ECE 411 Industry Design Processes: Assignment #2

Due on Monday, October 13, 2014

Foust 2:00pm

K. Lu, C. Halseth, M. Schmidt, M. Downey

https://github.com/DroningOn/ECE411

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Homework #2 Due Monday October 13, 2014
*****Please submit problems into the team wiki homework #2 folder on GitHub as well as a paper copy in class.*****

Problem 1:

Form a team with three other members of the class. Choose your teammates not only on the basis of friendship or familiarity but also to ensure a diversity of skills on the team.

Practicum Team: K. Lu, C. Halseth, M. Schmidt, M. Downey

Problem 2:

After forming teams of four, come up with four ideas for a term project that conforms to the project guidelines. Document each idea with a brief paragraph.

- Wireless Apparatus for Real-Time Classroom Feedback
    - Classroom ``clickers'' have been used at Colorado State University in increase classroom participation and create an active classroom experience. Some research studies show strong correlation between test scores in classrooms with and without clickers. The purpose of this project is to develop a cheap $5-15 dollar clicker for real-time classroom feedback in ECE 411.
- Measurement Electronics for lifetime an electron produced by μPCD (Microwave Photoconductive Decay)
    - μPCD is a contactless measurement technique for measuring the lifetime of photogenerated carriers in a solar cell. This topic address an interesting problem for quality and reliability measurements in the solar cell manufacturing process. Measurement of lifetime using typical silicon solar cell parameters requires that the time base resolution be on the order of a few microseconds. The scope of this project is to develop electronics that takes at its input a voltage mathematically described by an exponential curve and extracts electron lifetime.
- Dual Channel Gamer Glasses
    - Develop shutter or polarizer based glasses to allow multiple independent gamers to utilize the same television to view separate images. The frame rate and glasses are synchronized so that the TV image switches between two different images that are unique to each viewer.
- Power Glove
    - Develop a multi sensor general input device based around a glove that can accurately represent the users hand configuration in real time. Device would utilize a USB output and up to 16 channels to represent user input. Design would be based around a prototype resistive stretch sensor developed by one of the team members.

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Problem 3:

Create a decision matrix showing the four potential project ideas and the criteria you used for selecting the project you'll actually undertake along with their scores. Document your criteria, your weights, and rationale for them. Describe the method you used to assign numerical values.

Method applied to generate the decision matrix: **Analytical Hierarchy Process**

The decision matrix for this problem was generated to indicate a design path for the Wireless Real-Time Classroom Feedback project discussed above. This particular design challenge was decided prior to this homework assignment via discussion with Andrew Greenberg. As such, we have selected four likely wireless MCU candidates on which to perform analysis.

The primary considerations motivating this decision matrix are cost, power usage (battery longevity), and development time. Other considerations are included as an expanded feature set for rev 2 improvements (see below).

Following the procedure outlined in Appendix B of "Design for Electrical and Computer Engineers" by R. Ford and C. Coulston we generate a decision matrix.

Determine the Selection Criteria

- 1.1. Cost
- 1.2. Power
- 1.3. Short Development Time
  - 1.3.1. Packet Handling
  - 1.3.2. Memory Space
- 1.4. Range
  - 1.4.1. Receiver Sensitivity
  - 1.4.2. Transmit Power
- 1.5. Features
  - 1.5.1. Tactile Feedback
  - 1.5.2. A/D Converter
  - 1.5.3. 2 Way Radio
  - 1.5.4. Timer/RTC
  - 1.5.5. Reprogrammable
  - 1.5.6. Capacitive Sensor

Determine the Criteria Weightings

- 1.6. 1 = equal, 3 = moderate, 5 = strong, 7 = very strong, 9 = extreme

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Identify and Rate Alternatives Relative to the Criteria

Pairwise Comparison of Selection Criteria

	Price $ @ 100 units	Power (sleep)	Dev Time	2 Way Radio	Packet Handle	RTC	Geometric Mean	Weight
Price $ @ 100 units	1	1/3	1	3	1	5	1.3077	0.191
Power (sleep)	3	1	1	1	3	3	1.7321	0.253
Dev Time	1	1	1	3	1	5	1.5704	0.229
2 Way Radio	1/3	1	1/3	1	1	3	0.8327	0.122
Packet Handle	1	1/3	1	1	1	5	1.0889	0.159
RTC	1/5	1/3	1/5	1/3	1/5	1	0.3101	0.045

Pairwise Comparison of Price

	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2	Design Rating
PIC16LF1824 T39A	1	5	7	9	0.6335
CC430	1/5	1	5	7	0.2446
Si1010	1/7	1/5	1	3	0.0814
Atmel ATmega2564 RFR2	1/9	1/7	1/3	1	0.0406

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Pairwise Comparison of Power

	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2	Design Rating
PIC16LF1824 T39A	1	9	5	7	0.6402
CC430	1/9	1	1/7	1/5	0.0361
Si1010	1/5	7	1	3	0.2176
Atmel ATmega2564 RFR2	1/7	5	1/3	1	0.1062

Pairwise Comparison of Development Time

	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2	Design Rating
PIC16LF1824 T39A	1	1/3	3	9	0.3015
CC430	3	1	3	9	0.5222
Si1010	1/3	1/3	1	3	0.1323
Atmel ATmega2564 RFR2	1/9	1/9	1/3	1	0.0441

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Pairwise Comparison of 2 Way Radio

	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2	Design Rating
PIC16LF1824 T39A	1	1/3	1/3	1/3	0.1000
CC430	3	1	1	1	0.3000
Si1010	3	1	1	1	0.3000
Atmel ATmega2564 RFR2	3	1	1	1	0.3000

Pairwise Comparison of Packet Handling

	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2	Design Rating
PIC16LF1824 T39A	1	1/3	1/3	1/3	0.1000
CC430	3	1	1	1	0.3000
Si1010	3	1	1	1	0.3000

Atmel ATmega2564 RFR2	3	1	1	1	0.3000

Pairwise Comparison of RTC

	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2	Design Rating
PIC16LF1824 T39A	1	1/3	1/3	1/3	0.1000
CC430	3	1	1	1	0.3000
Si1010	3	1	1	1	0.3000
Atmel ATmega2564 RFR2	3	1	1	1	0.3000

4. Now that we have all of the weights and relative design ratings we are able to compute the decision matrix.

The Decision Matrix

Criteria	Weights	PIC16LF1824 T39A	CC430	Si1010	Atmel ATmega2564 RFR2
Price	0.191	0.6335	0.2446	0.0814	0.0406

Power	0.253	0.6402	0.0361	0.2176	0.1062
DevTime	0.229	0.3015	0.5222	0.1323	0.0441
2Way Radio	0.122	0.1000	0.3000	0.3000	0.3000
Packet Handling	0.159	0.1000	0.3000	0.3000	0.3000
RTC	0.045	0.1000	0.3000	0.3000	0.3000
Score		0.384613	0.273236	0.198697	0.142522

5. Review the Decision

By comparing the values generated from the decision matrix we can see that the PIC based solution is most favorable, primarily due to its low cost and power consumption, with the CC430 being next in line and the other two options lagging significantly behind. Andrew Greenberg will be contacted for verification on the selection of this part, but it currently seems as though the PIC should be selected providing two way communication with the devices is a low priority.

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Problem 4:

Choose one project idea from these four that you will actually pursue for your term project and develop a brief proposal for that project. Because these projects may not be fulfilling an actual need, your project proposal will not have all the usual content that an actual project proposal will (e.g. needs statement, objective statement, market size, preliminary schedule, etc.) The purpose is primarily to describe your project so that we can determine whether it meets the guidelines (see ``Practicum Term Project'' on first day of Syllabus page on the course website). You must have your project proposal approved. A reasonable project proposal for this purpose will fit on one page.

Wireless Apparatus for Real-Time Classroom Feedback

Project Concept

This project enables a professor or instructor to receive real time feedback from students in the classroom. Some research done at Colorado State University suggests that classes utilizing "clickers" outperform classes without clickers when it comes to exams. Systems like these are available commercially. However, often times the cost of "clicker" systems are prohibitively expensive. This project was suggested by Andrew Greenberg.

Objective Statement

The objective is to design and build a low cost transmitter/receiver network allowing direct feedback to questionnaires presented to the class. A simple GUI will be devised to present questions, collect student feedback and display the class statistics.

Market

The target market is ECE 411 Professors and their classroom.

Requirements[1]

- Must
  - Transmitters
    - Be usable by 100-500 students in a single classroom
    - Use the unlicensed ISM bands (400, 900 or 2400 MHz)
    - Have an on/off switch to save battery life
    - Have some kind of indication that they are on, and that a vote has been sent
  - Receiver
    - Be able to receive up to 100-500 transmitter "votes" at a time with < 0.001 losses of votes per transmission
    - Connect to a PC via USB for data display and logging.

[1] Requirements suggested by Andrew Greenberg. https://github.com/DroningOn/ECE411/adg-requirements.markdown.

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- Should
  - Transmitter
    - Cost between $5-15 each
    - Have the antenna built into the PCB for cost savings.
    - User a cheaply available COTS battery, like a CR2032, or a CR1612, etc
    - Have some serial number so user can identify a particular unit (but not a particular student)
  - Receiver
    - TBD
- May
  - Transmitter
    - Be in a COTS package, like a remote control or other pre-existing package.
    - Have bidirectional communication, so that the user can light up an LED on a transmitter
  - Receiver
    - Be in the same form factor as a USB flash drive, but with an external antenna connector like SMA or RP-SMA.

Schedule

Week 3

1. Preliminary Transmitter & Receiver board schematics started.
2. Conduct feasibility studies of Python, MATLAB and C-sharp as a GUI interface.
3. Decide on MCU & purchase of dev kit

Week 4

1. Preliminary Transmitter & Receiver board schematics completed by 10/18
2. Decision on Programing language for GUI by 10/18

Week 5

1. Peer design review of Transmitter & Receiver schematics on 10/29.
2. Begin GUI programing & testing

Week 6

1. Final Peer Design Review of Transmitter & Receiver schematics on 11/3.
2. Preliminary Transmitter & Receiver layouts completed by 11/5
3. Continuation for GUI programing & testing

Week 7

1. Boards sent to fab 11/10

Week 8

1. Assembly of boards

Week 9

1. Debug & Testing

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Week 10

1. Continuations of Debug & Testing

Week 11

1. Project demonstrations 12/8

Problem 5:

E-mail the URL for your team's project Wiki to the course TA. If your Wiki requires login/password access include that information.

https://github.com/DroningOn