IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

"Road Safety Under Low Visibility"

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ABSTRACT:
The purpose of this research is to investigate the element of road safety that is often underestimated the risks posed by the low visibility on roadways. This state that applies to many other factors such as adverse weather conditions; storms, heavy rains, smog, and high winds, among others. These factors, which only create fog, smoke, and shorten visibility distance, greatly influence the behaviors and decisions of the motorist, the movement of traffic as well as safety. One of the factors that most significantly contributes to road accidents, especially when does fog or heavy rain, occurs. It is also important to examine the strategies factors that diminish visibility have on drivers and vehicles performance in order to prevent road traffic accidents. If a drivers effectiveness is likely to be reduced due to lowered vision which does not permit a certain range of distance due to bad weather, the performance may degrade with the increased chance of conflict. The evaluation of the drivers low visibility performance is also useful in foreseeing the effective drivers interventions which will minimize the hazards present when driving under such conditions. In addition, one of the approaches that can be applied to ensure the safety of the roads during the low visibility periods is improving the mental and physical preparedness of the drivers to the bad weather. This revolves around knowing how effectively speed and control of the vehicle can be utilized where visibility is a challenge.

In the same way, analysis of how effective changeable message signs, CMS or variable speed limit signs, VSL in reducing accidents would be worth embarking on. These concepts are useful in traffic management when there are strong fogs and torrential rains when the reinforcing messages are only displayed on the overhead structures. This study aims to examine causes of road traffic incidents occurring under low visibility weather conditions and also investigates if any use of warning messages on roadside CMS and on VSL signs are effective towards safer driving during such weather. Such concepts could help implement better safety systems on the roads.

Keywords: Interactive messaging boards (IMB), Dynamic speed control (DSC), Road Sign Safety Decrease in Road Crashes Poor lighting Traffic Maintenance The consciousness of Drivers Climatic dangers Emergency notifications Preventive measures for visibility enhancement Optimization of traffic ranges Safety control measures for incident happening. Responding to incidents Preventive measures against hazards Management of information processed on a real time basis.

I. INTRODUCTION

Most road accidents take place during poor visibility or due to failure to apply brakes in time. This generally takes place during winter and rainy seasons when the visibility is nearly nil due to fog and heavy rainfalls. Along with hills, a similar problem occurs when the vehicles ahead are not visible due to natural obstructions like mountains and curves. In all such cases, a collision avoidance system becomes essential in preventing accidents as well as ensuring the safety of roads along with vehicle protection. This paper discusses implementing an accident avoidance system made with ultrasonic sensors to help avoid accidents by collisions in automobiles. The implementation and working of the system are described, and the existing systems are covered with limitations such as composition of sensors and hardware devices. In this particular study, the importance of installing such devices on poles along the roads to detect and alert vehicles coming in low-visibility conditions is considered. What's more, safe navigation under bad weather conditions is enhanced through advanced image processing technologies. Fog is a very risky meteorological condition since visibility is minimal; such instances cut down the sight distances and increase the distance one takes to stop safely. There have been over 500 fatalities annually resulting from vehicle-related accidents occasioned by fog. The identification of vehicles or objects in fog is therefore critical to avoid the worst-expected collisions. Visibility range is the farthest distance a black object of sufficient size can be observed from over the horizon. It is an important indicator in judging road safety. It is estimated that 47% of total casualties in France occurred during night driving in 2011. The accident rate is found to be 1.7 times more during night compared to day. This is mainly because of poor visibility, too much speed, and driver fatigue.

To counter this, the intensity of high-beam headlights is often reduced in fog because fog causes light dispersion, making the situation even worse. To answer the issues above, automation must advance to maximize the outlook where it will increase visibility during bad weather. Camera-based Advanced Driver Assistance Systems, which are often degraded in fog and rain due to the poor quality of images, can thus enable vehicles to be released with more secure and independent systems, requiring them to have the capacity to perceive other vehicles and maintain a safe distance at all times. This project develops improvements on vehicle safety and autonomy by combining sensors for better performance. LiDAR is utilized for object detection and measurement of the range through laser light pulses. Ultrasonic sensors and microwave radar discover moving objects and presence from a distance. These sensors in collaboration identify the vehicles, animals, and human beings which potential hazard can alert the driver.

II. METHODOLOGY

It is very likely that you have experienced a similar situation where you are driving in the cruise control mode and entering a foggy region with a visibility of only ten feet. Out of nowhere, a stalled car appears in front of you. Driving under low-visibility allows for faster reaction times, which in this case is a dangerous maneuver that reduces sight distance and increases the probability of being involved in a road crash. The empirical studies show that fog leads to disruptions in flow or a series of accidents with several vehicles getting involved in it and thus the need for better warning systems. At such a moment, we can expect that an accident will take place, based on studies that have looked into the effects of weather conditions on driving patterns and the rates of accidents in various seasons, it is such that in low visibility conditions and low levels of human activity, accidents are most likely to leading to their occurrence. Roads are crowded, and in such a situation, a half-sensor system helps. This is achieved through the use of a sequence of ultrasonic sensors and a hardware component mounted on road posts. Studies done on the sensor based collision avoidance systems have proved to be true that ultrasonic sensors are important in motion detection where there are low visibilities. Up until the point a vehicle comes to a complete stop, ultrasonic sensors will recognize an object that is not moving or moving slowly, and trigger the warning system. The danger then alerts neighboring poles through red lights and buzzers on wayside flags seeking to inform the driver on a situation so that he or she can be ready for it. This is a very important safety component because studies show that such measures including advance warning signals significantly lower the occurrences of rear end collisions especially as the weather improves toward such nursing periods. An obstacle ahead gives an indication to give time to slow down and reposition thus helping in saving lives and reducing the scale of property destruction due to accidents.

III. MODELING AND ANALYSIS

It is very likely that you have experienced a similar situation where you are driving in the cruise control mode and entering a foggy region with a visibility of only ten feet. Out of nowhere, a stalled car appears in front of you. Driving under low-visibility allows for faster reaction times, which in this case is a dangerous maneuver that reduces sight distance and increases the probability of being involved in a road crash. The empirical studies show that fog leads to disruptions in flow or a series of accidents with several vehicles getting involved in it and thus the need for better warning systems. At such a moment, we can expect that an accident will take place, based on studies that have looked into the effects of weather conditions on driving patterns and the rates of accidents in various seasons, it is such that in low visibility conditions and low levels of human activity, accidents are most likely to leading to their occurrence. Roads are crowded, and in such a situation, a half-sensor system helps. This is achieved through the use of a sequence of ultrasonic sensors and a hardware component mounted on road posts. Studies done on the sensor based collision avoidance systems have proved to be true that ultrasonic sensors are important in motion detection where there are low visibilities. Up until the point a vehicle comes to a complete stop, ultrasonic sensors will recognize an object that is not moving or moving slowly, and trigger the warning system. The danger then alerts neighboring poles through red lights and buzzers on wayside flags seeking to inform the driver on a situation so that he or she can be ready for it. This is a very important safety component because studies show that such measures including advance warning signals significantly lower the occurrences of rear end collisions especially as the weather improves toward such nursing periods. An obstacle ahead gives an indication to give time to slow down and reposition thus helping in saving lives and reducing the scale of property destruction due to accidents.

Fig-1: Design for Traffic Safety Under Low Visibility.

IV. SENSORS

IV.1 ULTRASONIC SENSORS

The ultrasonic sensors are used extensively for the detection of blind spots. They have a measuring range that varies from 2 cm to 400 cm. These sensors work periodically by sending short bursts of ultrasonic sound towards the target. Once they hit the object, the bounce back to the sensor provides echo that feeds input for measurement. The device calculates the distance to the target as based on the time taken for the echo to return. This will depend on the velocity of sound within the medium as well as the amplitude of the signal received. Combining these two variables-the travel time of the sound wave with intensity of the signal-a sensor could then calculate accurately the distance to the object. The literature has noted that ultrasonic sensors have been applied in the upgrading of safety features for motor vehicles, which has been shown to avert accidents as they provide the driver with necessary information regarding their environment. With these sensors, one improves situational awareness by detecting anything within the blind spot. Through such improved maneuvering capabilities in tight spaces, also, they ensure road safety. Ultrasonic sensors in the vehicle form a very significant advancement of intelligent transportation systems and are improving functionalities and safety feature-equipped modern vehicles.

IV.2 RADAR SENSOR

The radar sensor developed by Baumert makes use of Frequency Modulated Continuous Wave (FMCW) technology. This allows for the precise measurement of distance and the relative movement of objects even in complicated situations. The high carrier frequency employed produces a very narrow beam, facilitating the reliable detection of small objects without the risk of interferences from nearby objects. This capability guarantees consistent operation under adverse weather conditions such as rains, fogs, and snows, hence its great importance to automotive safety and industrial automation. It has been revealed that the effectiveness of FMCW radar systems in the detection of moving and stationary objects is much better than that of a conventional radar, which increases their scope of usage in contemporary transport and industry. This sensor's applicability makes it a key element in safety and operational efficiency in various industries.

IV.3 UNO ARDUINO UNO

A small board is provided with the ATmega328P microcontroller, which has robust performance for electronics projects. There are 14 digital I/O pins for controlling devices connected and six analog input pins that quantify variables like temperature and light. The board is powered by a 16 MHz quartz crystal oscillator to balance power consumption with performance. USB and power jack are also available for easy access to programming and an external power supply. A reset button also enables easy system reset which aids in quickening the debugging and iterative testing procedures. According to scientific research, boards such as this microcontroller have the merit of optimizing the development process of projects; therefore, engineers and hobbyists cannot do without them.

V. BENEFITS OF SENSORS

V.1 Advantages of Ultrasonic Sensors

1. Non Dependence on Color or Transparency: Ultrasonic sensors emit sound waves and therefore confidence levels do not change with the color or transparency of the object.
2. Dark Environment Capability: They work well even in dark conditions, which is not the case for infrared sensors. 3.Cost-Effective: Our ultrasonic sensors available adjustments will start at $10, as they are of superior quality.

V.2 Advantages of Radar Sensors

1. Not Affected by Color or Transparency: Radar sensors make use of radio waves and thus there is performance variation of an object in different aspects.
2. Dark Environment Capability: They do not require any light when functioning well in the darkness.
3. Economical: Our freshly delivered fully operational radar sensors are priced from $20 and installed ready.

V.3 Advantages of LiDAR Sensors

1. Not Affected by Color or Transparency: Laser beams are fired by LiDAR sensors allowing distance measurements despite the physical properties of the objects.
2. Dark Environment Capability : They have an impressive low-light performance.
3. Value for Money: Our LiDAR sensors are available from $15, fully adjustable and operational when you need them.

VI. CONCLUSION

The primary objective of this study was to analyze thoroughly road safety aspect in the country of India and to assess the reasons behind road injuries and casualties. It presents crucial findings about the numbers of fatalities attributed to road use, the broad range of health impacts due to road accidents, and the control and prevention efforts. Identifying and detecting road objects in these conditions is often a tall order especially when the weather is not cooperating for example when it is foggy outside. In such conditions, the surrounding environment is so limited that it is difficult to notice any obstacles, vehicles or even pedestrians in time consequently leading to a high probability of an accident occurring. And even the lesion detection is not immune to the effects of such environmental features as high buildings and trees or even people that may affect the performance of the system and the state of the road.

New detection technologies like RADAR (Radio Detection and Ranging) are lightly used nowadays to sense the presence of an object whereas LiDAR (Light Detection and Ranging) does the measurement of distance. However each of the two technologies has its own set of limitations if used separately. There is an example in that LIDAR is restricted within few hundred meters to about couple of kilometers effective range in locating any far away targets but cannot locate too near objects within a few meters range. Conversely, the working distance of an ultrasonic sensor is very effective for short range distances but starts to lose accuracy when it comes to long range distances. Given the limitations posed by these sensors, they are often used in conjunction with one another where the strengths of one technology helps to offset weaknesses of the other. Adopting such a strategy is more advantageous than other methods.

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