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Sensor based System for Computation of Speed, Momentum of Vehicle, Traffic Density and Vehicular Force

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Abstract: *This sensor based system can compute the speed of vehicle. It also computes the momentum of vehicles and the traffic density on the approach road. This system will also detect any vehicular problems such as brake failure, accidents on the roads and also detect the section which is affected or will be affected. The system can be easily rectified in case there is a failure in the sensors. The system can also be used for estimating any obstruction in between two ends of the road.*
Keywords: *Traffic Density Measurement; Accident Detection; Vehicular Speed Computation; Road Acceleration*

I. Introduction

There are systems which compute the speed of vehicle like speed guns, which optically track a vehicles position and determine the speed. These systems are relatively complex and require a stable platform on which the speed gun can be mounted upon. Any movement of the platform affects the speed computed by the system. There are few systems which can compute the vehicular density and momentum simultaneously. Using image processing one can easily compute the length of vehicle and its velocity, simultaneously. However this is done with the help of a single camera. Any error in the system becomes impossible to be detected.

The proposed sensor based system is essentially autonomous and can be corrected easily when it comes to the failure of any of the sensors. It uses non-optical sensor but can give same results during day and night. It can compute high vehicle speeds and also compute the density of vehicles in various lanes. It is also an innovative approach for making smarter roads which detects the section of road which is affected or will be affected as result of vehicular problems.

II. Sensor Architecture

The sensors will be embedded on the ground and will consist of load cell and an amplitude modulated signal demodulator. This signal demodulator will compute the amplitude of the carrier wave and also the frequency of the message signal[5].

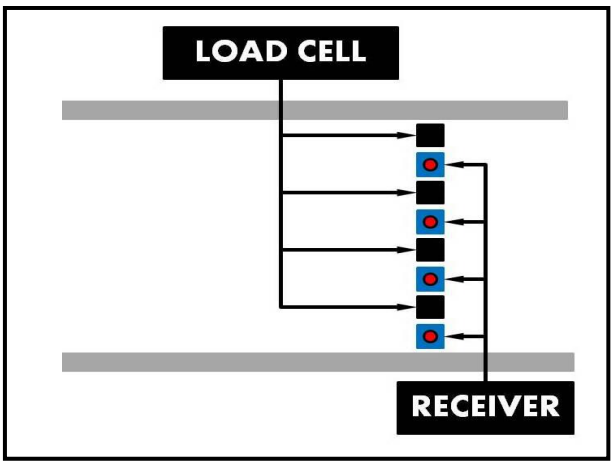

Figure1 Sensor Bed Design

III. Speed Computation

This segment is the most vital part of our system. It will consist of a transmitter and receiver module. The transmitter will be attached to the base of the vehicle and receiver will be embedded on the road as shown in the figure.

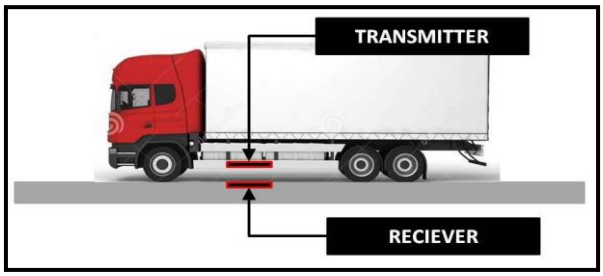

Figure2 Vehicle Speed Transmitter and Receiver

The transmitter will transmit amplitude modulated(or pulse modulated) signal. The amplitude of the carrier wave will be equal to the radius of the wheel. The message signal will be (revolution per minute) of the wheel. The rpm transferred will be a pulse signal. It will vary in frequency depending upon the speed of the vehicle[1].

The receiver will measure the amplitude of carrier wave. It will also measure the rpm which will essentially be the frequency of the modulated signal. The product of rpm, radius with 2π will yield the speed of vehicle[4].

IV. Momentum Computation

For computation of momentum of vehicle, there will be a load cell embedded on the road. The load cell will calculate the mass of the vehicle. Momentum of the vehicle is given by the formula:

Momentum = Mass x Velocity

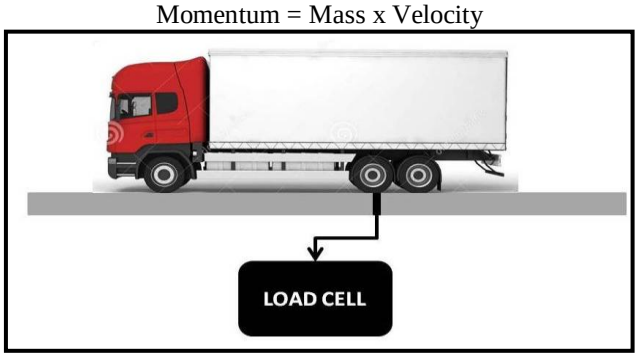

Figure3 Momentum Measurement

The change in momentum across the different sections of the road will yield the vehicular force using the formula given in the next section.

V. Road Length Acceleration

The term road length acceleration is a new term. The meaning of the term used in this paper is the net acceleration of the vehicle while travelling on that particular length of road. This is done by measuring the mean initial velocity and final velocity computed by sensors on the two ends of the road. Using the formula given below.

$\{(\text{final velocity})^2 - (\text{initial velocity})^2\} / \{2*\text{distance}\} = \text{acceleration}$

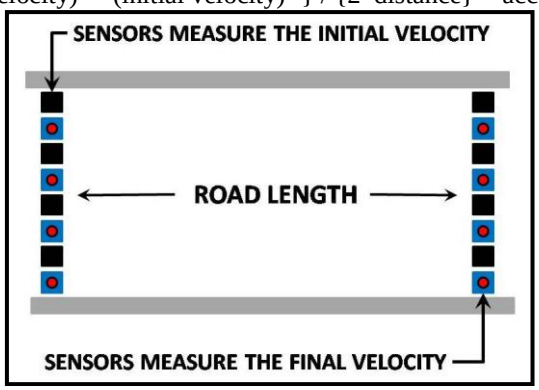

Figure3 Road length

The acceleration so calculated can be used to tell the force with which vehicles travel. In case there is a failure in brakes of any of the vehicle then the average velocity of that vehicle would be greater than the average velocity of the vehicles travelling on the road. This will also show an increase in the force with which the vehicle is moving. This computation will give a timely warning of the consequences[2].

VI. Traffic Density Computation And Road Problem Detection

We can easily compute the road traffic density in terms of the number of vehicles per unit length of the road using the speed computation technique. The speed computation technique will check the vehicles travelling in every lane. As we can measure the number of vehicles moving per unit time across a particular cross section of the road, it can be used to estimate the number of vehicles entering and leaving a road length. For an ideal road the traffic density entering and leaving the road will be same as shown in figure.

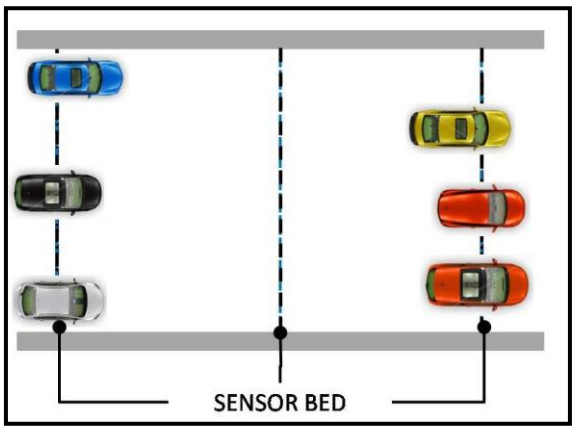

Figure4 Ideal Road Conditions

This is highly useful for detecting any accident or any road problem as shown in figure below.

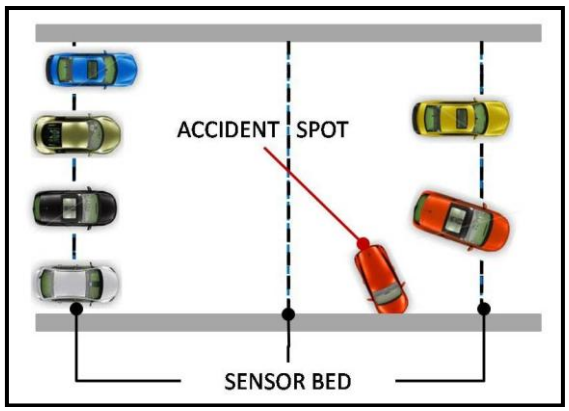

Figure5 Road Problem Detection

In this case, as shown in figure, the traffic density reduces as it reaches third sensor bed. If the sensor beds are separated at small intervals then the reduction in acceleration will also be seen from one sensor bed to the other. This will not only determine whether a problem has occurred on the road but also help in informing the section on which the problem has occurred[3].

This will also help in timely reduction of vehicular inflow into that section of the road but also reduce the time consumed in correcting the problem that has occurred on the road.

VII. Conclusion

This system is highly useful for computing and reducing the disasters on the road. The system can be attached to satellite to study traffic movement on various roads, detecting road problems and also for the timely mitigation of accidents.

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