Bridging Robotics Education between High School and University: An Outreach Development in Southeast Asia*

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***Abstract*— Comparing to the learning contents in high school level robotics education leads us to discover a gap of missing skill sets required in university level robotics development. Our objective in this work is to bridge this gap by outreaching our development in RoboCup@Home Education. We aim our study in the less involved Southeast Asia region with Thailand and Malaysia as our target regions. We had conducted workshops in Thailand and Malaysia, and finally gauged the project outcome by organizing the Education Challenge.**

I. Introduction: The "Bridging Problems"

A. The challenges of RoboCup@Home

Starting from 2006, RoboCup@Home [1] has been the largest international annual competition for autonomous service robots as part of the RoboCup initiative. The challenge consists of a set of benchmark tests to evaluate the robots' abilities and performance in a realistic non-standardized home environment setting [2]. It has greatly fostered artificial intelligence development in various domains including human-robot interaction, navigation and mapping in dynamic environments, computer vision, object recognition and manipulation, and many more developments on robot intelligence.

However, it is observed that the learning curve of the RoboCup@Home teams have a very steep start. The amount of technical knowledge and resources (both manpower and cost) required to start a new team has made the event exclusive to only established research organizations. For instance, in RoboCup Japan Open challenge, the participating teams in RoboCup@Home were only around 10 teams and similar teams for the past many years. There were actually several new team requests but the development gap was too huge for them to even complete the robots.

B. The "Bridging Problems"

One of the reasons of the above mentioned steep learning curve of university students in service robot development is the readiness of the students in robotics and AI development. In many developed countries, robotics education can be started as young as in primary schools. In RoboCupJunior, primary school students have been developing robots playing soccer, rescue and stage performance. However, it was observed that many RoboCupJunior "graduates" (after age 19) were hardly continuing their involvement in RoboCup Major leagues (university level).

Comparing to the learning contents in RoboCupJunior leagues (high school level) leads us to discover a gap of missing skill sets required in RoboCup Major leagues (university level) robotics development. This is mainly due to the bottom-up approach in school level robotics education, where students are trained from basic electronics circuitry, mechanical construction and basic programming; while in university, students are learning from a top-down approach, where given a specific robotics function or application, and then figure out what are the building blocks required. As robotics technologies advanced, the distance between these two approaches goes further and hence widens the gap in between high school and university. Another distinctive difference between these two is the expected output. School level robotics education generally designs abstract development goal, where the robots are built to follow lines, play balls, etc., with very little real life application value. While in university, solving real world problems is normally the objective of the robotics education. This is mostly caused by the education driven motivation in schools, and research driven motivation in universities.

Our objective in this work is to address these "bridging problems" by outreaching our development in RoboCup@Home Education [www.robocupathomeedu.org] initiative. We are setting our outreach region to Southeast Asia because RoboCup (robotics education) is relatively less involved by Southeast Asia countries, apart from Singapore and Thailand [3]. We have selected Thailand (RoboCup regional committee) and Malaysia (not RoboCup regional committee) for our comparative study in this work. We have gathered project members from these two countries to assist the project development and implementation.

II. Solution: RoboCup@Home Education

A. Outreach Development

RoboCup@Home Education is an educational initiative in RoboCup@Home that promotes educational efforts to boost RoboCup@Home participation and service robot development. In this work, we outreached the contents of this initiative to the target regions to study on the robotics education issue.

B. Learning Robot Platform

The development of an open source robot platform (Fig. 1) for RoboCup@Home was started since 2013. The goal is to develop a basic robot platform to facilitate startup team for the participation in RoboCup@Home. It is developed based on open source solutions for both hardware and software developments for low cost and large community support to facilitate startup of the novice teams.

*This is a collaboration work under RoboCup@Home Education.

We use TutleBot2 as the basic robot hardware platform. TurtleBot2 is a low cost (basic kit is approximately USD 1,000), personal robot kit with close integration to popular open source software, ROS (Robot Operating System) [4]. The open source robot kit is adapted as the basic mobile platform for this development. The vertical range of the mobile manipulation can be adjusted with an elevated arm with linear motor, a secondary vision system is paired with the robotic arm for object recognition in the manipulation tasks, and 3D printed parts for component systems. An interactive interface with speech and facial expressions is in development for human-robot interaction. A general laptop PC (currently working on a single board computer system) with speakers and microphone is served as the main robot controller.

We use ROS as the robot software framework. ROS (Robot Operating System) is an open source robot software framework with a large community to provide huge col-lection of robotic tools and libraries. With ROS as the fundamental software frame-work, this work will adapt and assemble ROS packages and stacks to realize the navigation, manipulation, vision and speech functions of the robot in order to perform the tasks in RoboCup @Home.

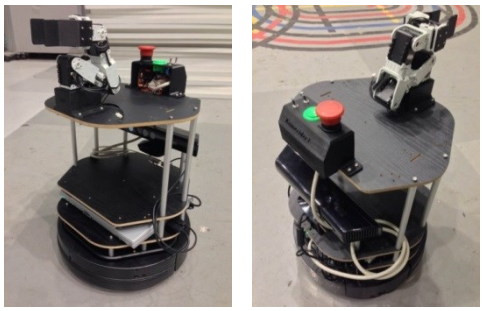

Figure 1. Open source robot platform for RoboCup@Home development.

C. *Hands-on Workshops*

One of the core activities of the RoboCup@Home Education initiative is the hands-on robotics workshop. The contents of the workshop are designed based on the development of the open source robot platform. We plan to outreach this workshop to the target regions.

A 3-day workshop schedule is designed to cover all the basics required to develop a robot that fit to perform Stage 1 tasks in RoboCup@Home competitions. The workshop will be concluded with trial competitions that resemble RoboCup@Home competitions, in order to gauge the robot development and expose the participants with the actual field experience.

The general content of the workshop plan includes:

<u>Workshop Day-1</u>

- AM Workshop 1 Setup
  - ✧ Introduction
  - ✧ Hardware setup
  - ✧ Software setup
- PM Workshop 2 Speech
  - ✧ Speech synthesis (Text-to-Speech)
  - ✧ Speech recognition

<u>Workshop Day-2</u>

- AM Workshop 3 Navigation
  - ✧ SLAM map building
  - ✧ Autonomous navigation of a known map
- PM Workshop 4 Vision
  - ✧ Color-based object detection
  - ✧ Object following

<u>Workshop Day-3</u>

- AM Workshop 5 Arm
  - ✧ Robot arm setup
  - ✧ Inverse kinematics and manipulation
- PM Workshop 6 System Integration
  - Field testing

<u>Trial Competitions</u>

III. Project Development

A. *2018/5: European RoboCupJunior Championship EURCJ 2018 Montesilvano, Italy*

In the workshops, the participants hands-on developed and programmed the robots to perform competition tasks. There were 5 teams with more than 15 participants had taken part in this event, where 2 of the teams were from high school students.

Figure 2. Workshop and competition event at European RoboCupJunior Championship EURCJ 2018 Montesilvano.

B. 2018/6: RoboCup 2018 Montreal, Canada

We had gathered 11 teams with more than 40 participants representing 9 countries and 4 continents to take part in the event. Among all the teams, there were 3 teams from high schools and the youngest participant was only 11 years old.

Team SKUBA-Jr from Kasetsart University, Thailand had joined the event and won the 2nd Place in University category.

Figure 3. Workshop and competition event at RoboCup 2018 Montreal.

C. 2018/10: World Robot Summit 2018 Tokyo, Japan

Dr. Kanjanapan Sukvichai from Thailand and Dr. Zool Hilmi Ismail from Malaysia were invited as organizing committee members to experience the competition organization.

D. 2019/1-4: Workshop Development in China

We had organized several workshops for high school students in China

Figure 4. Workshop for high school students in China.

We had organized the first Education Challenge in RoboCupJunior China Open 2019 Shaoxing, China

Figure 5. Workshop and competition event at RoboCupJunior China Open 2019 Shaoxing.

E. 2019/4: Workshop Development in Malaysia

We had outreached the workshop activities to the local communities with the collaboration with several universities in Malaysia.

Figure 6. Workshop at Universiti Tunku Abdul Rahman (UTAR).

Figure 7. Workshop at Universiti Putra Malaysia (UPM).

Figure 8. Workshop at Universiti Kuala Lumpur (UNIKL).

F. 2019/7: RoboCup 2019 Sydney, Australia

We had gathered 15 teams with more than 70 participants representing 7 countries to take part in the event. Among all the teams, there were 9 teams from high schools.

Teams from Malaysia and Thailand had joined the event. Team SKUBA-Jr from Kasetsart University, Thailand had won the 1st Place in Open category.

Figure 9. Workshop and competition event at RoboCup 2019 Sydney.

IV. Project Members and Collaborators

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