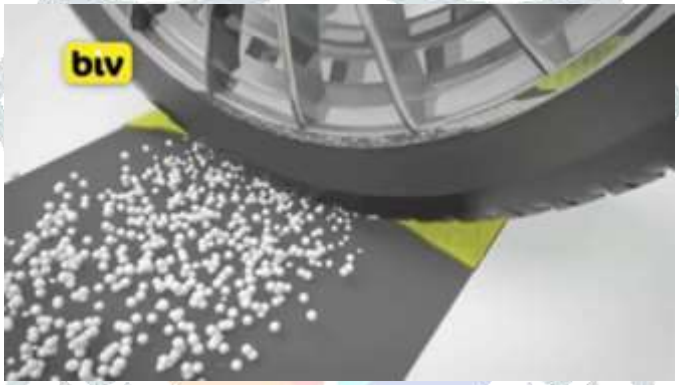

Fig. 5. The motion of fluid particles of the viscous fluid when the vehicle is passing at a normal speed. The bump deforms itself to allow easy passage for the vehicle.

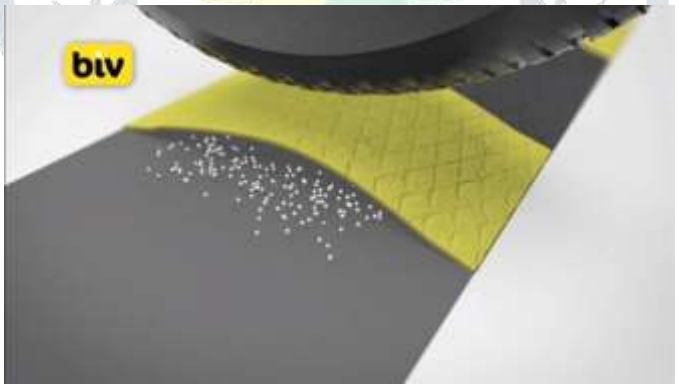

Fig. 6. The motion of the fluid particles of the viscous fluid when the vehicle is passing at a higher speed. The bump toughens itself to exert shock on the high speeding vehicle.

The following incredible properties of a non-Newtonian fluid can help in designing elastic speed breakers which could easily let pass a vehicle driving at a normal speed, while acting tough for a vehicle passing at a higher speed. This idea has already been tried and tested by a Spanish company Badennova S.L.[3]. The company has designed a "liquid speed breaker" as shown in Figure 4, which has a soft and deformable exterior with the viscous non-Newtonian fluid inside it. Thus, when a vehicle is passing over the speed breaker at a normal speed, the speed breaker deforms itself in such a way that the vehicle could easily pass through it. The process is illustrated in Figure 5. This helps in minimizing the fuel consumption for the vehicles which are traveling at a nominal speed limit and also enhances the comfort of driving on roads. However, when a vehicle is passing at a higher speed through the speed breaker as shown in Figure 6 ; instead of absorbing that higher force of a passing vehicle to get itself deformed, the speed breaker hardens itself and transfers that shock to that same vehicle and thus, it's speed remains under control.

IV. CONCLUSION

Thus, the three proposed systems given in this paper aim to solve various issues related to road transportation system such as effective traffic management through smart dividers, potholes detection using machine learning techniques and speed control along with effective fuel consumption with the help of elastic speed breakers. Such initiatives would help in enhancement of road safety and lessen the burden of congestion on the roads. There is a huge scope in the future for the proposed ideas. For example, in smart movable dividers, we can implement the system such that the cameras detect emergency vehicles such as ambulance, fire engines, etc. and move the divider accordingly for their effective routing through the busy roads. In the pothole detection system, we can create an app which displays the locations of the potholes as well as provide an update whether the work on those potholes has been completed or not. The app could also be launched for the general public usage so even they can check where the potholes are currently unattended during the roads and avoid passing over them thus preventing accidents.

However, the proposed methods also do have certain draw-backs. For example, implementing the pothole and bump detection would be an expensive task since large number of cameras would be required at various junctions/checkpoints. The initiatives are quite complicated to implement since it would require a huge revamp on the current roads. Even then, with proper planning, the proposed systems could be implemented as a pilot project on the National Highways and the State Highways. If the results turn out to be positive, then the nationwide renovation of the existing system could be foreseen successfully.

V. REFERENCES

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