TECHNIQUE OF VEHICLE DETECTION SYSTEM IN FOG FOR ROAD SAFETY

[1]Vaibhav Gahukar, [2]Shiwani Mahale, [3]Tushar Kakde, [4]Kajal Gotmare, [5]Sourabh Patle, , Prof. Preeti Morey
[1,2,3,4] Final Year Student, Civil Engineering department, SCET, Nagpur
[5] Prof. Civil Engineering Departments, SCET, Nagpur

Abstract The effect of low visibility on both crash occurrence and severity is a major concern in the traffic safety field. It is known that crashes tend to be more severe in low visibility conditions than under normal clear conditions. Thus, there is a drastic need to evaluate low visibility countermeasures to improve driver safety and performance under reduced visibility conditions. For this reason, the research team investigated the human factors issues relevant to implementing a visibility system on Florida's highways. Specifically, we designed driver simulator experiments to evaluate how drivers respond to low visibility warning strategies using an in-vehicle warning device. The repeated - measures analysis of variance (ANOVA) models were employed to analyse the impacts of low visibility and fog countermeasures. It was found that the fog warning systems can significantly improve safety. The systems can also reduce drivers' throttle- release time and make the braking process more smooth. Meanwhile, age effects were observed during the braking process. Old drivers are prone to have harder braking than other drivers. Further research was conducted based on the drivers' questionnaires. The results showed that drivers thought the head - up display had better effects than warning sounds. Also, drivers' travel frequency and education levels have significant impacts on their behaviours. Those who drive fewer than five times every week or have higher educational attainment rates (a bachelor's degree or higher) are more likely to have larger minimum time to collision.

Index Terms- Vehicle , Road Safety, Modelling

I. INTRODUCTION

In Florida, a low visibility roadway environment due to fog is one of the major traffic safety concerns. It is known that in low visibility conditions, such as fog and smoke, crashes tend to be more severe than under normal clear conditions. Thus, there is a drastic need to test and develop countermeasures to improve traffic safety and driver performance under reduced visibility conditions. The research team studied the human factors issues relevant to implementing a visibility system on Florida's highways. Specifically, we designed driver simulator experiments to evaluate how drivers respond to low visibility warning strategies using an in-vehicle warning device.

To our knowledge, drivers may adjust their behaviours under fog conditions. It was found that drivers are prone to decrease their speeds under fog conditions, but the reduction was insufficient, especially when dangerous situations occurred, while age - related differences were also observed during fog.
Meanwhile, crash risks may increase under fog conditions, while rear- end crashes are among the most common crash types under fog conditions. Rear - end crashes are usually related to small headway, long response time, and insufficient brake force. However, those problems can be more severe under fog conditions. A general rear - end crash-avoidance process is a consecutive process that consists of a mental process and movement. Different measurements were employed in order to evaluate the process. One of the key components is the perception response time (PRT), which is the same as response time (RT) in most studies. Another indicator commonly employed in safety analysis is the time to collision (TTC). In order to improve traffic safety under low visibility conditions, it is necessary to evaluate different warning methods during low visibility conditions.
Above all, we try to investigate drivers behaviour under fog conditions and their response to warning systems, especially in emergency situations. Three warning strategies are compared in this project : warning with head - up display (HUD) and audio, warning with HUD only, and no warning. Therefore, the main research objectives of this project can be summarized as follows:
Exploring river behaviour under low visibility conditions, and
Investigating the impacts of fog warning systems and determining whether they could improve traffic safety.

II. METHODOLOGY

Analysis of variance has been widely employed to analyse the differences among group means and their associated procedures when comparing samples with more than two groups. One of the assumptions when using ANOVA is that the observations should be independent from each other. Meanwhile, ANOVA also assumes homoscedasticity of error variances.

During the experiment, each participant drove three different scenarios, and the sample in this research didn't meet the independence requirement of ANOVA. Thus, the repeated-measures ANOVA model is used in this analysis. Repeated - measures ANOVA is commonly used for repeated-measure designs; the repeated-measures factor is the within-subject factors.

Meanwhile, Welch's ANOVA is an alternative to the classic ANOVA, which is employed to compare means even if the data violates the assumption of homogeneity of variances. In this research, the sample sizes of different age groups are not the same. Therefore, Welch's ANOVA is used to analyse the age effects.

Moreover, multivariate analysis of variance (MANOVA) is an ANOVA that includes severa dependent variables, which controls the Type I error rate. A MANOVA also can consider inter - dependencies among the dependent variables, enhancing the power to detect significant differences between groups. In this research, MANOVA is employed for both the throttling releasing process and the braking process.

Since the minimum TTC is a continuous variable, a linear model with random effects is adopted to analyse drivers' crash-avoidance process. The model can be represented by Where yij is the dependent variable of experiment j by participant i and α is the fixed intercept. $\boldsymbol{x}$ represents independent variables, and $\boldsymbol{\beta}$ the \ corresponding parameters. In addition, εi is the random effects for participant i with normal distribution. Since each participant was asked to drive three scenarios, the random term can be used to account for the effects of repeated observations.

Design Of Model

After the study of all collected data from the different areas of different countries and all the reference we assume that the prototype related to the road safety is should be converted into the model form and we work on the prototype to make the model for this report. The model we design for the report of road safety is depending on the different parameters of the actual situations related to the speed of vehicles , visibility to the driver , atmospheric conditions , road width , height of the poles , distance between the poles , use of detecting sensors , etc.

The present report summerises the activity undertaken to provide FHWA with information about research needs pertaining to optimising the roadway visibility system.

Through a focused review of the relevant recent literature , and through a working group meeting of researches and stakeholders about the road way visibility system held on August 19,2003 ,the LRC obtained input from this stakholders bout the potential benefits of visibility components. That input , as well as additional input from stakholders will help to provide FHWA with usefull and valuable information about promising research avenues in the future . the findings of the literature review and of the roundtable meeting are in subsequent sections of this report .

The findings herein do not outlines specific recommended project activities , but rather discuss areas of research that have been identified as lightly to provide FHWA with usefull information upon which to based future visibility – related activities and recommendation. This areas include ,for ex. , understanding the interaction among various components of the roadway visibility system , understanding the degree of information required in various application and by various populations , and understanding and minimising the impact of adverse weather of visual information.

Visual information to drivers , pedestrians and other roadway users come from sign , roadway marking and other informational elements during the daytime as well as the nighttime . A good deal of the focus of this report however , is on nighttime visibility , main system such as lighting are also a potential benefit . This focus reflects the greater proportion of crashes that occur at night compare to the day time as a function of driven – miles (BOYCE, 2003) but should be considered alongside the continue need for many visual information systems (Eg. Traffic control devices) to function during day light hours .

Because the focus of this project was to understand requirement for providing visual information in and along the road way , the areas of consideration that are outlined in this report include not only infrastructure – related issues but also those pertaining the roadway users and vehicles . while some of these issues lie outside the preview of the FHWA , they are considered within the scope of this report nonetheless and it is envisioned that not only the FHWA but other organisations been considered the approaches in this report for identifying priorities invisibility – related research activities.

III. CONCLUSION

1. This research project conducted at UCF aimed to evaluate driver behaviour under fog conditions and how drivers respond to low-visibility warning strategies. Also, the effects of different fog levels were investigated in this study. Two different fog level were considered : 300 ft. and 100 ft. In addition, three types of warning strategies were included in the experiment. In total, six scenarios were designed and 48 participants were recruited for this experiment.
2. Drivers' speed - decreasing behaviours were divided into two parts: the throttle - release process and the braking process. It was found that drivers' throttle - release reactions were faster with the provision of warning strategies. Meanwhile, drivers' braking process was smoother when warning systems were present. No significant effects were observed by gender and fog levels.
3. Four indicators were employed in order to evaluate traffic safety: PRT, minimum TTC, respons time, and brake peak. The results show that driver safety was related to both fog levels and the presence of warning systems, while significant impacts of gender were observed only under dense fog conditions.
4. The results indicate that older drivers are prone to brake harder in emergency situations, and that drivers thought HUD had better effects than warning sounds. The results also reveal that the participants who drove more than 5 times every

week were prone to have smalle minimum TTC, while those who drove fewer than 5 times every week or had higher educational attainment rates (a bachelor's degree or higher) were more likely to have larger minimum TTC.

5. Considering the results of drivers ' crash-avoidance behaviour under low - visibility conditions, we can conclude that a warning system could improve safety. It was also found that traffic safety in low-visibility conditions was related to visibility levels, driver age, travel frequency, and education levels. Moreover, different fog warning systems that could be deployed, such as the FDWS (Lee et al, 2012) and the Intelligent Guidance System (Li et al., 2011) , could be considered in a follow-up study.

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