Robotics for Engineering Education

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Outline

- Introduction – some observation and thoughts
- Product – a key to open the door for a wonderful engineering world
- Some Examples of engineering teaching practice
Introduction

- Most products are the integration of modules from different engineering areas – mechanical, electrical and electronics, computing etc.
Engineering graduates are expected to design, manufacture and control those products, and specifically they should be competent in:

- Mechanical design … *parts* and *mechanism*
- Circuit design … *digital* and *analogue*
- Controller design … *classical* and *modern*
- Computer programming … *low* and *high levels*
- Man-machine engineering design
- Integration of different engineering modules

Are current education models suitable for producing such versatile graduates?

Mechatronic major is designed as one of the responses to this question.
Some issues in common teaching practices:

- Simple addition:

- Imbalance in allocation of teaching contents
  - Dominated by either mechanical, electrical or electronic engineering.
  - In mechanical engineering,
    - more on mechanics/materials, less on mechanism
  - In electrical/electronic engineering
    - more on digital circuit, less on analogue circuit
    - more on low power circuit, less on high power circuit
    - more on low frequency, less on high frequency
    - more on microcontroller, less on application specific circuits of logic gates or flip-flops
  - More on computer aided design tools, less on fundamentals
More on computer intelligence, less on mechanical intelligence
More/first on individual topic (“trees”, “building blocks”), less/later on a whole system (“forest”, “house”)
- Labs are full of computers, but lack real engineering gears
- Research and teaching is detached
- Engineering teaching or science teaching?
- Knowledge perceived by the students is piecewise, and its relevance to their lives in real world is fuzzy
- A generic impression is that engineering courses are hard and “dry”, against other so called “soft” courses look more appealing

If people can enjoy many new experiences brought by engineering products, why cannot they find the same enjoyment from engineering education?

How about link products to the teaching from the very beginning of students’ learning journey?
**Product** – a key to open the door of a wonderful engineering world

**Analysis**

**Product** → Mech., Elec., & Computing → Math./Physics

Specific → Generic → Abstract / Fundamental

Daily Language → Engineering Language → Sci. / Math Language

‘Forest’ → ‘Tree’ → ‘Root’

‘Palace’ → ‘Room’ → ‘Brick / Tile’

**Design**

**Product** - a stimulus (frequency rich ‘delta’ function) to trigger all the good elements and processes of engineering teaching
Take robotics as an example

Robot
(Mobile Robot and Robotic Manipulator)

Structure and Motion Transmission
- Mechanism
- Mechanical Part
- Engineering Design
- Computer Aided Design
- Theoretical Mechanics
- Material and Mechanics

Power and Drive System
- Power Electronics
- Fluid Dynamics
- Thermo Dynamics
- Electrical Machines
- Digital Electronics
- Analogue Electronics

Sensing and Control System
- Systems and Control
- Microprocessor and Microcontroller
- Signal Processing
- Computer Programming
- Artificial Intelligence
- Image Processing
- Logic Design

Examples

- **RoboCar** (design, fabrication, report, competition and blogs; budget controlled)

Maze Navigation/Line Following

Hill Climbing

Happy students

RoboCup Workshop, Singapore, 17 June, 2010
- **Mousetrap Car** (design, fabrication, CAD, competition and report; recyclable materials used)
- Inverted Pendulum - Pole Balancing Robot (analysis, real time control design, report, and demonstration)
Robotic manipulator and production line (analysis, control design, programming, report and demonstration)
- **Twin_rotor MIMO System – Flying Robot** (analysis, MIMO control design, Real time system, report and demonstration)

Twin-Rotor MIMO System Control
- Robotic Soccer System (mobile robot motion control, real time programming, assignment)

GUI

Mobile robot tracking a target
Conclusions

- Robotics is a very good platform for engineering teaching
- It stimulates students’ interest in engineering and equips them with
  - rigorousness in theoretical foundation
  - solidness and extensiveness in knowledge base
  - versatility in hands-on
  - employability upon graduation
  - potential for future development