STEM Engagement of 5-axis Industrial Pick-and-Place Pneumatic Robotic Arm Remote-Manipulation

Ahmad Anas Yusof[1], Syarizal Bakri[1]
[1]Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: anas@utem.edu.my

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ABSTRACT - This paper presents a first account of a public interaction with a remote-manipulation of an industrial pneumatic pick and place robot during a public STEM engagement. The aim of the engagement is to build public and student awareness of the advancement of remote-manipulation technology, and to observe their acceptance and interest of the system. The history of STEM education and remote-manipulation of robotic system, the preparation and implementation of the proposed system and the survey results and conclusion of the project are provided in this paper. Results show that the secondary school students are more attracted to the system rather than the primary students. Responds to survey shows that most of them choose Robotics as their number 1 interest, while Mathematics are the last option.

1. INDUSTRIAL ROBOTICS AND STEM

STEM-related initiatives and engagements has been organized for the surrounding communities in focusing on strengthening the foundations of existing knowledge and encouraging upper secondary and post-secondary school students to enroll into the Science stream. The term "STEM education" refers to teaching and learning in the fields of science, technology, engineering, and mathematics [1-2].

During the STEM engagement, the public will be asked to learn how to manipulate the system, and to try to pick and place a workpiece from certain distance, within visual range. A survey was also conducted after the public participation of remote-manipulating the robotic system. STEM education in remote-manipulation involves the learning of the master and slave concept in remote-manipulation.

2. METHODOLOGY

For the STEM engagement activity, a pneumatic robotic arm system has been designed so that it can be remotely manipulated by the operator from a distance. Remote-manipulation refers to the control of a mechanical arm or hand to move or manipulate hazardous materials for reasons of safety, due to extreme environment, where direct human involvement can very be counterproductive and extremely dangerous [3-5]. Robotic remote-manipulation has seen actions in the military and security services [6-10].

A programming is written and downloaded into microcontroller Arduino Uno, while a wireless PS2 transmitter and receiver unit is used as the master and slave device. Arduino software is an open source tool that can sense, monitor, store and control algorithm provided to the microcontroller. The robotic arm is actuated with three pneumatic linear actuators for the gripper, horizontal and vertical movement. Two rotary actuators are used for body and gripper swing movements. All actuators are controlled by five 4/2-way double pneumatic valves. The overall dimension for the pneumatic arm is 464 mm x 88.5 mm x 200mm (base x width x height). The wireless control has been developed by using 2.4 GHz radio control system. The control of robotic arm is also developed by using PS2 Arduino remote control system software, which provides the command platform that will produce the signals to the actuation of Cartesian robotic arm, and hence the movement of the arm. **Figure 1** shows the test bed for the STEM engagement.

Figure 1 Participation by the public during the STEM Engagement

3. RESULTS AND DISCUSSIONS

The rule of the remote-manipulation for the public is to be able to transfer the workpiece perfectly, and the operators must start at the beginning of the process, if they make a mistake in their action. After sometimes, the operators usually will be able to track the movement of the pick and place system and finish the task in a quicker pace. From the observation, it is also noted that gender difference among the operators does not influence the performance during the remote-manipulation. 57 participants have responded to the survey while engaging the pick and place robotic remote-manipulation during the carnival. This constitutes of 44 male students and 13 female students from secondary and primary schools. 93% of the participants are secondary school students, ages between 13 to 21 years old, while the rest is from

the primary school students. This shows that secondary students are more attracted to the pneumatic pick and place robot manipulation, rather than their younger counterparts. The results show that about 68% and 82.5% have the knowledge on how pneumatics and remote-manipulation works. Most of the participants also says that they are interested in the robotics system. Figure 2 illustrates that Robotic attracts the most participant that visited the booth. This is followed by Technology, Engineering and Science. It is also noted that in the STEM elements, interest on Mathematics is at the lowest level, with 15.8%. A more detail result shows that about 25 students that choose robotics as one of their preferences are male, while only 5 female students have opted for the same field. More detail analysis shows that 7 students choose robotics as their only interest, whereby 5 of them are male students.

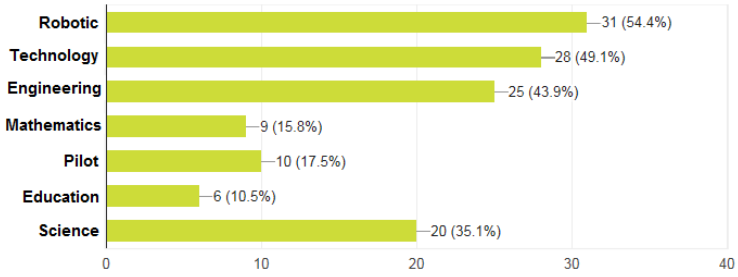

Figure 2. Interest of the participant after the STEM exhibition

4. CONCLUSION

STEM engagement of 5-axis Pick-and-Place Pneumatic Robotic Arm has been conducted during a STEM Carnival in order to build public and student awareness for latest concept of remote-manipulation in STEM education. In a field observation, it is noted that the learning process in remote-manipulation among the public spectators is incremental, since operators can conduct the tasks with more confidence after several trials. Such system can be utilized in STEM education for students and can positively influence the quality of remote education on both teacher's and student's sides. A survey on STEM engagement on robotic remote-manipulation has also been conducted during a STEM Carnival to build public and student awareness STEM education. Secondary students are noted to be more attracted to the pneumatic pick and place robot manipulation, rather than their younger counterparts. Results also show that male students are more interested into robotics. The questionnaire shows that Robotics is the most chosen interest. This is followed by Technology, Engineering and Science. It is also noted that in the STEM elements, interest on Mathematics is at the lowest level.

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