THE CHINESE UNIVERSITY OF HONG KONG

Courseware Development Grant (2016-17)

Final Report

Report due 31 January 2018
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PART I

Project title: From Traditional to Hands-on Lectures in the Teaching of Robotics

Principal supervisor: MAEG3060 Introduction to Robotics

Co-supervisor(s)

Department / Unit: Department of Mechanical and Automation Engineering

Project duration: From February 2017 to January 2018

Date report submitted: 31/01/2018

1. Project objectives

The project objective is to develop the courseware for a hands-on robotics lecture, which allows students learn fundamental robotics concepts with a real robot arm and custom developed tablet application with exercises to better learn the lecture content. Upon project completion, all objectives have been successfully completed and Figure 1 shows the resulting courseware developed. A total of 12 robot arms were produced for the class of 50 students such that approximately 4 – 5 students used one robot arm.

Figure 1: Developed robot arm and tablet application

The primary objectives of the proposed project did not change during the CDG project. Furthermore, through the CDG project, many additional extensions and future project ideas resulted.

2. Process, outcomes or deliverables

During the project, 12 sets of the system as shown in Figure 1 was produced. Each robot arm consists of three motors and degrees of freedom. The robot was designed, developed and built by our group using the funding of the project. The shell of the robot was 3D printed externally. For the tablet application, a total of 23 different pages (exercises) that correspond to 4 different sections of the course were developed:

- Sensors and actuators: 5 pages
- Transformations: 7 pages
- Kinematics: 4 pages
- Trajectory generation: 7 pages

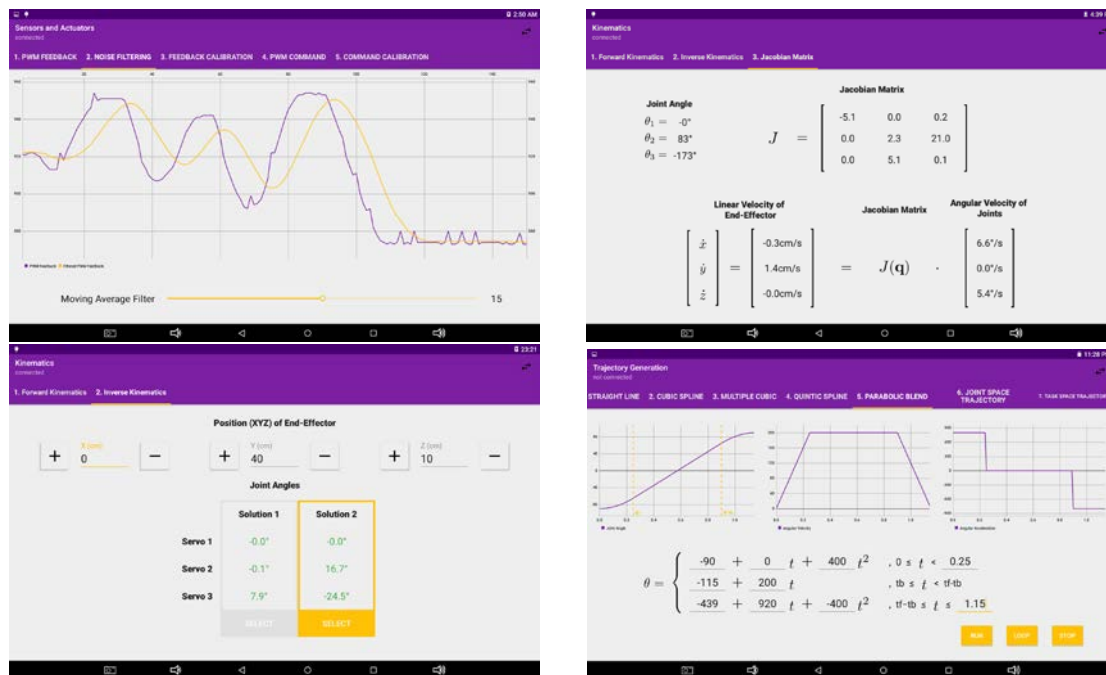Figure 2 shows screenshots of some of the pages from the developed tablet application.

Figure 2: Screenshots of the developed tablet application

These developed courseware materials was used within two courses during the project period:

- ERGM1717 Robotics: Automating the Future, the subject was taught during the Summer Institute of 2017 to a class of 50 secondary school students.
- MAEG3060 Introduction to Robotics, the subject was taught during term 1 of 2017-2018 to a class of approximately 55 undergraduate students (from year 2 to year 4).

Figure 3 shows photos of the classroom setting using the developed course material within an interactive classroom setting (WMY303).

Figure 3: Classroom setting with robot arm

The nature of the deliverables mostly remained consistent with that originally proposed. As more focus was placed on the hardware and application development, the MATLAB simulator development was not performed within this courseware development project. The timeline remained as expected and the development was completed on time to be used within the courses.

Overall, the project outcomes and deliverables were completed satisfactorily and process was performed as expected.

3. Evaluation Plan

During this project, as following the proposed plan, the following were conducted as evaluation:

1. Survey on the interactive classroom usage towards the end of the term
2. Survey on the robot arm courseware material and integration with course towards the end of the term
3. Focus group interview with a small group of volunteer students
4. Weekly reflection meetings with tutors to monitor the progress and propose future developments and improvements
5. Presentation of the project and summarized findings at the 2017 CUHK Teaching & Learning Expo as a poster and regular oral presentation

From the survey results and feedback from students, they indicated that the developed courseware material indeed made the classes more interesting and also made different abstract concepts clearer. A survey was conducted based on questions related to attention, relevance, confidence and satisfaction. Out of a 5 point scale, all categories of questions received scores of 4 out of 5. From these various sources of evaluation and feedback, the objectives of the project were shown to be satisfactorily achieved.

4. Dissemination, diffusion and impact

Through this project, the results of the work were disseminated through:

- Presentation at the 2017 CUHK Teaching & Learning Expo (received a poster award)
- Submission of conference paper titled "Addressing the Challenges in Engineering Classes: Harnessing Active Learning in a Robotics Course" to the IEEE International Symposium on Engineering Technology 2018 and is currently in review
- Display at the 2017 InnoCarnival
- Presentation at the 2018 CUHK-MIT eLearning workshop seminar

Immediate action plans include the writing of journal publication with the plan to be submitted to IEEE Transactions on Education.

The project outcomes (developed teaching tools) have been shown to visitors of the laboratory, such as secondary school teachers and principals and academics from other institutions. These teachers have expressed interest into the purchasing of our robotics learning kit and also further development of the syllabus (particularly for secondary school STEM education).

PART II

Financial data

Funds available:

Funds awarded from CDG $ 76,600

Funds secured from other sources $ Refer to note
(note: project was supported by department one-line budget and PIs own direct grant, but the expenses were not marked down, guess would be approximately 60,000 HKD)

Total: $

Expenditure:

Item	Budget as per application	Expenditure	Balance
Staff costs		48,351.30	
Parts expenses		27,930.52	
Total:		76,281.82	

Lessons learnt from the project

Key success factors

The development of a simple robot system and tablet application, although not very costly, brings large improvements to the teaching atmosphere and style into the classroom. The following advantages were observed to demonstrate the success of the developed courseware and its implementation:

- Increased attention and interest as the students have a physical robot arm to aid them in understanding more abstract concepts. Rarely did students sleep in class with this interactive mode of teaching.

- Promote working as a group in a class and discuss amongst peers and with the teacher.

- Attendance to class was observed to be significantly higher than the same course taught in 2016-2017 by the same course teacher (despite one of the classes began at 8:30am).

- Through the hands-on exercises, the teacher can easily observe individual students who are struggling and can provide extra help to them.

Difficulties encountered

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

- Development time available for the teaching material was very tight despite being able to successfully complete on time.

- Teaching using this material and approach requires a drastic change in teaching style and constant reflection to ensure that the new approach indeed is benefiting how the students learn.

- The amount awarded for the CDG was unfortunately not sufficient compared with the actual expenses required to develop the high quality set of courseware for this course. The principle investigator used other sources of money to cover the additional costs incurred.

The role of other units in providing support, if any

- During this project, support was obtained from colleagues from CLEAR to record the teaching environment (as it was performed within the interactive classrooms) and also conduct surveys with the students.

PART IV

Information for public access

All information from part I can be released to public if deemed appropriate by the committee.

1. Keywords

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

(Most relevant)   Keyword 1: Hands-on/active learning

                      Keyword 2: eLearning

                      Keyword 3: Interactive learning

                      Keyword 4:

(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**

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)	*1*
(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	*1*
(c) Project booklet	*0*
(d) A section/chapter in a booklet/book distributed to a limited group of audience	*0*
(e) Conference proceeding	1 in review
(f) A chapter in a book accessible internationally	*0*
(g) A paper in refereed journal	*0*
(h) Others (please specify)	*0*