PROBLEM BASED LEARNING IN MECHATRONICS

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Abstract: This paper briefly informs about the experience with teaching Mechatronics with the intensive use of real laboratory models. The HW and SW is based on Matlab/Simulink platform with extension to real-time applications. The difficult balancing between theory and students motivation is also mentioned.

Keywords; education; Mechatronics; educational models; Matlab/Simulink.

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1. INTRODUCTION

1.1 Motivation

The current civilization is based on technology, huge energy consumption and huge consumption of everything. Although many environmental and social problems we are facing now is based on negative impact of technology, it is widely believed, that further technical development can also help in solving those problems in the future.

Despite of this, the motivation of students in technical and engineering fields of study is more and more difficult in recent years. In this paper, the strategy of problem based education in mechatronics is described. The key concept of our Mechatronics laboratory is in the intensive use of educational models of real technical systems. The experience and gain acquired from the very basic and simple systems (such as DC motor with incremental encoders), more complicated MIMO systems and the real industrial problems are incomparable to the normal study approach.

1.1 Mechatronics

Mechatronics is typical interdisciplinary field of science and technology. Usually, mechatronics is defined as mixture (or optimistically: as synergistic combination) of mechanical engineering, electronics, computer sciences and control engineering to design the new product.

Most of power-producing and transportation systems consist of mechanical and electrical components and almost all new products require sophisticated computer control. Mechatronics is still relatively young field which allows the creation of integrated products with completely new functionality or can solve old problems using new approaches. Therefore it can be believed, that mechatronics can bring important contribution to the solution of challenging problems of the future.

Such wide spectrum of knowledge to be covered requires highly talented and motivated students but also offer enormous space for self-fulfilment and personal growth.

2. STRATEGY OF EDUCATION AT MECHATRONICS LABORATORY

The keystone of the problem-driven learning and teaching at Mechatronics laboratory is the use of real (physical) educational models. Based on this, the work in laboratory consist of following components:

- educational models
- Real-Time hardware and software for PC with Matlab/Simulink
- theory of modelling, control, signal processing etc.
- challenging team projects
- effective SW tools for teamwork and sharing of knowledge
- cooperation with industry (solution of practical demanding problems).

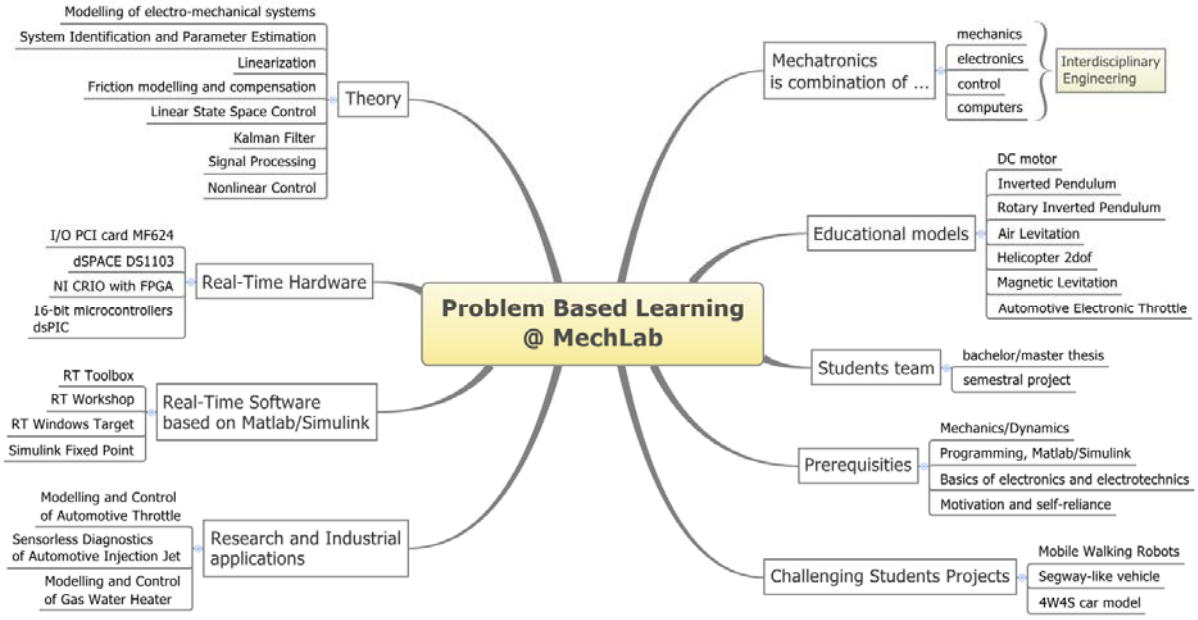

Figure 1 The map of PBL at MechLab.

1.1 Educational models

We use in MechLab these kinds of models:

- professional models
  - Magnetic levitation
  - Helicopter with two degrees of freedom
- models created by students as the result of bachelor/master thesis
  - Air levitation
  - Inverted pendulum
  - Rotary (Furuta) pendulum

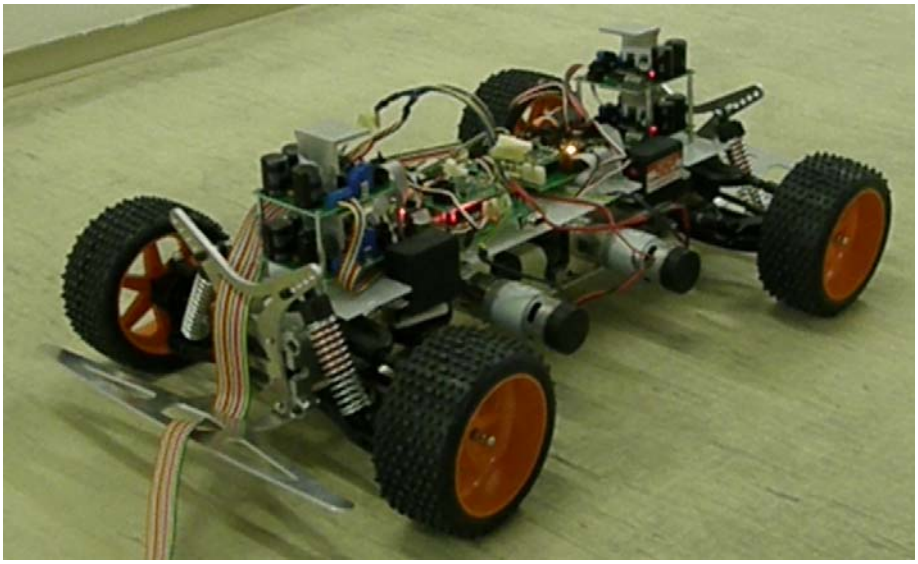

Figure 2 Students project: Experimental car with four steering and driven wheels.

- real automotive components
  - Electronic Throttle
  - Electrical Power Steering System
  - Solenoid Fuel Injection System
- complex team projects
  - Small experimental car with four steering and four driven wheels (Fig. 2)
  - Segway-like experimental platform

1.1 Software and hardware

Usually, many courses in Mechatronics uses Matlab/Simulink as the standard tool for modelling, offline simulation and control. We extend the application of Simulink into domain of Real-Time systems using special I/O hardware for standard PC and relevant software. This approach allows e.g. to teach the position control of DC motor with incremental encoder in 10 minutes, which is incomparable to classical (time consuming) employment of microcontrollers or DSP programmed in C.

1.1 Equations and other tools

The effective and motivated learning of complex theoretical topics must be driven by the actual problem. For example, our students group recently working on balancing wheel scooter is enough motivated to study Extended Kalman Filter for the signal fusion and processing.

Comprehensive theoretical knowledge is very important for the engineer although the trend is to use more “out of box” computer programs (generating colourful pictures) and much less pen and paper and equations.

1.1 Team projects

The teamwork is one of the fundamentals of problem-based learning. However, the justified scepticism is often expressed. The balanced compromise between the individual study and teamwork is the strategy in our laboratory. The team is the source of inspiration, place for dis-

cussions and interactive learning, but requirements, goals and responsibility must be clearly defined for each student separately.
In MechLab, most of our students work in team but all of them have individual bachelor/master thesis assignment.
The team spirit and knowledge exchange is also facilitated through the web portal with tools for project management and file sharing.

Figure 3 Student working on RobotX – project of mobile robot with hybrid undercarriage.

3. CONCLUSION

Our concept of the use of educational models as a means of motivation and problem-driven learning is successful. In previous years relatively high number of students went through the laboratory and finished with high-quality work and thesis. Most of students improved their results and increase motivation to study because of attractive and challenging projects. The only drawback of presented strategy is the enormous working load given on the teaching staff (besides lectures and exercises also the maintenance of laboratory models and equipment is required).

Finally, we would like to inform, that MechLab is interested in both pedagogical as well as scientific cooperation with similarly focused laboratories.

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4. REFERENCES

MechLab: Mechatronics Laboratory, Institute of Solid Mechanics, Mechatronics and Biomechanics, Faculty of Mechanical Engineering, Brno University of Technology.
Url: http://www.mechlab.cz