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主 論 文 の 要 旨

論文題目 Development of a Novel Robot Design Strategy for Children with Autism to Improve Affective Touch Skill (自閉症児の情動性タッチスキルを改善するための新しいロボット 設計戦略の開発)

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論 文 内 容 の 要 旨

Autism Spectrum Disorder is a development disorder that defined by communication deficit, repetitive behaviour and obsessive interests. People with autism, in particular, children diagnosed with autism tend to avoid involving in social interaction, even with people who are supposed to be familiar with them, their parents or siblings.

The prevalence of children with autism, aged from 6 to 17, was reported as 2 % in between 2011 and 2012, comparing with the 1.16 % in 2007, it has been significantly increased. For supporting the magnitude population of autism, many organisations and researchers has been developing various methods of education and treatment.

A few studies have revealed that the unique characteristics of autism are caused by the fact the autistic children prefer simple appearance and movement rather than complicated ones. In line with these ideas, robot-assisted autism therapy has been started testing to encourage autistic children communicating with other people in the environment the robot developing as mediator between them. One more benefit to use robots in autism therapy is that children with autism are able to predict the situations and control the environment.

The main limitation of previous studies is that the aimed aspects of communication skills to improve haven't been set clearly, and has designed without specific investigation in the effect of the robots' features on the therapy results. For example, they designed robots children might like, such as cartoon type or small humanoid type robots, and have tried using them with various communications skills, then explored if the robots fit as an agent in autism therapy.

Moreover, the assessment in previous studies has a huge limitation that they usually used the video analysis which is very subjective, and it doesn't have the benefit to use robot and only used for drawing their attention during the therapy.

Furthermore, robots should be designed differently depending on the level of autism, for example, in the case of a child who has very severe autism, robot could help their very

simple communication skills such as eye contact, and for children with slight autism the robot is capable of prompting more complicated social skills.

This study aims to use the assistive robot effectively in the robot-assisted autism therapy; to prompt, to evaluate, to give feedback, to be used depending on extent of autism.

There are 4 parts to be explored for designing the effective assistive robot in autism therapy.

(a) Action prompts: A type of stimuli that robot encourages autistic children to act the behaviour aimed to be improved through the therapy.

(b) Action: A specific social skill that is able to be drawn from children and to be set in the therapy system.

(c) Reaction: A type of stimuli as a robot's reaction that contains the result to inform to children against their action.

(d) Feedback: A type of feedback methods which encourages the child moving to next steps in the therapy.

This thesis consists of seven chapters as follows:

Chapter 1 introduces the definition of autism spectrum disorder and the characteristics of children with autism. The history of robot-assisted autism therapy and the literature review in this field are also described in this chapter.

Chapter 2 addresses the preliminary explorations the effect of various features of robots on the individual social skills. Features of favourite toy for children with autism are surveyed, and the findings are expected for designing the assistive robot for autism therapy.

Chapter 3 explores the effect of robot's verbal function on the children's social interactions. Several communicative aspects were measured and those outcomes indicate the potential design parts of assistive robot.

Chapter 4 presents the novel design approach to set a particular communication skill for children with autism improving through playing robot. The main proper social skill is explored and selected for designing a robot. This chapter also introduces a human machine interface device called Touch Ball and the Touch Game that is several artificial social interactions' scenes were provided to prompt children's applying their forces to Touch Ball during the experiment. The comparisons between autistic children's results and non-autistic children's results are shown in order to prove the abnormal touching behaviour of children with autism.

Chapter 5 introduces Touch Game is described in this Chapter as well and describes two experiments to explore effective methods of visual feedback. The experiments measured the scores of participants in Touch Game with various visual stimuli as feedback. The first experiment used facial expressions as method of feedback for providing to children with autism. As the continuation of first experiment, the second experiment treated colours as visual cues for interactions.

Chapter 6 addressed the continuation of the second experiment in Chapter 5, four visual stimuli were used in the second experiments; colour, simple facial expression, number and arrow in second experiment and different responses on the visual stimuli are explored de-

pending on extent of autism. The result demonstrates colour stimulus can be considered as the most effective way of feedback for the participants with autism tendencies.

Chapter 7 represents the continuation of Chapter 6. The experiment described in this chapter is to explore the effectiveness of robot's feedback during Touch Game. Colours were used as a method for showing results to children with autism, and it was provided them robot's visual and auditory feedback toward children with autism.

Chapter 8 concludes the thesis.

In conclusion, a novel assistive robot design strategy was found for training proper touching behaviour in autism therapy. This strategy contains 4 concrete parts as mentioned above:

- 1) Touch can be a main social skill capable of being improved through robot.
- 2) Colour is an effective stimulus among other simple visual stimuli for prompting children with autism, and also showing them the outcome.
- 3) Robot's visual and auditory feedback elicit children with autism can achieve better result in the therapy.

These findings provide that touch and effective method of feedback could become useful factors in the design of a novel assistive robots for children with autism to improve their social interaction abilities. Further work requires to be done to establish whether the results can be adapted in general use. The work in this thesis can contribute to develop better design of the assistive robot for children with autism.