Effect of simulated rumble strips in static driving simulator - a pre-study

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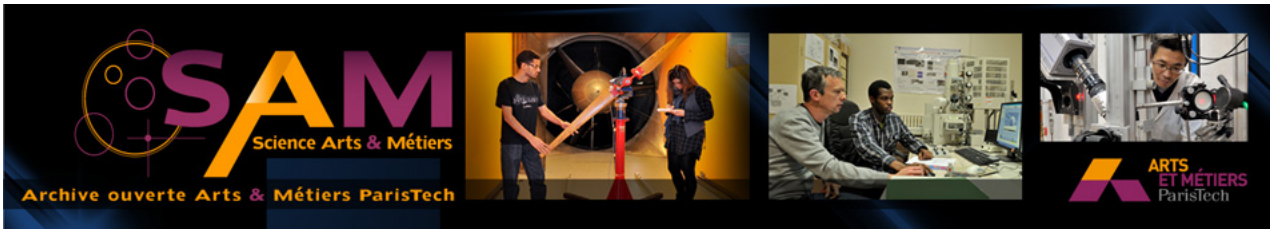

EFFECT OF SIMULATED RUMBLE STRIPS IN STATIC DRIVING SIMULATOR – PRE-STUDY

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Abstract – In this article, we present an experiment whose goal is to show the impact of adding transverse rumble strips on the driver's behavior. Actually rumble strips are used to increase the security on dangerous crossroad. To do this we developed a system that allows reproducing rumble strips in simulation using vibrations. The system is mounted on a dynamic driving simulator and the simulation is made with ScanerStudio.

Key words: Vibrations, Driving simulation, Rumble strips, Virtual reality, ScanerStudio

1. Introduction

The driving simulation is used to study drivers' behavior. Vibrations are commonly used to warn drivers about danger. Actually, the use of rumble strips on the road helps the driver to anticipate the upcoming road.

2. Scientific question

Yet driving simulator cannot simulate the vibration felt when a car go over a rumble strips. The scientific issue of this presented research work is related to the effect of vibration on the perception of simulated driving. In this context, the research question we propose to address is:

- How the Virtual Reality technology can simulate rumble strips to study their impact on the driver behavior?

3. Vibrations feedback

Some vibrations are created to warn the driver about a danger, they are created by longitudinal or transverse rumble strips. The strips typically consist of grooves crossing the roadway surface to provide a tactile and audible warning for drivers [SRI1].

Longitudinal ones are used to inform the driver when he goes out of his trajectory and risks to get off the road or cause an accident with a car moving in the opposite direction. They are on the side of the lane close to painted strips [KJE1].

Transverse rumble strips are used to warn about a stop, dangerous turn or crossroad. Depending on the country they are put in different ways.

To warn drivers that they are approaching a stop, the strips are present before the sign announcement and before the stop line itself. They are formed with a succession of close grooves line and a normal road portion.

The strips must be placed wisely because if the rumble strip is located too close to the hazard, sufficient driver reaction time is not given; and if they are located too far away, the driver may not relate the rumble strip to the hazard. [PHI1] [SRI1].

4. Transverse rumble strips

4.1. The use of transverse rumble strips.

Transverse rumble have two distinct purposes. [STA1] They may be used when unexpected condition may surprise the driver or they serve to bring the driver's attention to other warning devices.

There are three situations where transvers rumble strips may be considered when there is a demonstrated safety problem and if adequate trial of other warning has failed to increase safety:

- Approaches to intersection
- Approaches to horizontal curves
- Approaches to reduced speed zones

It is also recommended to set transverse rumble strips approaching toll plazas where drivers are required to stop or slow to pay.

At last it is possible to put temporary transverse rumble strips in front of a work zones.

4.2. Effect of these rumble strips

A study in China on the effect of these transverse rumble strips before pedestrian crosswalks shows that using this kind of rumble strips is effective in reducing vehicle speeds [LIU1]. Actually, the reduction varies from 3.1km/h to 16.9km/h with a mean value of 6.2km/h where speed limit is 60km/h and a mean value of 11.9km/h where speed limit is 80km/h. Consequently, transverse rumble strips are effective in reducing crashes. On the other hand, they have at best an influence area of 0.3km.

Many other study show that transverse rumble strips have an impact on the speed approaching an intersection. The mean speed decreases however the variance increases. [THO1] [OWE1] [TOR1] [TRA1] [KER1].

5. Experimentation

Experiments are done on a dynamic driving simulator with an integrated vibrations system. For this experiment, the simulator is used in static mode.

The aim of the experimentation is to evaluate the effect of transverse rumble strips on the driver's behavior. Thus, we create a scenario in the software ScanerStudio reproducing a situation as described below. The scenario is made of three different cross roads along a priority road. The first cross road is a normal one with clear view. The second is a roundabout and the last is a normal crossroad but this time with no view. And for this crossroad we tumble down a cyclist in front of the car to surprise the driver and measure the braking distance. For each crossroad we measure the speed and the brake pedal position and the speed of the car. And for each crossroad measurements are recorded from the first rumble strip to the end of the crossroad.

There are two groups of five subjects. One will do the simulation without rumble strips before crossroads and the other will do with. Rumble strips are disposed in two sections for each crossroad. The first one is just before the signal and the second 70 meter before the crossroad. The goal is to see if rumble strips make the driver more carefully.

6. Results and analyses

All subject were asked to respect the Highway Code and to drive carefully. They had to drive as they drive in reality. At the end of the simulation, they had to tell how they perceived crossroads approaches. That allow us to compare their feelings with their reactions thanks to objective measurements.

Results show that the mean speed approach is likely the same with and without rumble strip for each cross road. On the other hand, subjects brake more when there is not rumble strip for the two last crossroad, especially for the last one. Furthermore, in 3 cases without rumble strips, the subject hit the cyclist at the end while none of the 5 subject did it with rumble strip. Last but not least, the questionnaire shows that subject almost perceived the crossroad announcement in the same way.

7. Conclusion and future works

Results show there is a learning of the rumble strip. With rumble strips, drivers are more careful on the approach of a crossroad. They anticipate the hazard. That is the reason why they brake less but do not hit the cyclist. We can also note that with the same crossroad perception, their reactions are different.

On the other hand rumble strips do not have impact on the speed whereas the study on real situation shows one. This may be explained by the fact that in the driving simulation and in reality, sensorial feedbacks are not the same. And in the driving simulation it may be a lack of feedbacks. Perhaps rumble strips should be more exposed using a non-realistic color. This way they can be seen more easily. In another way the vibrations strength may be too low to be well perceived by the driver. So it would be interesting to increase the vibrations level in a future study.

We have to keep in mind this is a pre-study and that its results are only tendencies. In future works, it would be mandatory to make the experience with more subject in order to validate the results with statistics. This pre-study still shows that rumble strips impact on driver behavior.

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