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A Driving Simulator Investigation of Road Safety Risk Mitigation under Reduced Visibility

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Abstract: *In recent years adverse weather condition is one of the causes of vehicle crashes and human life fatalities. The severity of the accident may depend on various factors. So the main focus should be on the development of precise detection of type of weather condition and warning system. In this study we have expressed the safety risk for low visibility on roadways. Stormy or rough weather or smog causes fog/smoke, heavy rain & high winds also affect every visible road by disturbing visibility conditions, driver's behavior, visibility distance etc. However, they affect traffic safety and traffic flow rate. Visibility is weak for the driver and reduction invisibility due fog or other weather conditions such as heavy rainfall is an advanced factor that affects road accidents.*

Keywords: Speed detector technique, Prevention of accident, Fogg/smoke, IR sensor, Traffic operation and safety.

I. INTRODUCTION

The effect of weather events on traffic operation and safety has become a more important issue, and visibility reduction due to fog is a major concern. In the past four years, fog related road fatalities in India have risen almost 100 percent. North India sees the most number of fog related road deaths in the month of December and January .The sad news is that they are getting deadlier with every passing year. In 2016, as many as 9,317 people died due to fog related crashes, the number increased to 11,090 in 2017, this is a jump of almost 20 percent in one year alone. Worse, between 2014 and 2017, fatalities on road due to fog related crashes surged almost 100 percent.

Most of the road accidents occur when the visibility conditions are poor or the driver is unable to apply brakes on time. Driving in bad weather condition seems to be impossible task as it reduces a visibility and Fog being one of the most difficult weather conditions that driver many people face. Fog has the potential to reduce visibility significantly, so it is critical that drivers stay focused on the road in order to stay safe. This may happen during winter and rainy seasons, when the visibility drops to zero due to fog and heavy rainfall, respectively. Other such situations providing inadequate visibility may be in hilly terrain, where even nearby vehicles may not be directly seen. In all such situations, an accident avoidance system can play a crucial role in preventing vehicle collisions and saving people's lives apart from avoiding damage to the vehicles. There are some systems available for avoidance of vehicle collisions. This paper explains in detail the implementation of an accident avoidance system designed using IR sensors and some hardware devices which can be installed in all poles on the road. Its features, like image processing makes it possible to travel in extreme weather conditions. The effect of fog on both crash occurrence and severity has become a major concern in the traffic safety field. Moreover, accidents rate in night is increases by a scaling factor of 1.7 as it is compared with day time. The main reasons for this are poor Visibility, speed and drowsiness. To avoid this problem intensity of high beam headlights is kept low in Fog, as Fog causes dispersion of light. So advancement has to be seen in this regard to automate the system and as well as to increase or maximize the visibility in bad weather. Adverse effect of sensors weakness, particularly cameras made bad effect on the vision applications of the vehicle thus resulting in failure of ADAS. In particularly unfavorable conditions like fog or rain are major considerations. Firstly, they affect the safety of the driver by reducing his visibility. Secondly, they reduce the efficiency of camera based system as they change image quality thus making it inefficient. To ensure the self-sufficiency of the vehicles with more security the vehicle should have find and maintain a distance from vehicle in any ranges, during day and night. This project major focus will be on the making the vehicle driving safer and self-governing.

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II. LITERATURE REVIEW

Anik Das , Ali G , Mohamed M Ahmed (2019) ; studied effect of fog weather Condition on driver lane keeping performance using the SHRP2 naturalistic driving study data. The Second Strategic Highway Research Program(SHRP2) and Naturalistic driving Study (NDS) data was used to evaluate driver lane keeping behavior in clear and foggy weather condition. The study found that individual variables such as visibility, traffic conditions, lane change, geometric characteristic, surface condition and driving experience significantly affect lane keeping ability. Visibility caused by the foggy weather condition decreases lane keeping ability significantly. This results provide a better understanding of driver lane keeping behavior and perception of fog condition and can be used to improve lane departure warning system.

Neelima Chakrabarty, Kamini Guptab (2013); studied the virtual traits and psycometer Behavior of drivers along with their choice of speed, time of reaction and behavior During adverse weather under simulated and environment conditions. Drivers Characteristic have been measured with the help of the virtual box with three cameras To measure drivers reaction time, eye movements along with road assets during the various situation.

The findings highlights driver state and pattern of crashes during simulated adverse condition. The frequency and the severity of accidents like situations and other related incidents can be reduced by proving drivers with enough information about the road way and the traffic conditions as well as through better management during adverse weather conditions.

Yina Wu, Mohamed Abdel-Aty, Jaeyoung Lee (2017); studied the crash risk during fog condition using real time traffic data. Using real time traffic flow and weather data at two regions in Florida, the traffic patterns at the fog duration were compared to the traffic patterns at the clear duration. It was found that the average 5-min speed and the average 5min volume were prone to decreasing during fog. Based on the studies, a "Crash Risk Increase Indicator (CRII)"was proposed to explore the differences of crash risk between fog and clear condition. A binary logistic regression model was applied to link the increase crash risks with the traffic flow characteristics. The results suggested that the proposed indicator worked well in evaluating the increase of crash risk under fog condition. It was indicated that the crash risk was prone to increase at the ramp vicinities in fog conditions. Also, the average 5-min volume during fog and the lane position are important factors for the crash risk increase. It was expected that the proposed indicator can help identify the dangerous traffic status under fog conditions and then proper ITS technologies can be implanted to enhance the traffic safety when the visibility declines.

Jinhua Tan, Li Gong, Xuqian Qin (2019); studied the effect of intimation phenomenon on two-lane traffic safety in fog weather. To illustrate the effect of the intimation phenomenon on traffic safety they developed an extended two –lane car following model in fog weather. Numerical stimulation were carried out to study the effect of intimation on multiple vehicle collision induced by a sudden stop, as well as perturbation propagation when a small perturbation is added to the uniform traffic flow. The results indicate that the number of collisions depends on the influence coefficient of neighboring lane's vehicles, sensitivity, headway and initial velocity. Furthermore, the number of crumpled vehicles decreases when the intimation phenomenon is taken into account. In addition lower vehicular velocity in the neighboring lane can reduce the magnitude of acceleration and fluctuation of headway. Therefore traffic safety can be
improved by considering the effect of the intimation phenomenon on two-lane traffic flow in fog weather.

F.Rosey, F. Vienne (2017); researched on Driver behavior in fog is not a question of degraded vibility- A simulator study, while research they determine the efforts of fog on driver behavior were identical for a given road type. There were three visibility condition, i) clear weather, ii) 60-m visibility, iii) 30-m visibility and two driving situation were adopted i) non-free driving, ii) free driving and the fog was simulated using special software designed as part of the French project VOIR, allowing vehicle headlight and halos to be displayed. The results show that the drivers decrease their speed with decreasing visibility distances and the distances travelled in conjuction with the speed driven according to two second rule revealed that Headway time are less than 2 seconds and smaller Headway Distances.

Amandeep Singh, Hemant Sood (2017); studied the Influence of Fog on Road Crash. In this paper they have studied the different types of fog formed at different duration of day and the accidents and crashes occurred due to low visibility. In recent years adverse weather and road traffic crashes are the foremost causes of motorized vehicle fatalities.

The degree of severity may be influenced by a number of factors. Various mechanisms were tested with different conditions and speed response to understand the reaction of drivers in changing fog levels. New algorithms have been proposed in recent studied for raring visibility enhancement techniques, on the basis of summation of various types of fog generated on artificial and camera images. The main concern should be the development of the effective detection of fog and warning system with respect to speed and headway. Further research analysis is necessary to quantify the influences of

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deicing materials, particularly in relation with frequency and application rate on transport safety. A state-of-the-art critique of study on relationship amidst fog and highway safety is provided in this paper. Reduction in the count of fatalities is expected in future on account of development of Advanced Driving Assistance Systems (ADAS).

Mohamed Abdel-Aty, Al-Ahad Ekram, H. Huang (2011); They did a Study on Visibility obstruction related crashes due to fog and smoke. Research efforts on weather effects have been concentrated on snow or rain related crashes, however there is a lack of good understanding of crashes occurring under fog/somke (FS). This study presents a comprehensive examination on FS related crashes using crash data in Florida (2003-2007). A two-stage research strategy was implement so as to examine 1) fog smoke crash characteristics with respect to temporal distribution , influential factors and crash types, and 2) estimate the effects of various factors on injury severity given as fog smoke crash has occurred. The morning hours in the months of December to February are the prevalent time for crashes. Compared to crashes under clear-visibility conditions, the fog smoke crashes tend to result in more severe injuries and involve more vehicles. Head-on and rear-end crashes are two most common crash types in terms of crash risk and severe crashes.

III. System Development

3.1 Introduction

In our research we are mainly focusing on use of new technologies to reduce the crash risk during bad weather conditions. In today's date there are so many electronic gadgets, equipment and many more technologies used in the vehicles for the betterment and safety of people, still we always here news about accidents happening around us, this means there is still lot of development to be done to make people's life happy and safe.

In this chapter we are going to study about "Speed Detector Technique using Microcontroller" and further we will be discussing its merit and demerits.

3.2 Methodology

In speed detection technique using Microcontroller, we are going to detect the vehicle's which are suddenly not able to work due to any circumstances in the middle of road, which is dangerous for the vehicles coming from behind, this technique is more helpful in bad weather conditions where road visibility decreases due to change in climatic conditions, which can leads to many unwanted accidents. So to prevent the accident we can do the following measures. Poles are established at an approximate distance of 20 meter, every pole consist of an Microcontroller , IR sensors, timers, Red alert light, Buzzer, Solderless breadboard, Resistor, battery and battery clip and multiple circuit would be fitted inside the divider. When any vehicle is having breakdown, immediately the IR sensor detect the motion of vehicle and with the help of Microcontroller, which is uploaded with the coding to detect speed of the vehicle, the corresponding red light and buzzer gives the signal of the broken vehicle so as the driver of moving vehicle approaching the incident place is able to see the red light and can safely hit brakes at a safe distance, preventing the accident due to low visibility in the foggy weather. element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators.

Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity. Resistors are common elements of electrical networks and electronic circuits.

3.3 Components used in Speed Detector

Microcontroller: Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. In the context of the internet of things, microcontrollers are an economical and popular means of data collection, sensing and actuating the physical world as edge devices.

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Figure 1: Microcontroller

A. IR Sensor (Infrared Sensor)

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor.

Figure.2: IR Sensor

B. Solderless Board

A breadboard, or proto board, is a construction base for prototyping of electronics, the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design.

Figure 3: Solderless board

C. Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit In the speed detector system the IR sensor are connected to timer's, Microcontroller is programmed according to detect the vehicle and is connected with Red light alert and Buzzer. The two IR sensor are fitted in two consecutive electric poles, and red light alert and buzzer are fitted in 5 adjacent electric poles (i.e. 5 poles just before the pole where vehicle is detected). The moment when a vehicle passes 1st pole the timer record its time and similarly at the 2nd pole, the distance is fixed between the poles, the calculation for determining the speed is done with programmed Microcontroller and the speed is detected. But when the vehicle is stoped due to some circumstance the 1st sensor will detect the vehicle but the second sensor will not be able to detect and time difference to travel the distance between the poles will be increased, due to which the speed calculated will be either zero or it will be tending to zero, that means there is vehicle is either stopped or is moving very slow, red light alert and buzzer connected with Microcontroller get activated and this provide an indication to the vehicle coming from behind that there is a vehicle in front so the driver can apply brakes from a safe distance to avoid accident.

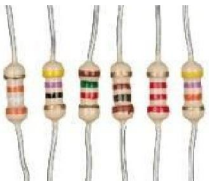

Figure 4: Resistor

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3.4 Mechanism

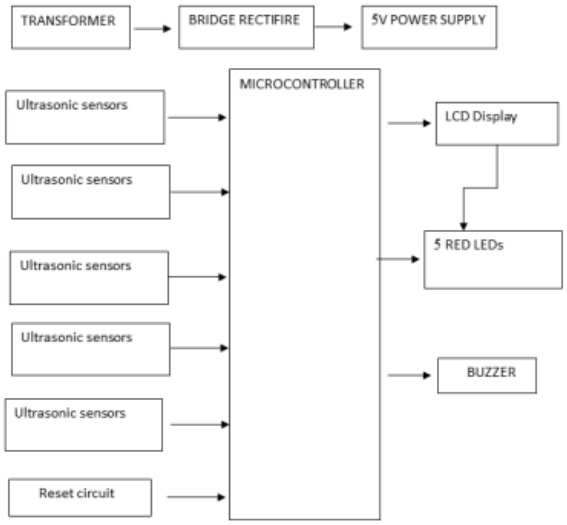

Figure 5: Block Diagram

IV. Result And Discussion Result

After the research we are now aware of new technologies been developed and proposed for the improvement in road safety for the people. Having studied this technique we can say that this technique can prevent accident to some extent.

4.1 Discussion

As we know that both the equipment uses infrared light, but OFS, the interior fog sensor works by transmitting a beam of infrared light onto the interior glass. When fog is present, the beam is scattered back to the sensor. The fog sensor's high sensitivity allows fog to be detected by the sensor before it is detected by the human eye. Using this precise technique it increases the cost of the equipment and it can detect fog upto a range of 1kilometre, that to in a straight line. But as we know that highways are not always straight and in northern regions where fog develops easily due to hilly areas and change in climate, straights roads are not possible therefore optical fog sensor can't be used in hilly regions roads, so as an alternative speed detector using Microcontroller can be used, it has a range of 2-3 metre and can be used in electric pole on roads as studied in chapter 3, it also cost very less than OFS. As an OFS cost nearly about Rs.50,000 – Rs.1,50,000.

4.2 Advantages of using Speed Detector

- Using this technique accidents can be prevented to some extinct.
- This equipment is cheap in cost compared to other equipment.
- Does not require a lot of power supply.
- Low maintenance is required, can also be installed quickly.
- Components required for detection purpose is commonly available in market.
- If included in construction of highways and roads it will be economical.

4.3 Limitations of using Speed detector

- It can't be used in very dense fog condition, due to the increase in density of water droplets the IR beam gets scattered in different direction.
- It can't detect more than one vehicle at a time.
- It can't be used in crossing of roads or highway in low visibility, because when the sensor will detect vehicle on crossing, the indication provided can confuse driver of other lane, as where the vehicle has been breakdown.
- Temperature changes may affect the equipment.

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V. CONCLUSION

- Use of speed detector technique can prevent accident upto some extent.
- This technique is useful in bad weather condition but not in very bad weather condition.
- Speed detector are cheaper in cost than an OFS.
- Speed detector are economical and does not require much of maintenance.
- This technique has been useful in the improvement of safety of roadways.
- This study will be helpful for the researchers and developers in future reference.

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