Project Title: Development and evaluation of an interactive robot for use in virtual reality applications

Project summary

This was a research and development project. 3 students were employed to help develop a robotic foot platform responsive to touch and motion that would have potential applications in flight or racing simulators or in rehabilitation of patients with ankle injuries. Each student had a different role in the project team which involved mechanical engineering (CAD, manufacturing), control engineering (electromechanics, sensing) and software development (VR application, embedded system) skills. After passing a safety induction, the team was provided with full access to Robotics lab facilities. They came here to work and to participate in weekly and sometime bi-weekly meetings (2 hr) with the project lead. Additional discussions took place through e-mails; Googledocs was used as a repository for documentation. Outside of this the majority of the work was done independently with students working on average up to 10 hours per week.

Outcomes of the project were: CAD design of the system, list of materials to be purchased, proposal for the system integration, software code for VR simulator and data communication with the Arduino board.

Project team

Led by Dr Ildar Farkhatdinov (EECS)

Undergraduate Researchers

3 students in different development roles:

Mechatronics R&D engineer – a 2nd year, SEMS, Medical Engineering
Application software developer – a 1st year, EECS, Computer Science
System integration and evaluation engineer – a 3rd year, SEMS, Mechanical Engineering

Assessment

The students participated in the suggested pilot assessments:

> **Component 1): Appraisal: Setting and Reflecting on Personal Learning and Work-based Objectives**

Students commented individually on the objectives they had set at the beginning of the process, wrote a reflective piece and self –assessed. The project lead commented on this as 'Professional skills assessment':

- With my students we discussed informally about what skills they acquired during the project, so that it can be reflected in their CVs and can help them to build their careers.

- To evaluate this formally, it is possible to compare the student's CV before and after the project, such that new skills are highlighted. This is specifically important for 3rd year students.

- A supervisor can assess this with some feedback from student support/career office.

The project lead added a comment about assessment of time/project management: 'I think it is good to have a record on how regular each particular student is attending the project meetings and delivering the results. This would help to prepare them for industry and improve their teamwork skills in group projects.'

Component 2: Research Practices and Processes

In this project this was:

Technical outputs (evaluated by the supervisor during the project):

- Source code for the embedded system (C-code)

- Virtual reality application for the desktop computer (Unity 3D app)

- Mechanical drawings of the platform and list of materials required for manufacturing (Solidworks CAD files)

Project report

- All of these technical components were described in the technical report. Ideally the technical report was supposed to be well structured and formatted (similar to BSc/MSc reports/thesis), but due to limited time this was organised in a shared Google document

The project lead commented: 'Probably, having a formal project report (individual per student) is a good way to assess the project. The report should have a lay

summary (for non-professionals), abstract, background, and contribution + Appendix (to describe technical things, like code, mechanical drawings, etc). The project report should not be too long, and should be evaluated by more experienced staff: these can be faculty, postdocs, PhDs in the same field.'

Component 3): Presentation of the Research (including submitting an abstract)

Oral presentation: Project lead commented:

- 'This was very important for the students to develop their presentation skills and to learn how to explain their projects to general public. My feedback:
  (1) students did not spend enough time improving their slides (they even did not show them to me before presenting, which I believe should be the case, as they will be able to learn what to do and not to do before the actual presentation);
  (2) presentations should be 10 mins long +5 mins Q&A (in case if there will be many students to present);
  (3) audience should be from the same school/department.'

Poster presentation/conference

- 'If the QM model project will be used widely, probably it is good to have an annual QMUL (or per faculty) UG research conference (half day event should be fine) where selected best students work will be presented orally and the rest with posters + potentially some student exhibition. Probably, this can be combined with some existing events for UG students.'

- 'Making this happen will require quite a lot of efforts, and I am not sure if QM has enough support for this.'

How the project lead assessed: Rather than assessing each of the above components individually, the project lead made summative global judgements of the students using just 2 categories a) 'professional skills' and b) 'personal skills'.

For example:
Student X: professional skills 60% (sometimes lack of technical skills or understanding), personal skills 80% (good communication and teamwork, but no leadership).

More general comments from project lead

Experience acquired by the students:

- CAD of complex electromechanical systems (students do not have experience in designing such complex systems in their regular SEMS degree programme).

- Understanding basic principles of system integration (combining software, hardware, sensors, actuators, and ergonomic design requirements).

- Selected hardware components (online) based on system requirements: cost, technical datasheet.

- Hands-on experience with several robotics components.

- Understanding technical documentation preparation for manufacturing (CAD drawings for dedicated manufacturing processes).

Problems met:

- Students were not available or had very limited availability for about 4-5 weeks during the exam period (May 2017). At QMUL all exams are done at the end of the academic year, which is considered to be a big disadvantage for this type of project based learning.

- Access to QMUL facilities (SEMS robotics lab and workshop) was limited in the beginning due to various regulations, as by default only SEMS senior year students can access lab facilities, while an EECS student was involved in the project.

- The project budget covered the workforce cost, but there was no budget for hardware/lab consumables. It may be considered in future to relocate part of the budget to materials/equipment.

- In relation to the previous point, not all of the workforce budget was spent. This may potentially mean, that (1) students were not able to allocate more time for the project or (2) less time is actually required to achieve the project goals. I think that the statement (1) was the reason for under-spent budget.

- Final year students (3rd year) tend to be busier in May-July period, as they are looking for job/next degree programme, etc. Towards the end the project lead had limited contact with the 3rd year student involved in the project. To avoid this, the projects involving final year students should start earlier and finish by May.

Proposal for further QM model development:

- Types of projects.
    - Keep *role-based* QM model projects for 2nd year students in the format it was done this time. To be more specific, each student had a professional role (software developer, mechanical designer, system integration) within this project but all had a common goal and worked as one team.
    - While 2nd year projects are team and role based, last year (3rd year) projects should be individual, so that the student has to act in different roles and take full responsibility.
- The student projects should be seen as internships (work experience), and ideally should be linked to companies which are interested in the project results. These companies can be potentially interested in hiring the best students, and co-funding the project costs.
- QMUL should consider having two exams sessions (December and May) instead of a single one. This will give students more time for the projects, their personal development, job search and reduce the examination stress.