UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF HUMAN-ROBOT INTERACTION (HRI) METHODOLOGY FOR AUTISM REHABILITATION USING HUMANOID ROBOT WITH A TELEREHABILITATION PLATFORM

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Thesis submitted in fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Mechanical Engineering

December 2015

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Advances in technologies and improvements in diagnostic procedures have contributed to the rising number of autism detection worldwide. Autism is a brain disorder that affects behaviour, communication and social interaction. The use of intelligent robots to rehabilitate children with autism hosts great untapped potential. Robots offer rehabilitation applications that are accurate, motivating and repetitive. However, validity and access to such intervention are still scarce. This research investigates the potential use of a humanoid robot as an adjunct rehabilitation tool to assist children with autism. The focus is also on developing a single, web-based platform that enables stakeholders in autism rehabilitation to gain access to robotic applications. A robot in human shape has great potential to generalize the skills learnt during human-robot interaction to human-human interaction scenarios. The humanoid robot used in this study is NAO. It has moderate degree of likeness to human. Children with autism prefer robots with simplified features. NAO is also the most widely used humanoid platform by engineering and clinical researchers in autism research. The first objective analyses the behaviour response of children with autism when exposed to a humanoid robot for the first time. The pilot experiment took place at NASOM Titiwangsa, a special school for children with autism. A 24-items behaviour score sheet was developed as an observation instrument to measure the children's responses. Qualitative results from video evaluations showed that for the subscale of stereotyped behaviour and communication, 10 children responded positively with reduced autistic behaviour when the robot was present. For social interaction subscale, 7 children showed encouraging responses. In addition, children with higher IQs (more than 80) responded better to robotic interaction. Next is the assessment study of the quality of the behaviour score sheet. Based on the expert opinion method, the instrument was found to have good validity. More than 67% of all experts scored at least 3 on the 5-point Likert scale. In reliability; high internal consistency was seen with a Cronbach's alpha of 0.872 for the whole tool. As a continuation from the pilot study, more interaction contents involving child and robot are in need. New robot scenarios that are socially engaging based on the pre-school curriculum for children with special needs by the Ministry of Education Malaysia and the Applied Behavioural Analysis (ABA) technique were developed. This resulted with six new programs choreographed with body movements and interaction dialogues to fit the purpose of the robot as a learning tool. The interaction scenarios were co-developed with experts from the special education and medical fields. In the final stage, a telerehabilitation platform was developed and tested for its usability by therapists. The RoBIn website enables access of robotic technology to a larger population regardless of location. Survey results show that RoBIn provides an acceptable usability level based on System Usability Scale (SUS) scores. In addition, 80% therapists agree that their overall first-time experience in using RoBIn's website was good. This study was the first of its kind in Malaysia to develop a rehabilitation system involving robots to aid the autism population via the telecommunications technology.

ACKNOWLEDGEMENT

CHAPTER ONE

INTRODUCTION

Chapter 1 introduces the background study of this research and organization of the thesis. The flow of information discloses the originality and relevance of the research contribution, beginning with the background of the research study. This is followed by motivation, problem statement, objectives, methodological considerations, scope, limitations, and thesis contributions.

1.1 BACKGROUND OF THE STUDY

Recently, robotics technology has achieved significant progress in developing various types of robots to assist humans in day-to-day tasks at home, in workplaces and even on dangerous sites. Undeniably, the robotics revolution is upon us, 'breaching' through many facets of human life. Robots are not only confined in manufacturing facilities but have become fascinating machines that are imagined to co-exist with humans. The research trend in robotics is shifting from industrial robots towards socially assistive robotics and human-friendly robots. An assistive robot is a robot that helps or supports a human user [1].

Humanoids are an integral entity when one envisages the future. Humanoids are robots with anthropomorphic body structure similar to humans. The research trend involving humanoid robots is evolving from robot-centred studies towards socially assistive robotics and human-friendly robots. Humanoids now have extensive capabilities and have become a remarkable research tool that symbolizes human nature and intelligence. When robots and humans share the same environment; social aspects that encompass people's anticipation, human-robot interaction and human behaviour need to be justified [2]. The interaction between human and robot specifically for medical purposes is complex in nature. Thus, proven results on its reliability and safety need to be gained in advance.

The expanding global population also represents the growing number of people born with disabilities. It is crucial for the disabled to receive proper care and rehabilitation to help them achieve a degree of independence in their daily lives.