

Smart Rumble Strips

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Abstract— Smart rumble strips are the strips which are useful for various purposes like cooperative driving to avoid accident around blind corners, to avoid the overturning of trucks and lorries, energy harvesting and many more. We developed system for different types of problem for that we need to use different sensors as per the requirement. Like in cooperative assistance system (Ultrasonic) sensor is used, for energy harvesting system piezoelectric harvesting tech. is used. And open source Arduino uno is used as a microcontroller. Bluetooth module for communication within system. In this paper we mention about cooperative driving to avoid accident around blind corners. And other application which could be possible. Demonstration of the project is also carried out to test field performance and found very successful.

Keywords: SRSt-Smart Rumble Strip, PEH-piezoelectric energy harvester, cooperative driving system, piezoelectric material

I. INTRODUCTION

The transportation is the back bone in development of any country. INDIA is a developing country and the increasing booming economy, and technological advances there has been increasing industrialization and urbanization. An increased economic spending capacity with more affordability of vehicles there has been an unprecedented increase in the number of incidents from road traffic accidents (RTAs) and the injuries thus caused.[1] As the rate of automobile sector increase in INDIA not any other sector develop. Although India has only 1% of the world's motor vehicles, but it accounts for 6% of the global road traffic deaths.[2] As increase in development the accidents should have to lower but day by day accidents becoming more worst. There are several reasons behind it like roads quality is not develop yet. Poor maintenance ,according to times of India 3,597 deaths due to pothole-related accidents in 2017.[3]more than 60 % of roads in INDIA are single leaned roads. To avoid over speeding speed bumps are in use but they are not that efficient. A lot of research and advancement require to restrict over speeding, to find solution on overturning of heavy trucks and two wheelers, for co-operative driving system along the corners. About 120,000 people died because of road accidents in India every year.[2]

On the other hand with the rapid development of society, the increasing energy consumption leads to the shortage of nonrenewable energy resources. Researchers are working on several energy harvesting techniques, like piezoelectric energy harvesting technology has been studied for many years. Priya (2005) invented a pocket piezoelectric windmill which was attached to a rotating cam [4].An Israel company INNOWATTECH (2010) announced that they had developed a pavement energy harvesting systems: Innowattech Piezo Electric Generator (IPEG), which is based on a piezoelectric transducer. According to reports, when traffic volume of vehicles is more than 500 in the single lane

per hour, up to 250 kW of electrical energy can be collected per kilometer per lane [5].

In this paper mention about, Smart rumble strips applied to actual road and its performance is tested for overturning prevention module and over speeding module. As well as the others application which are possible with the help of SRSt are followed. Like Energy harvesting module, Data collation module and Cooperative driving module along the corners.

II. BASIC DESIGN OF SRST

SRSt will get actuated millions of times while in practical use, the rumble strip are should be made up with such material which is having high compressibility, fatigue resistance as well as anti-corrosion. There have been many research done in pavement materials by several researchers [6,7,8]. Design of the rumble strip in such a way that it will protect the sensor by getting damage after the vehicle passes over it. SRSt is designed to be 1500 mm long and 100 mm wide. Generally rumble strip are in these dimensions to having better contact with the wheel of the traveling vehicle. The thickness of the SRSt is 25 mm, which is slightly thicker than the regular rumble strip used in India.

The SRSt consist of four parts: the sensor unit, the packing material, supporting material in both the sides to absorb the load, electronic material and other fastening elements. As per the various application (output) different sensors have to use. e.g. for the energy harvesting piezoelectric sensor are used , while for overturning avoiding application presser sensors are in use .. The upper most layer is made up of rubber (neoprene) which provide better grip to tire and work as a shock absorber in SRSt. In the lowermost layer we use used bicycle inner tube to carry the superimposed loads without causing shear or crushing failure and avoiding the slip on the surface of the road. The majority of inner tubes will be made of butyl rubber. It's the least expensive material and also the most robust. MS metal plate is placed up the used tires to provide the rigidity. Mild steel having the high impact strength. Next is the sensor section in which we used (8888888888*****).(Fig.1) After connecting all the sensors to the microcontrollers we seal the joints with fastening material. All the solders are sealed with the electronic glue.

The LED signal is made up with small red LEDs. The each and every LED is connected in series and parallel combination to each other. The working voltage of the LED signal is 5 V and current is 2 A. And entire circuitry is fix in the frame. We use Arduino Uno, Bluetooth module and RTC (real time clock) DS3231 for particular uses.

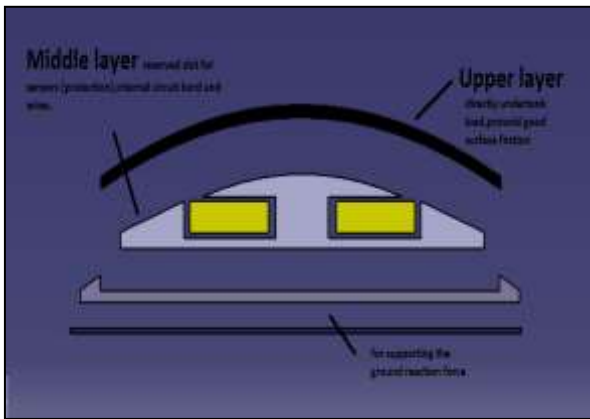


Fig. 1:

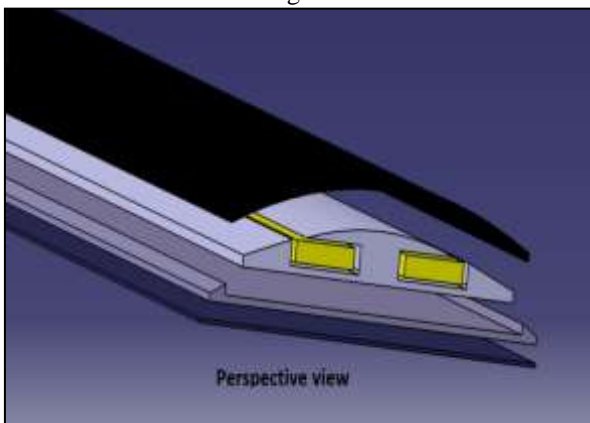


Fig. 2:



Fig. 3:

III. DEMONSTRATION OF PROJECT

The demonstration of our Smart rumble strip for the is located at college campus of Dr. J J Magdum Collage of Engineering Jaysingpur.

Overtuning involve in almost one in five fatal vehicle accidents. But unfortunately no any technology or system yet develop to prevent the overturning or help to avoid it. we know when the vehicle moves along a curved path with very high speed , then there is a chance of overturning of the vehicle. An inner wheel leaves the ground first. As we all know centrifugal force -



Fig. 4:

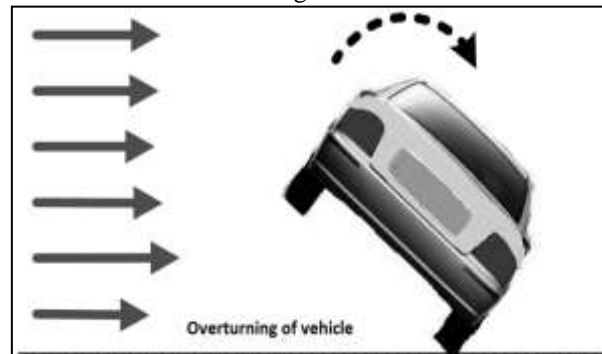


Fig. 5:

$$F_c = m \cdot v^2 / R \quad (1)$$

where F_c – centrifugal force

M =mass

V = velocity

R = radius of curvature

And the couple tending to overturn the vehicle (C_o)-

$$C_o = F_c \cdot h \quad (2)$$

where h = distance from ground to center of gravity

So as per the equation Eq.2 to avoid the overturning velocity (V) and distance from ground to center of gravity (h) should be less. And radius of curvature should be more but always it is not possible due to according to land condition and situation we have to build road so only velocity and distance from ground to center of gravity is in our hand.

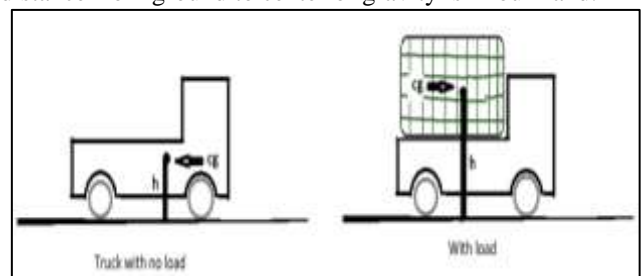


Fig. 6:

Generally loaded trucks and two-wheeler vehicles are having more chances to be victim of these mishaps because due to goods the center of gravity shift upwards and distance from ground to center of gravity (h) increases , consequently chances too (Fig.3). In two wheeler vehicle h is almost same but velocity is the reason. So smart rumble strip helps to mine the speed of vehicle and accordingly the type of vehicle it will guide to slowdown the velocity if necessary.

For particular turn the maximum speed limit is different for various vehicles so we are categories all the

vehicle in three type 1) light vehicle under all two and three wheelers comes 2) medium weight vehicles under which all cars and mini-trucks 3) heavy vehicle all trucks and lorries in this type. Generally cars and are stable around the corner because distance from ground to center of gravity (h) is low, so they can go with higher velocity. that's why as per the condition of the road set different speed limit for these different types of vehicle. In this design module SRSt measures the speed of the vehicle if it is beyond limit then it will show red signal to driver to reduce the speed.

A. Working

Working – we place smart rumble strip before the corner if vehicle pass over it then it sends signals to the microcontroller to analyze the speed of vehicle. then it compare the speed of that vehicle with maximum speed limit for that particular group if it's more than the speed limit then it will send signal to the output LED signal, then driver come to know that he / she have to apply the brakes.

We use the (0w76) which is ----. when the vehicle strike the first strip then 1st signal get actuated and microcontroller which is arduino Uno with the help of RTC clock (DS3231) Start counting the time. when the wheel hits another rumble strip then 2nd signal generate, with the help of RTC arduino calculate the time between the two consecutive signal. With that we can precisely calculate the speed of the vehicle.

The both rumble strips are placed at 15cm apart so if the vehicle is at 40kmph then the time gap between the two consecutive should be ---. And that was the threshold value. If the time period of the two consecutive signal is less than -- then vehicle is faster than the 40kmph and if the vehicle speed is exactly --- or more then vehicle is less than 40kmph. In our project 40kmph is the limit if the vehicle is greater than 40kmph then signal starts blinking for 3sec blinks and if the vehicle is below 40kmph then it remains off. If the vehicle is fast then by its pair of front and back wheels signal blinks for 6 sec.

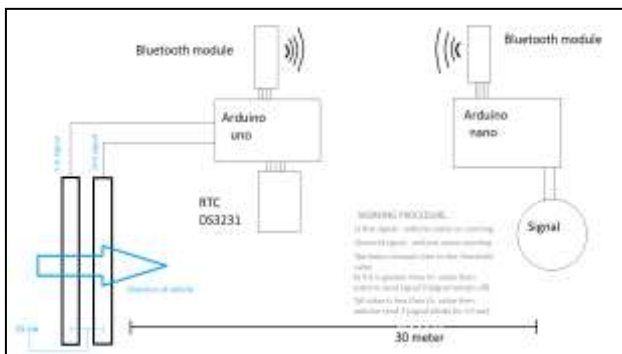


Fig. 7:

Over Speeding responsible for the most of accidents so by using same method control on over speeding could be possible. Currently developing country like INDIA where speed bumps are used to avoid the over speed along the city or sensitive area like school and hospital. But there are a lot disadvantages speed bumps. According to website-Joincrush.com [7]

- 1) Speed bumps are detrimental to the environment, increasing pollution by forcing cars to slow well below the speed limit and then accelerate away.

- 2) They increase noise levels where they are implemented. Not just by engine and brake noise from people slowing down and speeding up, but also from trucks and Lorries carrying loads that get bounced around.
- 3) They cause damage to vehicles, particularly sports cars (even at low speed), cause discomfort and back injury to drivers and passengers.
- 4) They slow the response times of emergency vehicles.
- 5) They are responsible for traffic and often divert traffic to alternative residential streets.
- 6) They cost drivers money by using more petrol and brake pads in addition to the damage caused to suspension, oil sumps and exhausts etc. This often makes cars more dangerous.

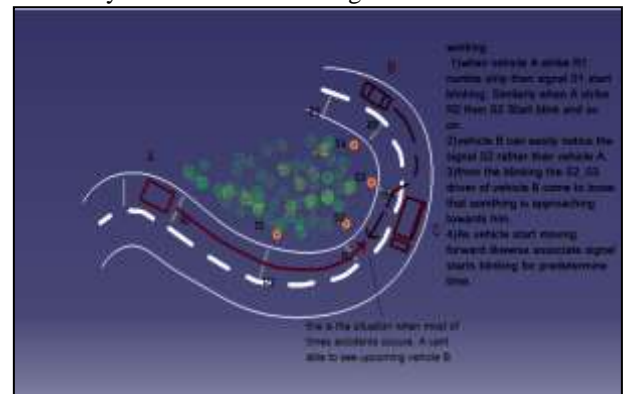
So it will be better if we use the SRSt to control over speeding. One additional benefit we will get and that is we will able to set different speed limit with respect to daytime night time, with respect to weather. In rainy season break efficiency is low so we set different speed lime in such weather.

IV. OTHER APPLICATION OF SRST

A. Cooperative Driving Along the Corners

Accidents involving overtaking maneuvers are important problem on rural area in India. Because of the two-lane roads. To overtake the vehicle driver have to travel through such lanes where other vehicle travelling in the opposite directions. It could be dangerous along the corners, because driver can't able to see further upcoming vehicle. Dangerous roadway curves cause too many car accidents in real life. These types of car accidents are often fatal or cause serious and crippling injuries. As we all know overtaking is an difficult maneuvers in which driver have mine relative speed of vehicles, driver should be aware of road condition and most important he should have past experience, still not major innovation is occur to reduce or help driver to do such an difficult maneuver.

With the help of smart rumble strip driver get to know that is any vehicle approaching towards him or not from opposite direction. Specially in curved road where vision is not clear and looming vehicle are not able to see. If driver come to know that the road next to him/her is empty then it will be easy to take overtake along the corners.

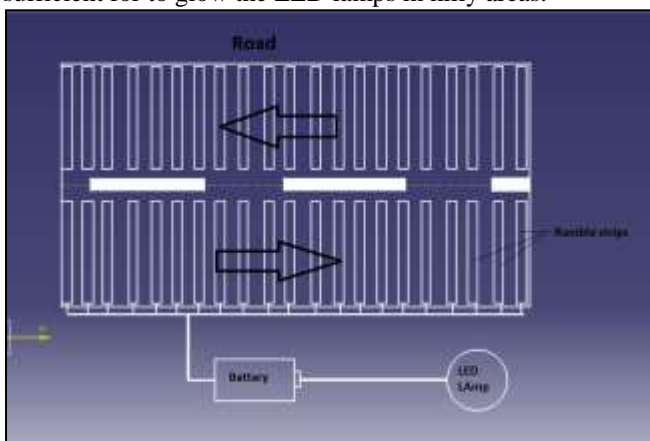


In the fig. rumble strips are shown only side but in actual condition both sides equipped with rumble strip and associate signals. This should be directional sensitive technology which will detect the direction of vehicle. If the

vehicle are moving in same sense then signal will not get actuate.

B. Energy Harvesting

The energy harvesting with piezoelectric material has been studied for many years. In 2010 Alexander develop a system to collect the vibration energy by pedestrian walking on roads. An Israel company INNOWATTECH (2010) had developed a pavement energy harvesting systems: Innowattech Piezo Electric Generator (IPEG), which is based on a piezoelectric transducer. Most of the researchers who work on piezoelectric pavement are in exploratory phase. A research paper published on 2017 “A preliminary study on the highway piezoelectric power supply system” by Hailu Yanga , Linbing Wangh , Bin Zhouc , Ya Weid, Qian Zhaoe Had developed PEH ad tested on actual road. The PEH developed to convert the mechanical energy by traveling vehicles into electrical energy. The open circuit voltage generated from the PEH under the actual road traffic conditions was higher than 250 V. And that much energy is sufficient for to glow the LED lamps in hilly areas.



C. Data Collecting

In each sector every field we almost have come across a story about how “data” changing the face of the world. In almost every sector giving the priority to data, collecting data become most important and necessary step nowadays.

Data collection is gathering and measuring information from a various of sources to get information and a complete picture of an particular issue. With the help of SRSt we can collect various type of data like

- Number of vehicle passes through the particular road
- We can differentiate the vehicle like lightweight vehicle, medium weight vehicle and big trucks or lorries. Go get
- This record will be helpful to measure vehicle traffic flow, vehicle density
- Data could beneficial for advanced traffic management for the improvement in traffic signal.

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