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Study on Recognitive Load of 3D Camera Image for Vehicle (First Report)

-The Effect and Issue of 3D Image -

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1. Introduction

In recent years, adoption of 3D HMIs to vehicle has been growing. But the 3D image cognitive load and benefit for driver have not been clarified, yet. So, we focused on CMS (Camera Monitor System) because which has been increasingly used in automobiles in recent years. In addition, we suggest the method for measuring cognitive load when a driver recognize the 3D camera image and confirm the effect and issue of 3D display.

2. Hypothetical theory

In the current CMS, there are customer comments that "it is difficult to understand obstacle’s front-back positions" because the driver can see the camera image display that has been 2D and the front-back position information has been reduced. On the other hand, by using a 3D camera image, since an image from a different viewpoint enters the driver's left and right eyes, information on the front-back position is added, and the obstacle appears in 3D. However, since 3D images have more information to display than 2D images, the cognitive load may increase. In addition, it is generally known that the activity of DLPFC (DorsoLateral PreFrontal Cortex), which is the working memory of the brain, is closely related to the recognition and judgment of visual information. Therefore, we suggested that measuring the activity of DLPFC for cognitive load using portable fNIRS system, HOT-2000 produced by NeU Co..

3. Experimental method

3.1 Characteristics of subject

The recognition of the front-back distance from the bumper of the vehicle to the obstacle using a CMS is thought to be related to the driver's ability to grasp the space in the parking scene. Therefore, participants in this experiment were asked to give a verbal answer in advance "whether or not they are confident in parking". Twentyfive individuals participated in the experiment (20 external general drivers in their 30s to 50s, 5 Nissan Motor employees, for a total of 25 people).

3.2 Camera Image Cognitive Load Measurement Experiment

3D and 2D image with three obstacles (red obstacle, blue obstacle, and mannequin) snapshotted in advance (9 patterns each× 3 sets ×3D/2D, 54 times in total/person, Fig1). Experiment participants were asked to answer the positions of the three obstacles as quickly and accurately as possible, with measuring the change in the oxy-Hb levels of LDPFC at that time calculate the correct answer number of obstacle’s front-back positions (Fig.2). In addition, participants were asked to answer the sensory evaluation “easy to understand obstacle’s front-back positions”.

4. Conclusion

From the experimental result (Fig.3-6), there is no significant difference in the cognitive load of 3D and 2D camera images even if 3D image is easier to understand the obstacle’s front-back positions. In addition, regarding brain activity when recognizing camera images, the characteristics of the experiment participants, the difference between correct and incorrect answers and cognitive load are confirmed the tendency as follows;

Tendency 1: Cognitive load rises because they can recognize accurately, and it decreases after answering (the oxy-Hb levels of LDPFC rises then falls) ... 3D, correct answer, Male group, confident in parking group

Tendency 2: Unable to recognize accurately and the cognitive load continues to be high (the oxy-Hb levels of LDPFC remains rising)... 2D, incorrect answer

Tendency 3: The difficulty of the cognitive task is so high that the cognitive load decreases as soon as it is viewed (the oxy-Hb levels of LDPFC decreases first) ... Female group, diffident in parking group

Fig.1 3D/2D Camera View

Fig.2 Experimental Condition

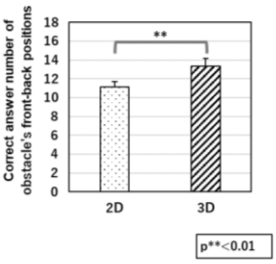

Fig.3 Correct Answer Number of Obstacle’s Front-back Positions

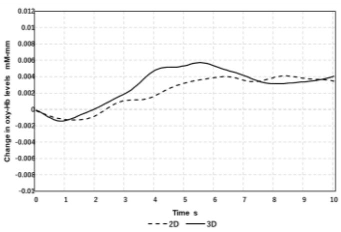

Fig.4 FNIRS Data (All_3D VS 2D)

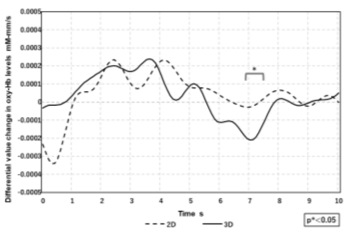

Fig.5 Differential Value of FNIRS Data (All_3D VS 2D)

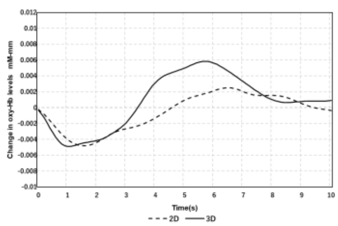

Fig.6 FNIRS Data (Female_3D VS 2D)