Enhance automotive interfaces to improve distance perception in foggy conditions, addressing the risk of accidents due to insufficient visual cues.

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Adverse weather, especially fog, is a major hazard to driving safety. This is made worse by the fact that existing car interfaces are not up to speed when it comes to providing accurate distance information. To overcome these constraints, this study presents an innovative interface design that uses dynamic visual signals, such as bars and an automobile icon. Participants in a controlled experiment used the keys 'W,' 'A,' 'S,' and 'D' to interact with simulated scenarios within predetermined time limits. The experiment measured the participants' response times. The statistical study, however, indicates that the observed variations in driver performance across scenarios with and without visual cues did not achieve significance, as indicated by a t-test value of 0.1617342878. Even if the null hypothesis was not refuted by the data, the study still offers insightful information for additional research and advancements in vehicle interface

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1 PROBLEM STATEMENT

Existing vehicle interfaces inadequately convey distance information in fog, increasing accident risks. This study proposes a dynamic visual cue design using bars and a car icon to improve driver safety. Assessing its effectiveness aims to contribute to enhanced vehicle interface design in low-light conditions.

2 RESEARCH QUESTION

How can visual cues in automotive interfaces enhance communication of precise distance information to drivers navigating in foggy conditions, thereby improving safety in low-visibility scenarios?

3 HYPOTHESIS STATEMENTS

The study was conducted with the following hypotheses:

3.1 Null Hypothesis (H0)

There is no significant difference in driver performance between participants with and without a visual cue in foggy conditions.

3.2 Alternative Hypothesis (H1)

A visual cue in automotive interfaces improves driver performance significantly in foggy conditions.

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4 METHOD & STUDY DESIGN

4.1 Research Objectives and Hypotheses

The purpose of this study was to assess how drivers' experiences and performance in foggy conditions are affected by enhanced visual signals in vehicle interfaces. While the alternative hypothesis (H1) proposed a considerable improvement with visual cues, the null hypothesis (H0) proposed no significant change in driving performance with and without visual cues.

4.2 Participants

Participants, comprising 83.3% males and 16.7% females, were recruited for this study. The average age of participants was approximately 25 years. Eligible participants had driving experience exceeding 1.5 years, were aged between 22-38 years, and possessed technical familiarity with active driving in foggy conditions.

4.3 Scenarios & Tasks

Participants are divided into two groups, each group exposed to specific scenarios:

- Emergency Vehicle Approaching from left lane.
- Emergency Vehicle Approaching from behind in the same lane.

4.4 Test Procedure

The defined situations were shown in a video simulation that was used in the study. The keys 'W,' 'A,' 'S,' and 'D' were used by participants to communicate within set time constraints. JavaScript was used to track response times, with an emphasis on how participants made decisions in unclear situations.

4.5 Data Collection

An integrated HTML system captured participant interactions with the scenarios and documented response times and faults. Data from the UEQ was gathered via a Google Form, which revealed perceptions and experiences of the participants.

4.6 Testing Environment

The study, which was carried out in a controlled laboratory environment, accurately mimicked real-world situations using a computer simulation.

4.7 Overview of Results

Testing was done on 18 people, 9 in each condition. Response times and error counts were part of the data analysis, which laid the groundwork for more in-depth study later on.

4.8 Collection of Response Times

Each scenario's reaction times were recorded by an integrated HTML system, and error counts were verified manually by comparison analysis.

4.9 UEQ (User Experience Questionnaire)

Through the use of a Google Form, participants provided their thoughts and responses on a range of metrics that were in line with the UEQ scale. The graph uses markers and trend lines to show individual replies and average attitudes, and it contrasts user ratings in conditions with and without visual inputs. Based on participant comments, this research helps to understand how visual cues impact user experiences and helps to shape future scenario design decisions.1

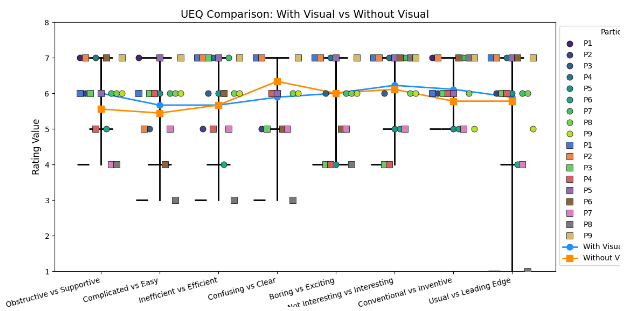

Fig. 1. UEQ Comparison: With Visual vs Without Visual

5 RESULTS

5.1 Mean Values of Driver Responses in both Conditions with and without Visuals

After examining average driver responses post-study, a visual comparison of mean values for scenarios with and without visual cues is shown in 2, illustrating the mean values for Scenario 1 and Scenario 2 under Two Conditions through respective sets of bars.

After the study's conclusion, we further explored average driver responses under different conditions. 3 visually compares mean values for conditions with and without visual cues, showcasing the mean values for Visual and without visual through distinct sets of bars.

5.2 Interface Design

In this section, i present a visual representation of my innovative interface design aimed at enhancing driver safety in foggy conditions. The design incorporates dynamic visual signals, including bars and an automobile icon, to convey accurate distance information. Below are screenshots illustrating the placement and functionality of these visual cues within the interface. 4 5 6 7

5.3 T-Test Analysis for Driver Responses

A t-test used for comparative analysis yields a result of 0.16, indicating patterns in the behavior of drivers in scenarios with and without visual cues in 8. Even though the results fall short of traditional significance thresholds, they still warrant further investigation and discussion in the conclusion.

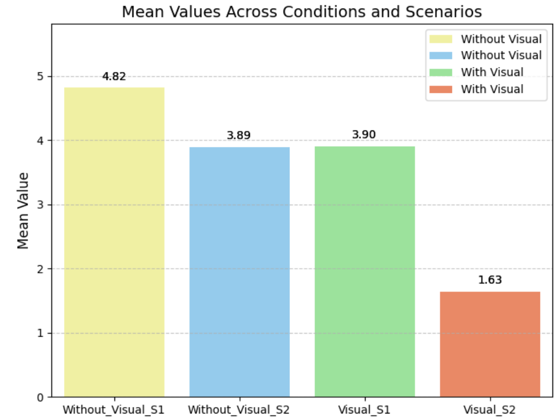

Fig. 2. Mean Values of Driver Responses in Scenarios with and without Visuals

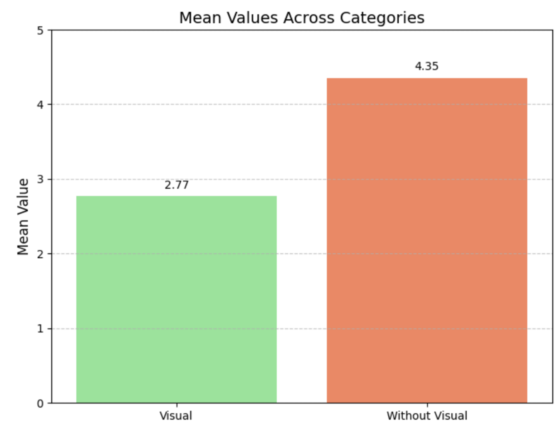

Fig. 3. Mean Values of Driver Responses in Conditions with and without Visuals

Fig. 4. There is no emergency so all bars are green

Fig. 5. Emergency Vehicle Approach from left backside of vehicle on left lane and red bar represent other vehicle

Fig. 6. Emergency Vehicle Approach from backside of vehicle on same lane and red bar represent other vehicle

Fig. 7. Without Visual Cues

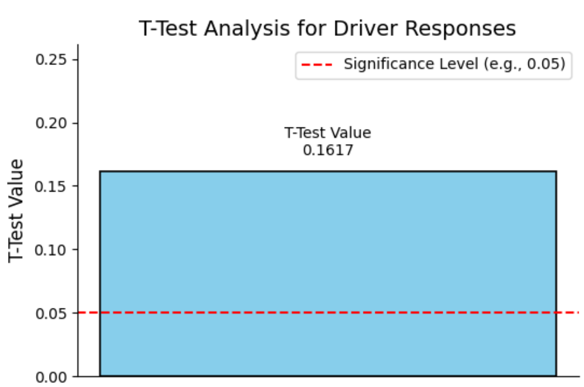

Fig. 8. T-Test Analysis Results

6 CONCLUSION

To summarise, although the statistical analysis did not reveal a noteworthy difference in driver performance across scenarios featuring and lacking visual cues in foggy situations, this study provides important information for the advancement of automobile interfaces in the future. In addition to the quantitative results, the User Experience Questionnaire gave qualitative information about participants' perceptions. Comparisons of mean values suggested potential trends, highlighting the need for in-depth research. The study lays the foundation for improving visual signals and creating more extensive investigations with larger samples and real-world testing, with the goal of improving the effectiveness of vehicle interfaces in low-visibility environments, even though the null hypothesis was not rejected.

7 LIMITATIONS

It is important to recognise a few limitations when interpreting the findings. Although the study's sample size is helpful, it might not be diverse enough to allow conclusions to be applied to a larger population. Furthermore, the complexity of actual driving situations might not be entirely replicated in the controlled laboratory setting. There were just two situations in the simulation, and the lack of variances in the weather or in each driver's driving style could affect the study's external validity. The need for a more accurate way to gauge driving performance or the inherent variability in participant replies could possibly be the cause of the statistical non-significance. In order to overcome these shortcomings, future studies should aim for more diverse sample sizes, practical testing, and a thorough investigation of the variables affecting how visual cues affect driver safety.

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