

Interactive System to Assist Rehabilitation of Children

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Abstract. We developed a new interactive system to support a child with physical disorders to continue appropriate rehabilitation pleurably at home. We selected a ten-years-old boy suffering from “Spina Bifida Aperta” as the target patient and constructed an interactive system that employed the step motion, an effective rehabilitation method for him. Experiments were performed to evaluate the system.

Keywords: rehabilitation, children, system.

1 Introduction

Ambulation difficulty and paralysis are the examples of symptoms caused by congenital diseases such as Down syndrome and brain paralysis. For such symptoms, symptomatic recovery is remarkable by early rehabilitation from childhood. However, rehabilitation is operative and monotonous. If the patient is a child, the continuation of long-term rehabilitation is even more difficult.

For domestic rehabilitation without the support of physical therapists, another problem exists: it is almost impossible to judge whether the rehabilitation is appropriate. Thus, this study constructed an interactive system for children with physical disorders to appropriately assist continuous rehabilitation pleurably in the home.

Since the symptoms caused by congenital diseases vary among patients, we constructed an interactive system for a particular patient. Then, we will expand our system for other patients. Such trials are very useful to assist the rehabilitation of children with congenital diseases. However, few researches exist, probably because bringing them to commercially-based development is difficult. Therefore, we consider our trial unique and important.

2 Method

2.1 Determination of the Target Patient

As the target patient, we selected a ten-years-old boy suffering from “Spina Bifida Aperta,” which causes muscle force degradation and sensory disturbance in the periphery of the lower limbs as an after effect of myelomeningocele.

2.2 System Design

Due to patient’s inability to put pressure on his tiptoes, he walks with too much pressure on his heels. For his rehabilitation, step motion was considered effective, in which he continues to put pressure on his tiptoes for a while. We built an interactive system using step motion for the system operation (Fig. 1).

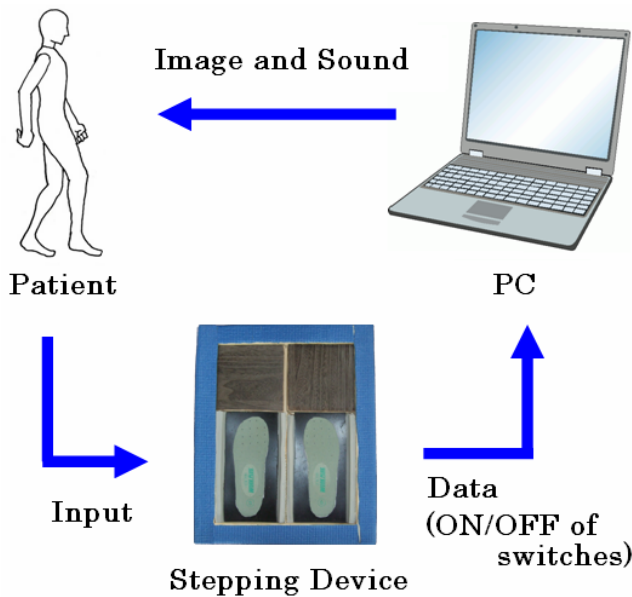


Fig. 1. System diagram

2.3 Stepping Device

We made an input device for step motion called a “Stepping Device” (Fig. 2). Two switches for the tiptoes and one switch for the heel were set under each foot’s position

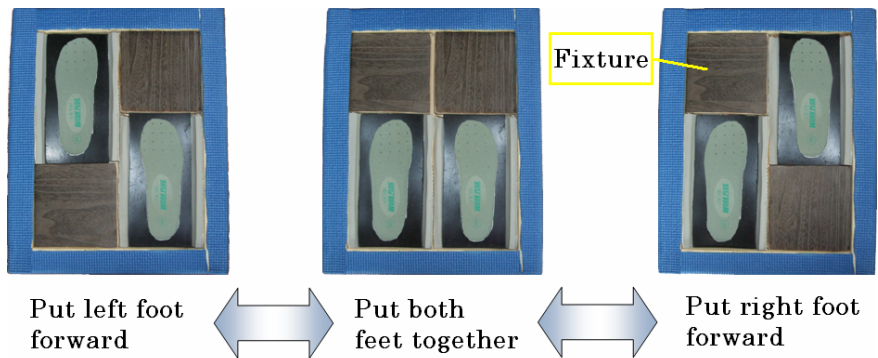


Fig. 2. Stepping Device

on the Stepping Device. In addition, each switch was adjusted to avoid being activated by the patient’s body weight.

2.4 Content

The patient likes creatures, especially insects and reptiles. Thus, we made a game system in which the patient captures such creatures as a “Hercules beetle” and a “King cobra” by maintaining the step motion for a certain period of time. During the game, the patient looks at the conditions of the switches on a game screen (Fig. 3). In addition, we prepared a parameter to control the degree of difficulty to maintain his interest. The degree of difficulty fluctuates based on the number of creatures captured the day before. By increasing the degree of difficulty, the score for each capture and the necessary time increased to maintain step motion. The dates, the degrees of difficulty, the total scores, the times of the moments of capture, the times of the switches being turned on, and other data were acquired as log data. Fig. 4 shows an example of a screenshot just after a successful capture.

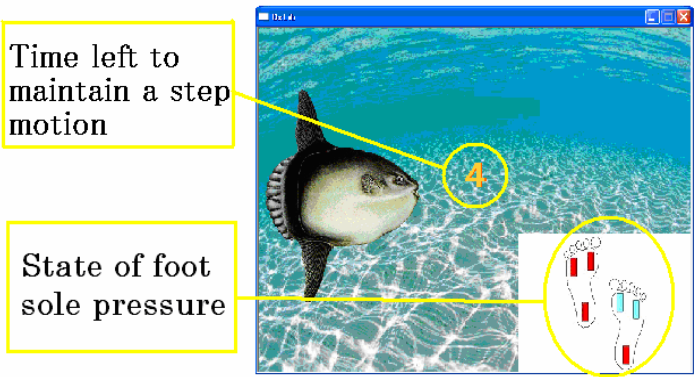


Fig. 3. Screenshot (1)

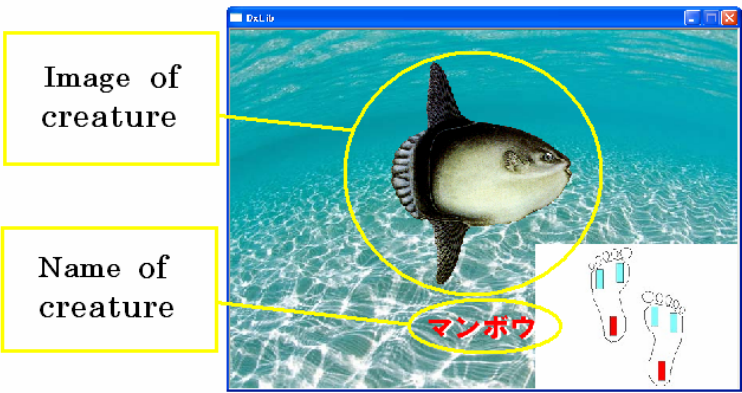


Fig. 4. Screenshot (2)

3 Assessment Experiment

3.1 Examination of Assessment Indexes

Game scores and foot pressure data were used to evaluate the rehabilitative effect. As for the foot pressure, strength distributions for clinging to the sole were calculated. The sole is divided into five parts; heel, toe, first toe, big toe tip, and middle. In addition, analysis of the data of the game's records and simple questionnaire answers were used to evaluate its continuity.

3.2 Experimental Procedure

1. Foot pressure was measured about one month before using the system.
2. Foot pressure was measured immediately before using of the system.
3. The game system was used daily for about one month.
4. Foot pressure was measured daily just after using of the system.
5. Foot pressure was measured about one month after using the system. During this period, the system wasn't used.

Fig. 5 shows the flow of the assessment experiment.

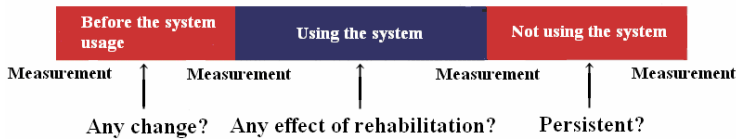


Fig. 5. Flow of the assessment experiment

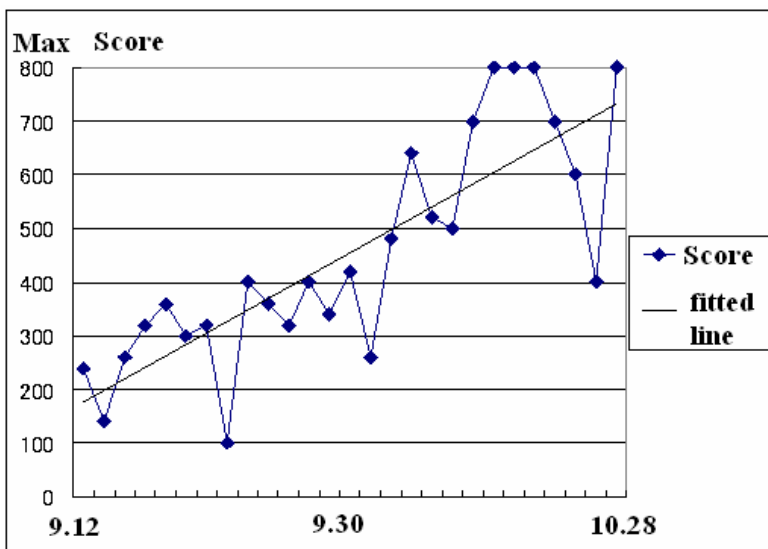


Fig. 6. Game score in right leg's steps

3.3 Experimental Results and Consideration

Figure 6 shows the time series of the game scores of the right leg's step. The score advanced well day by day, and became full marks. Moreover, the frequency at which he failed to continue pushing the switch decreased from 33 at the beginning to 12 at the end. This confirms that playing the game improved his step motion.

Figure 7 shows the ratio of the right leg's foot pressure in its steps, and Fig. 8 shows their standard deviation. Comparing the foot pressure data before and after system usage, the heel strength increased after system usage. On the other hand, tiptoe strength decreased. This result was contrary to our expectations. However, the standard deviation value decreased(Fig. 8).His balancing ability increased, although that was not our intended result.

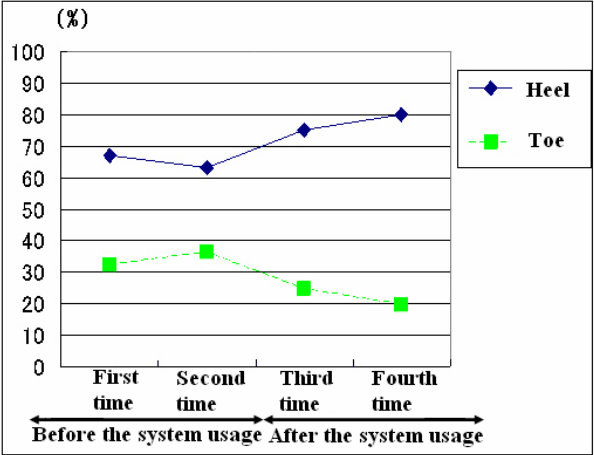


Fig. 7. Ratio of right leg's pressure in its steps

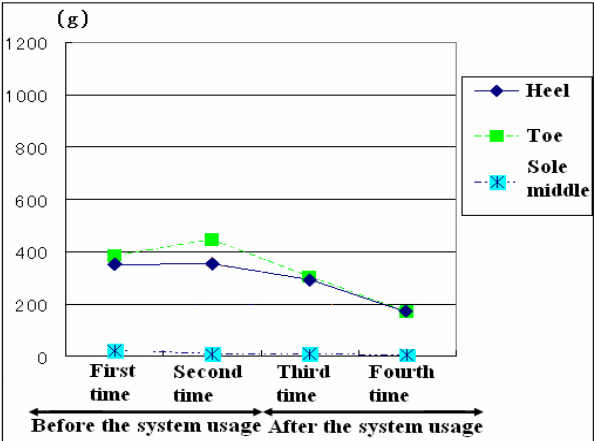


Fig. 8. Standard deviation

4 Discussion

Before the evaluation we expected that the increase of foot pressure to the toes would be the effect of rehabilitation. However, after the system usage, we noticed an improvement of the child's ability to keep his balance. Therefore, examining how to evaluate the effect of rehabilitation is necessary in the future.

5 Conclusion

We developed a new interactive system to support a child with a physical disorder to continue his rehabilitation appropriately and pleasurably at home. We built an interactive system using step motion for its operation and continued rehabilitation from the experiment outcomes. Before the evaluation, we expected that increased foot pressure to the toes would be the effect of rehabilitation. However, after system usage, we noticed improvement in the ability to keep balance. Therefore, examining how to evaluate the effect of rehabilitation is necessary in the future.