

## Practical exercise sessions for the lecture - Control Systems: Theory and Design Under the Qualification Programme on „Research-based learning at TUHH“

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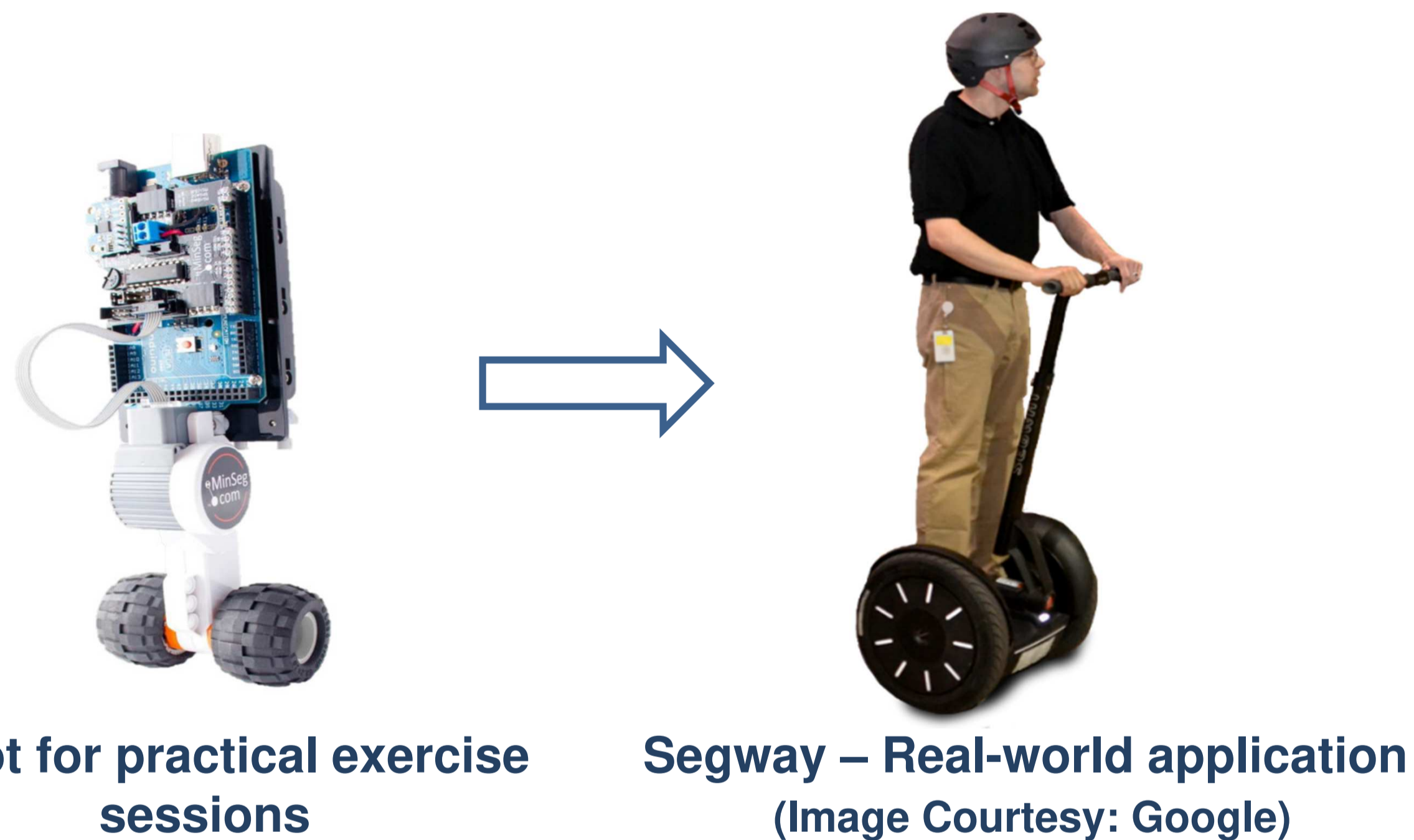
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### 1 Objective

To motivate and inspire the students, by engaging them through practical sessions in demonstrating how the concept of control systems learned in the classrooms are applied in solving the real-world problems, a teaching project is planned and designed which is to be implemented in the on-going semester.

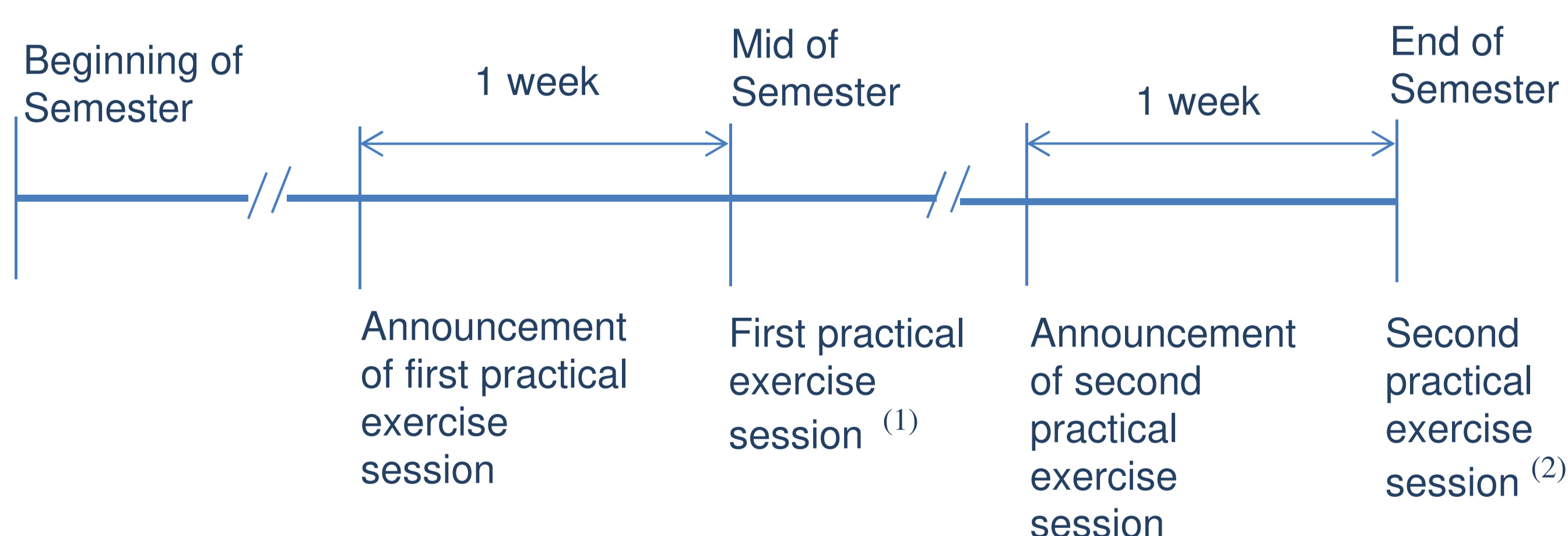
### 2 Motivation

The module “Control Systems: Theory and Design”, which is a fundamental course for many engineering streams, is currently structured as lectures and exercise classes. The key idea behind this teaching innovation project is that by including practical exercise sessions in the course, the students can be trained to design control systems for the real-world applications. In these practical sessions, students work in groups to solve a practical problem and while solving the practical problem they are intended to learn the concepts of control systems.



### 3 Course details

- Master Course in Winter Semester
- Approximate number of students: 200
- Weekly theory lecture class (1.5 hrs.) & Exercise class (1.5 hrs.)
- End-semester written exam (80%) + Mid-semester multiples choice questions exam (20%)
- No credits for practical exercises



Two practical exercise sessions are planned to be conducted:

- <sup>(1)</sup> mid-semester (dealing with continuous time-period)
- <sup>(2)</sup> end -semester (dealing with discrete time-period)

### 4 Practical Exercise Sessions

#### Before announcement ...

- Students are asked to form groups of 5 students; each group with students who are comfortable to work with each other. By working in groups, it is intended that each student is benefitted from peer learning.

#### In one week of preparation

- Announcement of tasks.
- The intended task is to design a control system for a two wheel self-balancing robot, which is more like a scaled down version of a self-balancing personal transporter Segway, using the software MATLAB.
- The control system should be designed in such a way to self-balance the two wheel robot and also to move it without losing its balance.
- The control system should also be designed to reduce noise and disturbance.
- To motivate and inspire the students, interactive videos, that showcase the real-world application of the task, are showed during exercise classes.

#### On the day of practical exercise session

- Each group is provided with a robot and groups are given some time to upload their MATLAB script and calibrate the code to run their robots.
- The efficiency of the designed control systems is tested by successfully running the robot for a designated distance without losing its balance even under any external disturbances.

#### After the sessions ...

- The best performed group is given a chance to explain and demonstrate their control system design in front of the whole class, and thereby the whole class is benefitted by self-assessing the mistakes in their own design.

### 5 Feedback

Feedback forms are distributed to each group after practical sessions to quantitatively analyse how the practical sessions benefitted the students. The feedback result can be helpful in further improvement of the practical exercise sessions in future.

### 6 Reference

Liliana Fernández-Samacá, José Miguel Ramírez. (2012). Project-Based Learning Approach for Control System Courses. *Revista Controle & Automação*, Vol.23, No.1, 94 – 107.