PRELIMINARY INVESTIGATION ON THE EFFECTIVENESS OF ROBOTIC TEACHER APPLICATION IN MALAYSIA TECHNICAL EDUCATION

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DECLARATION

I declare that this thesis entitle "Preliminary Investigation on the Effectiveness of Robotic Teacher Application in Malaysia Technical Education" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : 

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APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

Signature : .....

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Date : 12.07.2017

DEDICATION

To my beloved husband and family.

ABSTRACT

Application of robots is one of the trending used for this recent time. There is huge number of applications of robots in industry. Another application of the robot is in the education field. Normally, a robot is used in assisting teacher in their classroom, such as delivering stories, assisting in group activities, and showing interesting educational media. Meanwhile, in higher technical education, industrial type of robot is used by lecturers to teach students. There are plenty of robot teacher applications around the world. Robots in education are used widely in another country, but it is not in Malaysia yet. With the existing situation, this research work aimed to focus on studying the effectiveness and application of robot teacher in technical education. The question is, how effective is the robot in acting as a teacher? There are ways to measure the teaching effectiveness but it is not confirm that it can be applied to robot teacher. Another problem in applying robotic teacher is perception of the subjects (students). Many assumptions can be made, but what is the reality of the students' feeling? The objectives of this research work are to identify the possibility of applying robot as a teacher in technical studies, to investigate the effectiveness of a robot teacher by comparing the experimental results with a human teacher performance, and to determine the fundamental perceptions of the students (participants) that influence the student-robot teacher interaction, that may affect the effectiveness of robotic teacher application. Generally, the purpose of this research is to investigate the human-robot interaction in education environment. This is especially important for technical students from Malaysia. The method used to measure the robot teacher effectiveness is by giving quiz and questionnaire to the selected students. Distributing surveys to a number of participants is the first method in collecting the data needed for this research work before proceed to the experiments. NAO robot is properly programmed and used during the experiments. A set of quiz and questionnaire are constructed according to the elements (Interaction, Observation, and Understanding) that used to measure the effectiveness of teaching. The topic that has been decided for teaching the students is "Introduction to Mechatronics". Quiz and questionnaire is given to students after robot and human teacher finish their teaching for analysis. The comparison of robot and human teacher is made through (the result of the quiz and questionnaire). The results show that there is a possibility to use robot as a teacher since most of the students reacted in excited way during the robot teacher is teaching them. Although the effectiveness of the robot teacher is not good as the human teacher, this research work founds the factors that can increase the effectiveness in teaching. An important point that can be obtained from the result is students feel more excited when a robot is teaching them compared to a human teacher perhaps because of the character of the robot. From that point, this experiment contributes one of a very valuable knowledge on how a new thing attracts people and they keep their attention to it.

ABSTRAK

Aplikasi robot adalah salah satu penggunaan yang sentiasa meningkat pada masa kini. Terdapat penggunaan robot yang besar di dalam industri. Salah satu aplikasi robot adalah di dalam bidang pendidikan. Biasanya, robot digunakan untuk membantu guru di dalam kelas, seperti menyampaikan cerita, membantu aktiviti kumpulan, dan menunjukkan media yang menarik. Manakala di pendidikan tinggi teknikal, robot jenis industri digunakan untuk mengajar pelajar. Terdapat beberapa penggunaan guru robot di seluruh dunia. Robot dalam pendidikan telah digunakan di negara lain, tetapi ia belum lagi digunakan di Malaysia. Dengan keadaan sebegini, kajian ini memfokuskan dengan mengkaji aplikasi dan keberkesanan guru robot dalam pendidikan teknikal. Persoalannya, sejauh manakah keberkesanan robot sebagai guru? Terdapat cara untuk mengukur keberkesanan pengajaran tetapi ia tidak dapat dipastikan sama ada ia boleh diaplikasikan pada robot atau tidak. Masalah lain dalam menggunakan guru robot adalah persepsi pelajar. Banyak andaian yang boleh dibuat, tetapi apakah perasaan sebenar pelajar tersebut? Objektif-objektif kajian ini adalah untuk mengenalpasti kebarangkalian dalam aplikasi robot sebagai guru dalam pelajaran teknikal, untuk menyiasat keberkesanan guru robot dengan membandingkan keputusan eksperimen guru manusia, dan untuk menentukan persepsi asas pelajar yang mempengaruhi pelajar-robot guru interaksi, yang akan memberi kesan kepada keberkesanan aplikasi robot guru. Umumnya, tujuan kajian ini adalah untuk menyiasat interaksi manusia-robot di dalam pendidikan. Ini adalah penting terutamanya untuk pelajar teknikal di Malaysia. Kaedah yang digunakan dalam mengukur keberkesanan guru robot adalah dengan memberi kuiz dan boring soal selidik kepada pelajar yang dipilih. Pengedaran kaji selidik kepada beberapa peserta adalah langkah pertama di dalam mengumpulkan data yang diperlukan untuk kajian ini sebelum meneruskan kajian kepada eksperimen. Satu set kuiz dan borang soal selidik yang dibina mengikut unsur-unsur (Interaksi, Pemerhatian, dan Persefahaman) yang digunakan untuk mengukur keberkesanan pengajaran. Topik yang telah ditetapkan untuk mengajar adalah "Introduction to Mechatronics". Untuk mengkaji, kuiz dan borang kaji selidik diberikan kepada pelajar selepas guru robot dan manusia selesai mengajar. Perbezaan keputusan robot dan manusia guru dibuat (keputusan dari kuiz dan boring kaji selidik). Keputusan mendapati terdapat kebarangkalian untuk menggunakan guru robot memandangkan kebanyakan pelajar merasa teruja semasa guru robot mengajar. Walaupun keberkesanan mengajar dari robot guru tidak sebagus guru manusia, kajian ini menemukan factor-faktor yang boleh meningkatkan keberkesanan mengajar tersebut. Titik penting yang boleh diperoleh daripada keputusan kajian adalah pelajar merasa teruja apabila robot mengajar mereka berbanding guru manusia. Daripada titik tersebut, eksperimen in menyumbangkan salah satu pengetahuan yang berharga terhadap bagaimana benda baru menarik minat orang dan mereka memberi perhatian padanya.

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LIST OF ABBREVIATIONS

SPSS	–	Statistical Package for the Social Science
CMOS	–	Complementary Metal-Oxide Semiconductor
KAMIN	–	*Kansei* Mind Robot
FACS	–	Facial Action Coding System
DOF	–	Degree of Freedom
PDF	–	Portable Document Format
ABS-PC	–	Acrylonitrile Butadine Styrene Polycarbonate
AC	–	Alternate current
DC	–	Direct current
OS	–	Operating system

LIST OF PUBLICATIONS

Journals

1. Fairul Azni Jafar, Nurhidayu Abdullah, Noraidah Blar, Mohd Nazrin Muhammad, and Anuar Mohamed Kassim (2013), Analysis of Human Emotion State in Collaboration with Robot, *Applied Mechanics and Materials*, Vol. 682, pp. 465-466

2. Noraidah Blar, Fairul Azni Jafar, Syahril Anuar Idris, and Mahasan Mat Ali (2015), A Review of Humanoid Robots Technical Characteristics in the Application for Robotic Teacher, *Applied Mechanics and Materials*, Vol. 761, pp. 158-162

3. Noraidah Blar, Fairul Azni Jafar, Nurhidayu Abdullah, Mohd Nazrin Muhammad, and Anuar Muhamed Kassim (2015), Analysis of Human Emotion in Human-Robot Interaction, *Applied Mathematics and Computational Intelligence*, Vol. 1660, 070010

4. Noraidah Blar, Fairul Azni Jafar, and Radin Puteri Hazimah Radin Monawir (2015), Comparison of Student's Feedback between the Application of a Robot Teacher and Human, *Journal of Advances in Humanities and Social Sciences*, Vol. 1, Issue 1

5. Radin Hazimah Radin Monawir, Noraidah Blar, Fairul Azni Jafar, Zulhasnizam Hasan (2016), Pilot Study of Emotion Recognition by Using Facial Expression for Database Image Preparation, *Journal of Telecommunication Electronic and Computer Engineering*, Vol. 2, pp. 17-21

Proceedings

1. Noraidah Blar, Fairul Azni Jafar, Syahril Anuar Idris, and Mahasan Mat Ali (2014), Robot and Human Teacher – A Structure of Quiz and Questionnaire to

Analyze the Efficiency of Teaching, *Proceeding of International Conference of Computer, Information and Telecommunication Systems*, pp. 1-3

2. Noraidah Blar, Fairul Azni Jafar, Syahril Anuar Idris, and Mahasan Mat Ali (2014), Work in Progress: Experimental Design on Malaysian Technical Students Using Humanoid Robot Teacher and Human Teacher, *Proceeding of International Conference on Ubiquitous Robot and Ambient Intelligence*, pp. 504-505

3. Radin Hazimah Radin Monawir, Noraidah Blar, Fairul Azni Jafar, Zulhasnizam Hasan (2015), System Configuration for Visual Emotion Recognition Through Android-Based Software, *Proceeding of International Conference on Advanced Manufacturing Technology*

Chapter in Book

1. Noraidah Blar and Fairul Azni Jafar (2015), A Survey On Application of Robotic Teacher In Malaysia, *Advanced Computer and Communication Engineering Technology*, Springer International Publishing, pp. 605-613

Other Publications

1. Syahril Anuar Idris, Fairul Azni Jafar, Zamberi Jamaludin, Noraidah Blar (2015), Improvement of Corrosion Detection Using Vision System for Pipeline Inspection, *Applied Mechanics and Materials*, Vol. 761

2. Syahril Anuar Idris, Fairul Azni Jafar, Noraidah Blar (2014), Optimization of Single Filter Network on Visual Corrosion Defect, *Proceeding of International Conference on Ubiquitous Robot and Ambient Intelligence*, pp. 658-662

3. Syahril Anuar Idris, Noraidah Blar, Mahasan Mat Ali (2014), Analysis of Image Enhancement on Visual Corrosion Inspection Using Multi Filter Network, *Proceeding of 24th Design Engineering Systems Division Annual Conference*, Japan Society of Mechanical Engineers.

ACHIEVEMENTS

Best paper award of the Engineering & Technology at the International Conference on Engineering and Technology, Computer, Basic and Applied Science 2015

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Robots are used in wider applications compare to previous decade of year (Shuying, Wenjun, Shiguang, & Chongshuang , 2008). As previously known, robots have been applied in industry especially service sector, military and defense, food and beverage, and even in entertainment and media sector. They perform several tasks in order to help human's work. Robots are often used to make human's work easier and perform something that human is not capable to do. This is to ensure for safety etc. for the human. Researchers have been studying for many years and found that many benefits can be obtained by using robots in human's daily life such as limiting the workforce, safety environment, and entertainment (Hacker, 2003). Recent researches show that robots could be used for educational applications (Cooper, M., Keating, D.A., Harwin, W.S., Dautenhahn, 1999). Researchers believe that there are many more tasks that robots can do, which is not discovered yet, can do such as conveying education to students for example.

When speaking about education, the aspects that come out must be human teachers that convey their knowledge to various levels of students (kindergarten, primary, elementary, etc.). Human as a teacher is a conventional way to teach students to be a useful person. There are different kinds of teaching method among humans. Either it is effective or not to make students fully understand on what the teachers try to teach, this issue has not been discussed in details so far. And yes, some students are failing to understand what they learn due to many factors, in which one of them is the teaching method delivered by teacher. Living in a world that increasingly advanced is forcing human to find some other alternatives to make the education more effective and interactive.

Human discovers that robots may be able to teach people in education (Nicolescu & Mataric, 2001). There are many researches being done to identify a proper way of using robot in education. Although it is not proven yet that robot is an effective way to teach students in the future (Mutlu, Osman, Forlizzi, Hodgins, & Kiesler, 2006), but some preliminary movements should be done to make it happen. Most of the past research that did not focus on the effectiveness of the teaching by the robot teacher. This is found when reviewing all of the possible research papers that already published. In this research work, human feedback is needed as the medium to determine whether robot teacher is effective or not. Therefore, the main purpose of this research work is to study the level of effectiveness of a robot teacher towards students compare to human teacher.

1.2 Motivation

A great number of advanced technology applications such as virtual learning, e-learning, and online teaching (Sandanayake & Madurapperuma, 2009) in order to teach students, forced researchers to find other way to make the learning environment more effective. The application of robot teacher is another possibility of applying advanced technology in education but it is still not widely used in Malaysia. Most of the applications are already exist in another country (Zhang & Yu, 2011). This research work is inspired by the existing application of robot teacher in a classroom. While the application is still stick around within the school children, this research work is trying to deal with a new environment and bring it to the upper level of education, especially the technical studies.

Taking the first step by reviewing many research papers that are related to this topic, there are some hypotheses that can be made and thus become the motivation point of this research work. In general, there are no specific methods that can measure robot effectiveness in teaching human. Although the application is already exist to study mostly towards the children, but the existing research is only focusing on the interaction between robot and human without taking the consideration of the effectiveness. For that, this research work is studying another issue in order to know the level of effectiveness of robotic teacher, but the subject of this study are the

university students instead of children. This is due to the fact that this research work would like to do the study on technical studies in university level.

Applying a robot teacher in the education system might come out with a better result. Some of the methods that are done by the human teacher in teaching students are not enough to make students understand what they are studying. It is believe that with the help or application of a robot teacher, the students perhaps can obtain the similar contents of the learning scopes.

Other advantage that can be described is when the education system uses robot as a teacher, unnecessary manpower can be reduced at the same time. When the robot is well created to teach the students, and it is effectively proven can teach the students better, it can see that it can reduce the number of human power in teaching the students. It sounds a little harsh, but when talks about unnecessary manpower, it means that it should keep a better quality to ensure the learning can be conveyed well.

This challenge that is given by the robot can increase the human effectiveness in teaching. It is believed that most people will feel insecure when a machine is taking the responsibility in teaching their children instead of a normal human. So, what do the students feel when they learn something from the robot. It is also admitted that creating a perfect robot that manages to teach human sounds impossible. By that, this point has become the challenge for researchers in this field to realize the impossible matter.

1.3 Problem Statements

Application of robots was first applied for industrial usage (Hillman & Work, 2003). Robots perform such a hard task in order to make human's job easier. As time goes by, the application of robots technology becomes wider, from the industrial environment to assisting human in their daily life. It can be seen that robots have been used as delivery assistant in hospital and post office, or even robots have been employed as the helper to human daily routine.

It then increased its application in the education field. Usually, human is the one that creates the system for robots to complete tasks given, such as assembling, moving, and lifting. But now, the technology of robot becomes more advanced when

they can teach and help human in education. Robot technology is increasingly used in classroom settings not only for learning about robots, but also for learning from robots. It is known that human teacher is the most applied method to convey education. Robots are mainly used as teaching assistants and educational media rather than as a fully autonomous teacher and most of the applications are towards the young childrens. Many researches have been done to study if robots can teach people in education (Karna-Lin, Pihlainen-Bednarik, Sutinen, & Virnes, 2006) but no specific study is carry out to see whether the robot teacher can be applied in technical study or not. This research work is trying to fill up this gap to see whether robot teacher is possible to be used in the technical education.

One of the main questions that remain unclear is the degree of how effective are the robots in delivering lectures to humans, especially in term of the students' understanding level on the content of the lecture. Researchers are interested to study the effectiveness of teaching method in using the robot's services. Furthermore, when it involves the technical education, where technical topics, especially those in the hands on level, the question of the effectiveness of robot teacher is definitely a big issue to be solved. The question of long term interaction effects needs further investigation. An aspect that is often ignored is the challenge to integrate all qualities in a single platform which is necessary to conclusively measure the effectiveness of robotic tutors.

Another problem in applying robotic teacher in technical education is perception of the subjects (students). Many assumptions can be made, but what is the reality of the students' feeling? This issue is need to be resolved as it might help to achieve the perfection or almost perfect on the robotic teacher application in technical study.

1.4 Research Questions

i. Is there any possibility of robot to be used to teach human? Especially if the field that need to be teached by the robot is related to technical education.

ii. How effective is the teaching delivered by robotic teacher compared to human?

iii. What are the human emotional factors that can affect the human-robot interaction in education?

1.5 Research Objectives

i. To identify the possibility of applying robot as a teacher in technical studies.

ii. To investigate the effectiveness of a robot teacher by comparing the experimental results with a human teacher performance.

iii. To determine the fundamental perceptions of the students (participants) the student-robot teacher interaction, that may affect the effectiveness of robotic teacher application.

1.6 Research Contributions

The specific contributions of this research are as follows:

i. Preliminary knowledges on the possibility of using robot as a teacher to teach technical subjects.

ii. Actual feedbacks from respondent (technical students) on how they feel towards education environment nowadays.

iii. Improvements that can be done on how to increase the performance in teaching.

1.7 Research Scope

A type of humanoid robot is used for experiment purpose. The selection of the robot is based on its ability to teach students such as giving a lecture, conducting experiments in the laboratory, and giving a short quiz for student to answer. Due to these requirements, the robot is having a complete audio system (speaking and listening), moving mechanism (walking, hand and body gestures), sensors, and so on. Other than that, a human teacher is also used to convey the lesson. A schedule for the teachers to teach is constructed with several variables (day and lecture script).

Next is on the topic of the lesson that delivered by the teachers. The topic chosen is "Introduction to Mechatronic". This topic is chosen because the students that become the participants is from Faculty of Manufacturing Engineering. This subject is a basic knowledge for the students in that faculty. A lecture speech is prepared and the presentation slide is arranged. The teachers are teaching the basic knowledge about the subject that include basic elements of Mechatronic System, hydraulic and pneumatic system, and control system.

The duration of each session of the experiment is decided held for seven minutes. The limitations of the robot that cannot be operate for more than that (7 minutes) making this as the scope of time for the experiment. The robot will facing hot joints and making its movements disturbed.

This research is focused on the students that have the technical education background only. Therefore, the sample students for the Google survey data collection is from all of the Malaysian Technical Universities that covered Universiti Tun Hussein Onn Malaysia, Universiti Teknikal Malaysia Melaka, Universiti Malaysia Pahang, and Universiti Malaysia Perlis. Another survey question of this research is distributed to all possible students that having their study in Manufacturing Engineering. Next, the questionnaire and quiz that used during the experiments in this research are given to a group of students that currently performing their study in Manufacturing Engineering. 35 of students have been selected to participate in this research work.

The next scope is about the programming of the robot. The language that was used is Python. In addition, control panel software that used to monitor the robot movement is also used.