Visual interactive robot programming through augmented reality

**Short description**

One of the biggest challenge in learning programming is to become fluent in imagining what the program will do, to the point of doing that unconsciously while programming. This process of abstraction creation is typically rather slow because there are many elements to consider in parallel. The goal of this project is to speed up the learning by using visual programming and augmented reality. This project combines two lines of research: visual programming and augmented reality. Combining these two lines of research will enable interactive programming: while the student edits the program, the robot’s behaviour will be simulated using real-world data acquired by the phone and this behaviour will be overlayed over the live stream from the phone's camera.

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<td>Student(s)</td>
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<td>Internal supervisor(s)</td>
<td>Dr Stéphane Magnenat, Simon Lynen</td>
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<td>External supervisor(s)</td>
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**Key words**

Thymio, miniature mobile robot, educational robot, augmented reality, project Tango, visual programming, 3D mapping, robot simulation, programming language, visual debugger
Description

One of the biggest challenges in learning programming is to become fluent in imagining what the program will do, to the point of doing that unconsciously while programming. This process of abstraction creation is typically rather slow because there are many elements to consider in parallel. The goal of this project is to speed up the learning by using visual programming and augmented reality.

This project combines two lines of research. On one hand, it builds upon the visual programming language (VPL) for the Thymio II education robot that was developed at ASL [1]. This language allows to program the behaviour of a mobile robot fully graphically. On the other hand, this project exploits an augmented reality device from Google's project Tango [2], of which ASL is a research partner. This device is a prototype phone which is able to map an environment and localize itself in that environment.

Combining these two lines of research will enable interactive programming: while the student edits the program, the robot's behaviour will be simulated using real-world data acquired by the phone and this behaviour will be overlayed over the live stream from the phone's camera. This builds on works by designers [3] on improving programming experience, but brings this idea to the real world of a physical mobile robot and to the exciting emerging field of augmented reality.

Work packages

This project will have separate work packages, including:

- localizing the robot in the phone's live stream
- interfacing with VPL
- simulating the robot's behaviour using the acquired 3D map
- overlaying the resulting robot behaviour in "shadow" on the phone

Reference

Formal Requirements

Work schedule: Please provide your supervisor a work schedule within two weeks after the start of the project. Generally, Bachelor and Semester projects last 14 weeks starting at the first day of the semester and end at the end of the semester. Master projects last 6 months and the starting date is agreed on with the supervisor.

Intermediate presentation: An informal intermediate presentation (about 10 minutes presentation/discussion) about your work will take place around mid-term. The goal of the presentation is to give a brief summary of the work done, to propose a plan for the continuation of the project, and to discuss about the main directions of the project.

Final presentation: The final presentation will take place at the end of the project. A test run is presented to and discussed with the supervisors 2-5 days before the public final presentation. Exact dates and times for the intermediate and final presentations will be arranged by the lab administration.

Report: A report has to be handed in to the responsible supervisor. The report has to describe the full work performed during the whole project. A preliminary version has to be handed in one week after the final presentation or as determined with the supervisor. The preliminary version of the report is discussed with the supervisors. The final report has to be handed over to the responsible supervisor in 3 paper copies. All documents and files, including the report (original data and as a PDF-file) and the final presentation, have to be saved on a CD/DVD and handed in together with the final report.

Evaluation: The project is assessed according to the ASL evaluation sheet and the “Merkblatt für Studierende zum Thema Plagiate” of ETH Zurich. The responsible supervisor hands both of them out at project start. The final presentation is evaluated based on the public final presentation. The report is evaluated based on the preliminary version with the requirement that the remarks are incorporated in the final report.

Plagiarism: Every student has to make himself/herself familiar with ETH Zurich rules regarding plagiarism. http://www.ethz.ch/faculty/exams/plagiarism/index_EN

Duration of Final Presentations:
- Bachelor and Semester projects: 15 minutes presentation, 5 minutes questions / discussion
- Semester/Bachelor Project with integrated SoM: 22 minutes presentation, 8 minutes questions / discussion
- Master projects: 20 minutes presentation, 10 minutes questions / discussion
- Studies of Mechatronics (SoM): 10 minutes presentation, 5 minutes questions / discussion

Projects that include the “Studies on Mechatronics” (SoM): In general, the SoM have to be done at the beginning of the project ending with a public presentation (10 min. presentation + 5 min. discussion) on the same days as the regular intermediate presentation. In case this is not possible or integration with the final presentation is preferred, students must confer with the supervisor beforehand. Check the ASL Wiki regarding the rules for the SoM.

Zurich, Date: ________________________.

Notes
The internet provides detailed information on how to write a scientific report and how to make a presentation. The report and presentation should be done according to these common guidelines and the instructions from your supervisors. We recommend reading the following instructions before you start with your work:
- Writing Guidelines for Engineering and Science Students
  http://www.writing.eng.vt.edu/
- Prof. Bernstein’s Student Guides
  http://aerospace.engin.umich.edu/people/faculty/bernstein/guide.html
The style and format of your report should follow common practices and the instructions of your supervisors. However, the ETH template is preferred for the presentation. We recommend you using Microsoft Office, OpenOffice or LaTeX to create your report and presentation. Please ask your supervisor for the template files.

**Report**

- LaTeX Editor http://www.toolscenter.org/ or http://www.lyx.org/

**Presentation**

- *The LaTeX Beamer Class* http://latex-beamer.sourceforge.net/