TRIAL USAGE OF REHABILITATION SYSTEM; SIMPLE DRIVING SIMULATOR FOR THE DRIVING SKILL EVALUATION OF ELDERLY PERSONS AND HANDICAPPED PEOPLE

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Abstract: We have developed a simple tentative version of the driving simulator for rehabilitation using a Personal Computer (SDS). We described the overview of the system and the trial usage of this system. The SDS together with the Haptic Device System was used for the driving skill evaluation, and it's applicability as a practical rehabilitation system was evaluated. The effectiveness of the system was suggested in the preliminary experiments.

Introduction

We developed a simple tentative version of the driving simulator for rehabilitation(SDS) using a Personal Computer. This newly developed SDS together with the Haptic Device System was used for the driving skill evaluation, and it's applicability as a practical rehabilitation system was evaluated. A Haptic Device System is known as a kind of product of Virtual Reality(VR)[1][2][3]. The HD System measures the subject's basic hand to eye coordination. Using these systems, therapists would be able to offer good rehabilitation services of increased quality. It is hoped that these systems can be applied to develop effective rehabilitation techniques, to motivate clients by arousing their interest, and to quantitatively verify therapeutic results.

Materials and Methods

1. The Driving Simulator; SDS

This system consists of PC, liquid crystal monitor, and control device, Microsoft Sidewinder Force Feedback (Figure 1). We used software of Visual C++, and made an application system for the skill evaluation and training of driving. Test items are classified into reaction time of the upper limb, steering operation, and accelerator/ brakes pedal. This report introduces reaction time measurement, and basic steering operation test. The test of reaction time consists of two types and the basic steering test, four types.

Reaction Time A-Test; RTA-Test

RT-A test measures reactions of an individual undergoing operation and evaluates the accuracy of an action (reactivity of right hand alternating with left hand for stimulation). Six white circles are displayed on a monitor, and as one of the six circles turns red randomly, the subject is expected to push a button on a steering wheel device corresponding to the reddened circle with a finger (Figure 2). The target was so adjusted as to appear randomly at every three seconds. This system records reaction time, from the stimulation to the button push, as well as the accuracy of right button selection.

Figure 1: The SDS System

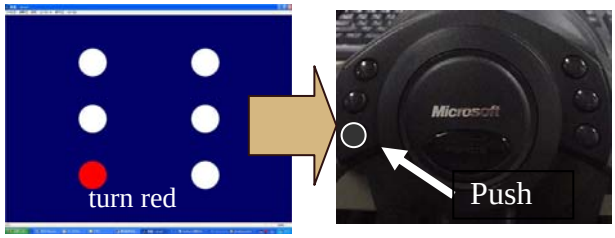

Figure 2: RTA-Test

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Reaction Time B-Test; RTB-Test

In this Task the subject is expected to push a button immediately after he discovers either a static or dynamic target (12colors, 4 patterns) unless an "X" mark is presented on a monitor. The system records the reaction time of the subject between the button push and the display of a target on a screen as well as the button he pushes. As for the interval of target appearance, arbitrary setting is indicated. The system is so set that the circles appeared at random interval, from one second to three seconds.

Basic Steering Wheel Operation tests; STR-Tests

The upper green triangle guide moves from side to side on a screen. In this task, the subject moves white triangle precisely towards the triangle guide by operating a steering wheel (Figure3). There are four movement guide patterns; STR-L (low speed), STR-M (medium speed), STR-H (High speed) and STR-R (random speed; the guide shows random movement).

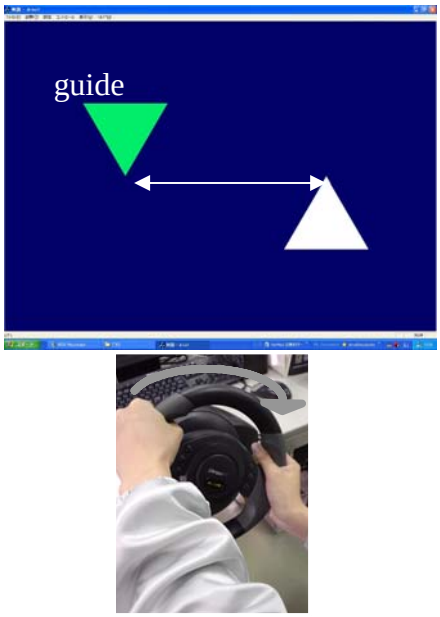

Figure 3: The STR-Tests

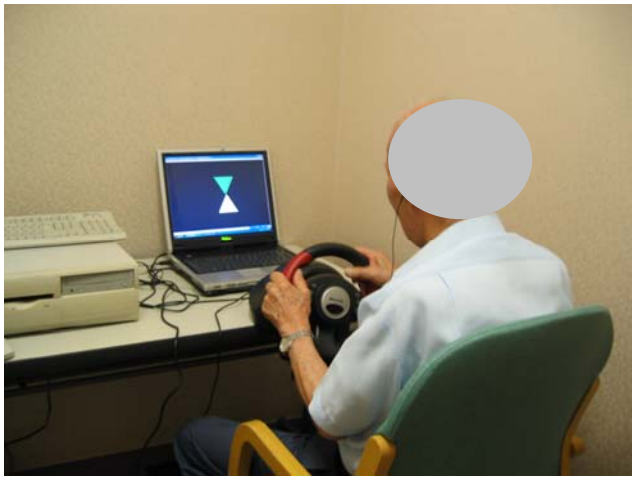

Figure 4: A Subject and the SDS

2. The Haptic Device System; The HD system

We have developed an equipment using haptic device which is given a load or assistance force on to the grip. This system consists of a haptic device, a display, a computer and software for evaluation and training (Figure 4). The haptic device consists of two AC servomotors, rotary encoders, two pair of links, a grip, a force sensor. This system includes five different programs for basic training, and two other programs for applied training. In the basic training programs, subjects are urged to move their arms straight, in a circle, in a wave and voluntarily. When moving the grip, a symbol on the display moves simultaneously, and the haptic device provides a force to either assist or resist the arm movement. Level and direction of force are also adjustable. Moreover, haptic responses can be altered to be perceived as contact force, viscosity, surface friction and so on. Subjects can play games in the applied training programs, including hockey and maze games, to facilitate training without loss of motivation or concentration. The characteristics of the HD system were clarified, and the effectiveness of the system was showed in our recent papers [1][2][3].

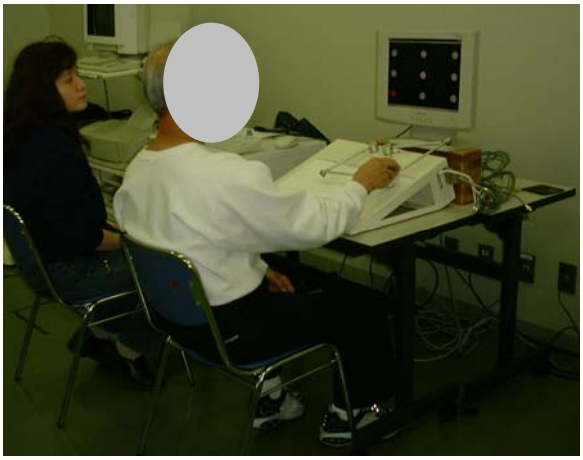

Figure 4: A subject and the HD System

The basic program, WAVE Program Tests; W-Tests

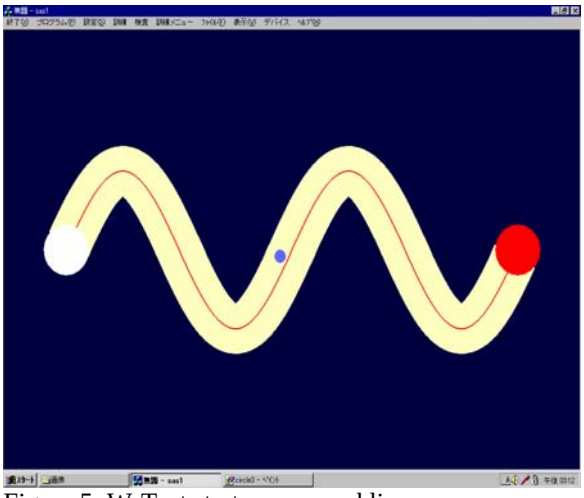

Figure 5: W-Tests to trace curved lines

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The WAVE program is one of the basic training programs, and shows 2 small circles and a thick sine wave on the display (Figure 5). The circles are connected by the wave. Subjects must move the cursor from one circle to the other while keeping on the line. The amplitude and length of the curve are changeable. The system gathers and stores training data for parameters such as time, grip position, and grip force. This data can be used in quantitative analyses of motor and cognitive function rehabilitation. The error of grip position was defined as the root mean square (RMS) of declination from the model wave.

3. The preliminaly experiment

Aims

We carried out preliminary experiments of SDS. The aims of the experiments are 2 points. One is to confirm the functions of the system by analysis correlation of other physical/ mental testing. The other is to make a hypothesis from the experiment's results. The data of healthy subjects will then be used as reference data to evaluate the degree of disability of clients.

Method

Testings carried out were RT-A Test, RT-B Test, STR-Test and W-Tests of the HD System. The same tests were given to both the elderly subjects and to the young subjects. The static analyses were done to study the correlations among all test results. We used "SPSS" Ver.13.0 for statistics analysis.

Figure 6: A subject who is engaged in the SDS

Results and Discussion

Subjects were 38 people aged 20 through 73. All subjects agreed to this study. The values indicate the average of the measured value. The over sixty group showed remarkable individuals differences. Among elderly persons, who showed results similar to the young group, on the other hand, there were those who needed about twice the time of the young (Figure 7,8). There were negative correlation between the mean of the results of the RT-A and the W-Tests (<.05). Significant correlations were found between the performance of those with good upper limb control and results of a high RT-A Test.

On our recent findings, it was suggested that the RT-B Test had relationships with mental functions of subjects[4]. There were positive correlations between the mean of the results of the STR-L, M, H and the W-Tests (<.05). These results showed that the results of the STR-Tests were related to the W-Tests. About the mean of the results of the STR-R, there were no correlations. We thought there was still room for further study on these points.

RT-Tests and STR-tests showed the tendency, the young group received a better grade than the elderly.

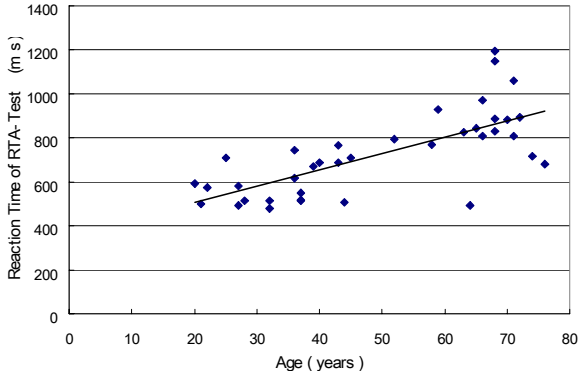

Figure 7: The results of RTA-Test

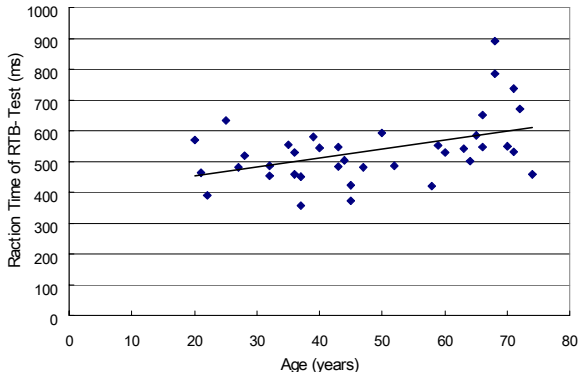

Figure 8: The results of RTB-Test

Conclusions

We developed a simple tentative version of the driving simulator for rehabilitation using a Personal Computer (SDS). The SDS together with the HD System was used for the driving skill evaluation, and it's applicability as a practical rehabilitation system was evaluated. The characteristics of SDS were showed, and the effectiveness of the system was suggested in these preliminary experiments. These results would serve as basic data, when therapists try to evaluate and treat clients who need rehabilitation in driving skills.

From these results, we considered that the hypothesis stated above was founded. These results would serve as basic data, when therapists try to evaluate and treat clients who need rehabilitation in driving skills.

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