Sustainable electronics and it

Schultz, Ole; Hundebøll, Peder M.

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1. Introduction

The Sustainable Electronics and IT – SUSIE (62562) is an elective course integrating sustainability for 5 or 6 semester IT and Electronics students. The course is offered in 3½ years Bi.Eng. Program, which includes a ½ year internship and Diploma engineering project in the industry.

This poster presents:
• the course curriculum.
• how ICT, low power design and LCA are integrated in students work.
• some students projects and results.

For our technical interested students, it makes sense to apply:
• the sustainable science in project work about energy consumption, monitoring and control of indoor climate in buildings.
• Design for low power, by practical examples.

2. SUSIE curriculum

Fig. 1 Course contents (Ref 10)
The course Teaching:
• a weekly lecture during 8 – 9 weeks.
• a weekly lab-exercise during the first 8-9 weeks.
• 4-5 weeks for a group chosen project.
• Teacher role is lecturer and supervisor in labs and project.

3. SUSIE Project work

Open Project framework in SUSIE

Team based project work is undertaken with the purpose of using all the topics from the classes in solving a self-chosen problem. At Campus Ballerup we are used to give open project frames; hence this part of the project proposal in SUSIE:

“...Choose a problem domain for which it is relevant to monitor environmental data and controlling actuators, e.g. in a house, at Campus Ballerup, a green house, plant control, electrical vehicle, etc.”...

“...One of the wireless nodes should be powered by a renewable energy source”.

For prototyping and experiments each team is given a Box

A: LAN-shield for Arduino – W5100 transceiver
B: Olimexino board – Atmega 328p
C: XBee, IEEE802.15.4
D: IBoard with LAN and XBee

4. Energy and protocols

Exercise about power and power management in an embedded system:
• Describe which main components and software parts a system contains.
• Which strategies can be used for power management due to reducing the energy cost?
• How can the energy Consumption be estimated?
• Discuss and list the Dynamic opportunities for power management.
• How should a design be carried out for best energy efficiency?
(Read chap. 3 and 7 in lit. Ref 1)

Practical lab-work:
“...To estimate the power required for two boards which can full fill the user’s needs and to do experiments with the XBEE in sleep mode together with the coordinator_controller board”.

By practical measurement as shown in Fig. 3 and 4 the students are taught what to consider when designing low power wireless systems.

Students are encouraged using alternative Wi-Fi devices such as ex. CC3000 from Sparkfunk with a TI and Embedded IPv4 TCP/IP stack ref 2.) – Or the ESP8260 to compare WIFI with low-power protocols.

5. Life cycle screening - MECO

Students are asked to do a Life Cycle Assessment (LCA) using the MECO method (Ref 3)

An Example:
An Xbee module is dismounted and its main parts identified.

1. Production-Data for main parts are found in SimaPro database (www.pre-sustainability.com)
2. They use the MECO method for:
   • calculating the resource load in mPR
   • the primary energy consumption for the production, transport, usage and disposal phase for the Xbee.
3. The results are normally used by the students:
   • comparing the found results with alternatives for the service of the functional unit.
   • Discussing the environmental impacts of substituting materials with a high resource load - in mPR
   • Energy use in phase found in the lab-exercise.
4. The results are based on a rather old dataset for materials?

For discussion – where to find newer data – and easy for students to get?

6. Room monitoring

How is a class room used? That was monitored using the SUSIE kit and the knowledge gained in the first part of the course and using a free cloud service Xively.com for storage and visualization. The prototype was made by SUSIE for the students in SDTU and that leaded to an energy saving campaign in 2013.

7. Preliminary results

Exams and practical prototypes proves
• In SUSIE the students obtain knowledge and can design for low power and get awareness about resources used in electronic devices.
• Courses have inspired students to bring their project to Green challenge.
• Some diploma thesis within the sustainable domain Relations to other courses.
• In parallel with the SUSIE course, a cross disciplinary optional course is given in Sustainable product development (SDTU) and students from the two courses meet and get inspiration for projects and prototypes which can support SDTU – mostly Civil engineering students.

References

3. Handbook for Environmental Assessment of Products by Environmental Project No 811, 2000
5. In-clinic climate monitoring project by Christian Frickhöcker et al., In: Energetic Medicine, Springer, Berlin, 2015
7. Window comparison project by André Daniel Birkkjær Christensen, Anna Østergren, Tomas Lindquist Olsen, 2014