THE CHINESE UNIVERSITY OF HONG KONG

Courseware Development Grant (2018-19)

Final Report

Report due 31 May 2019
Please return by email to CUHK cdgs@cuhk.edu.hk

PART I

Project title: Mobile eLearning and Manipulating for Making Students' First Robot
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Co-supervisor(s): LEUNG Yun-Yee Martin
Department / Unit: Mechanical and Automation Engineering
Project duration: From September 2018 to May 2019
Date report submitted: May 28th, 2019

1. Project objectives

The main objective of this project is to develop a wireless wheeled robot and a mobile application in a flexible and interactive way for learning and manipulating robots. Sub-level objectives include: Understanding the basic concepts and components of a wireless wheeled robot; Hands-on skills and experience for assembling robots; Getting familiar with basic robotics programming skills. It is noted that both main objective and sub-level objectives are well achieved upon project completion. Figure 1 shows that resulting courseware generated. Note that 12 wheeled robots with robotic arms were developed.

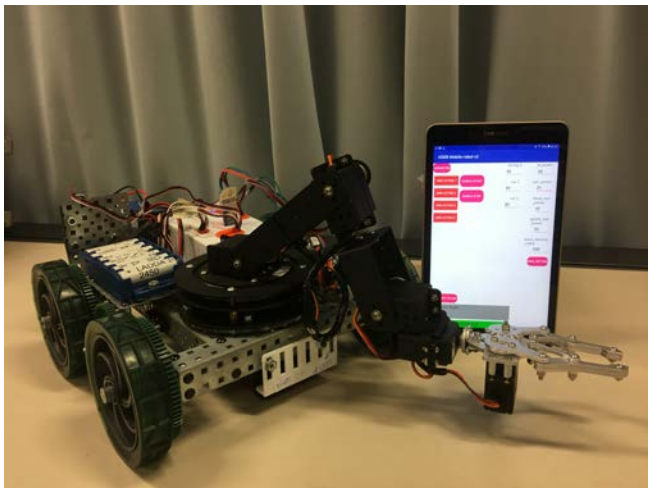

Figure 1: Developed robot and mobile application on tablet.

The primary objectives of the project have not changed. Meanwhile, through this project, some additional extensions have been made, and many promising ideas have been developed.

2. Process, outcomes or deliverables

12 sets wheeled robots with robotic arms are produced, and a mobile application is also developed for controlling and manipulating the robot.

- *For the part of hardware: We select appropriate Arduino board, VEX mechanical hardware, interface Printed Circuit Board for microcontroller, motors and power for robotic arms, and check their compatibility. Then, we assembled the VEX mechanical hardware for the wheeled robots, assemble the robotic arms, and interface printed circuit board.*
- *For the part of software (tablet application): Android Studio is used for developing the mobile application. Several key features are provided for the ease and convenience of students in learning and manipulating their robots. First, it has real-time sensor data monitoring function. Meanwhile, it can reflect the current parameters and time. More importantly, it can change these parameters and compiling them on board without using desktops. Some screenshots are given by Figure 2 from the developed tablet application.*

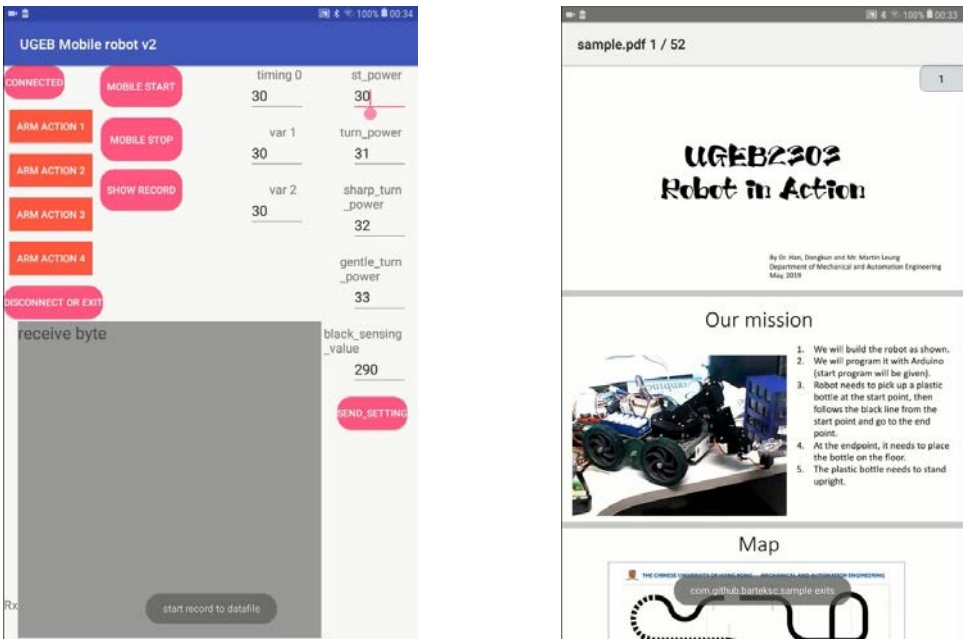

Figure 2: Screenshots of the developed tablet application: In manipulating mode and in manual mode, respectively.

The developed courseware was implemented in a general education course: UGEB2303 Robots in Action, which was taught in term 1, the academic year 2018-2019, with 27 students.

The process of project was carefully checked and controlled, and there is no adjustment of project timeline. The developments of both hardware and software were completed in advance and implemented in UGEB2303.

Overall, based on the project outcomes and deliverables produced, the project was completed satisfactorily.

3. Evaluation Plan

The following evaluation methods are executed for this project:

1. *Survey on the mobile eLearning experience towards the end of the course UGEB2303.*
2. *Survey on the wireless wheeled robot hardware material towards the end of the course UGEB2303.*
3. *Survey on the wireless wheeled robot software user-based experience towards the end of the course UGEB2303.*
3. *Focus group interview with a small group of volunteer students.*
4. *Feedbacks and discussions from the course website and small group forum.*
5. *Weekly reflection meetings with tutors to monitor the progress and propose future developments and improvements.*
6. *Presentation of the project and summarized feedbacks at seminars and conferences.*

From the above survey results and feedback from students, they indicated that the developed courseware project achieves its objective and makes the class more interesting and interactive. The results of Survey 1-3 show that above 96% students have a positive attitude toward this project. From these various sources of evaluations and feedbacks, the objectives of the project were obviously shown to be satisfactorily obtained.

4. Dissemination, diffusion and impact

Through this project, the results of the project are disseminated through the following ways:

1. *Presentation at the 2018 CUHK Teaching & Learning Expo. (Got the People's Prize and the Poster Commendation Award)*

Figure 3: Photos at *2018 CUHK Teaching & Learning Expo*.

2. *Submission of a conference paper to the IEEE International Symposium on Engineering Education.*
3. *Display at the InnoCarnival and other new technology promotion seminar.*
4. *Presentation at the future CUHK-MIT eLearning workshop seminar.*
5. *Presentation at the 2018 Institute on General Education cum Teacher and Student Conference*

The project outcomes have been shown to secondary school students who visited our lab and principals and academics from other institutions. The proposed tools and methodologies could be extended to be implemented in other department courses, like MAEG1010 and MAEG3060.

PART II

Financial data

Funds available:

Funds awarded from CDG	$ 86231.05
Funds secured from other sources (please specify_____)	$ ----------
Total:	$ 86231.05

Expenditure:

Item	Budget as per application	Expenditure	Balance
Material for 3D print housing for controller	600	20354.00	-1031.48
Arduino ATMega2560 MCU board compatible	600		
Material for interface PCB, tools, etc…	3600		
Robotic arm	14522.52		
VEX mechanical hardware	20028.53	21688.00	-1659.47
Tablets	23400	17966.00	5434.00
Robot base Arduino software development	5000	4966.50	33.50
Robotic arm software development	3300	3291.75	8.25
Tablet app software development	6600	6583.50	16.50
Assemble the homemade interface PCB and robotic arm	5280	5197.50	82.50
Design the interface PCB for MCU board	2200	2194.50	5.50
Design the housing for MCU and interface PCB	1100	924.00	176.00
Total	86231.05	83165.75	3065.30

PART III

Lessons learnt from the project

Key success factors

The development of wheeled robots and corresponding mobile application provides a convenient way for students to learn and manipulate the robots and gives a huge improvement to the teaching atmosphere into the classroom. The following advantages were found to demonstrate the success of the developed courseware and its implementation:

- *Provide a more convenient way for students to design, control, and test their first robot in the lab. By using the proposed courseware tools, the performance of students was improved clearly.*
- *Promote working as a group in a class and discuss amongst peers and with the course instructor and technician.*
- *Attendance to class was observed to be significantly increased than the same course taught in 2017-2018 by the same course instructor.*

Difficulties encountered

The following difficulties were encountered during the process of the project:

- *Development time available for the teaching material was quite tight despite being able to successfully complete on time.*
- *Getting the real-time feedback from students is difficult to be conducted and time consuming.*
- *It is generally not easy to find appropriate students as student helpers for completing the tasks like assembling and programming.*

The role of other units in providing support:

- *During this project, support was obtained from colleagues from CLEAR share their experience of the project and conduct surveys with the students.*
- *This project also received intellectual and technical supports from people from our department.*

PART IV
Information for public access

Summary information and brief write-ups of individual projects will be uploaded to a publicly accessible CUHK CDG website. Please extract from Part I the relevant information to facilitate the compilation of the publicly accessible website and reports.

1. Keywords

Please provide five keywords (in the order of relevance to your project) to describe your project.

(Most relevant) Keyword 1: eLearning

Keyword 2: Mobile Application Development

Keyword 3: Teaching Robot

Keyword 4: Lab teaching

(Least relevant) Keyword 5:

2. Summary statistics

Please provide information, if any, in the following tables, and provide the details in Part I.

Table 1: Publicly accessible online resources (if any)
(a) **Project website:** *To be completed*
(b) **Webpage(s):** *To be completed*
(c) **Others (please specify):**

Table 2: Resource accessible to a target group of students (if any)			
If resources (e.g. software) have been developed for a target group of students (e.g. in a course, in a department) to gain access through specific platforms (e.g. CU Learning Management System (Blackboard), facebook), please specify.			
Course Code/ Target Students	**Term & Year of offering**	**Approximate No. of students**	**Platform**
UGEB2303	*1st term, 2018-2019*	*30*	*Blackboard*

Table 3: Presentation (if any)	
Please classify each of the (oral/poster) presentations into one and only one of the following categories	**Number**
(a) In workshop/retreat within your unit (e.g. department, faculty)	*0*
(b) In workshop/retreat organized for CUHK teachers (e.g. CLEAR workshop, workshop organized by other CUHK units)	*1*
(c) In CUHK ExPo jointly organized by CLEAR and ITSC	*1*
(d) In any other event held in HK (e.g. UGC symposium, talks delivered to units of other institutions)	*0*
(e) In international conference	*0*

(f) Others (please specify)	*0*

Table 4: Publication (if any)	
Please classify each piece of publications into one and only one of the following categories	**Number**
(a) Project CD/DVD	*0*
(b) Project leaflet	*0*
(c) Project booklet	*1*
(d) A section/chapter in a booklet/book distributed to a limited group of audience	*0*
(e) Conference proceeding	*0*
(f) A chapter in a book accessible internationally	*0*
(g) A paper in refereed journal	*0*
(h) Others (please specify)	*0*

3. A one-page brief write up

This project is expected to develop a wireless wheeled robot, and a mobile application for helping the students with no background in technology to make and test their first robot in a flexible way.

This project is based on the teaching and learning experience of general education course UGEB2303: Robots in Action. Previously, this course is taught by lectures and followed by lab sessions, where students can only write their codes on desktops in the lab. Via the new wireless robot and mobile application, students could cherish the benefits that fundamental knowledge and tutorial of robots can be learned by mobile phones or tablets, and programming becomes an easy thing that coding and compiling can be done by simply using the proposed mobile application.

To the best knowledge of applicants, it is the first attempt to develop a mobile application of teaching purpose for programming, and coding in wireless robot control.