EE 382: Introduction to Design

Beacon Finder and Identifier Robot

or

Fire Fighting Robot

Department of Electrical Engineering
New Mexico Institute of Mining and Technology

January 14, 2014
Outline

1. Course Overview
2. Project 1
3. Project 2
Course Overview

Instructors:
- Aly El-Osery
- Kevin Wedeward

Time/Place:
- TR 2:00pm - 5:00pm
- Jones Annex 101 for lectures and presentations
- Workman 116/187 for work on project
Course Overview (cont.)

Prerequisites:

- EE 308 and EE 308L (microcontrollers)
- EE 321 and EE 321L (analog electronics)
- EE 333 (electricity and magnetism)
- EE 341 (signals and linear systems)
- Declared electrical engineering as a major
Course Overview (cont.)

Goals: Students will

- work in teams,
- implement key aspects of a design process,
- design and build a prototype electronic system,
- conduct experiments to characterize and verify design,
- communicate aspects of the design process through oral presentations and written documents, and
- manage the design process.
Course Overview (cont.)

Grading:

- White Paper - 10%
- Statement of Work - 10%
- Conceptual Design Review (Presentation) - 10%
- Mid-term Design Evaluation - 20%
- Final Project Evaluation - 30%
- Final Design Presentation - 10%
- Demonstration for Faculty, Family and Friends - 0% (for fun)
- Final Report (including electronic version) - 10%

Individual grades will be assigned; each student must participate in each graded-component of the course to pass the course.
Course Overview (cont.)

Budget

- Each team will receive a budget of $325.
- Use order form to purchase items through the department; fill it out, have it signed by instructor and then ask secretary (Carrol) to place.

Suggested Suppliers:

- Acroname Robotics
- Digi-Key
- Mini-Circuits RF/IF & Microwave Components
- Pololu Robotics & Electronics
- SparkFun Electronics
Course Overview (cont.)

There are two project to select from:

1. RF beacon localization
2. Fire fighting challenge.

A key requirement

Each team must identify, design and implement a key component using concepts from Analog or Electricity and Magnetism courses.
Project 1: RF Beacon Localization

Outdoor robot to remotely locate and identify RF beacon

- Design an outdoor robot capable of navigating a given, unobstructed area to remotely locate a RF beacon that has an identifier encoded via Frequency-shift keying (FSK).
- Location of the beacon will be computed as longitude and latitude along with a metric of error, and the beacon’s identity will be decoded.
Project 1: RF Beacon Localization (cont.)

Parts provided for Project 1

- Dagu Wild Thumper 4WD all-terrain chassis
- Dagu Wild Thumper 6WD all-terrain chassis
- 18v15 Pololu high-power motor drivers
- 18v25 Pololu high-power motor drivers
- ZFL-2500+ Mini-Circuits 500-2500 MHz amplifier
- ZAM-42 Mini-Circuits 1500-4200 MHz frequency mixer
- BBP-10.7+ Mini-Circuits 9.5-11.5 MHz bandpass filter
- ZX95-2400A+ Mini-Circuits 2000-2400 MHz voltage controlled oscillator
- 2S1P EP Buddy Lithium Iron Phosphate (LiFe) 6.6 V battery pack
- CellPro 4S FMA Direct battery charger (to be shared by class)
Beacon employs Frequency Shift Keying (FSK) modulation of serial message/identifier.
Project 1: Beacon - Serial Stream

Serial 7-bit at a Baud rate of 600 with even parity bit.

- **Baud rate** - each bit in stream will be of length 1/600 seconds
- **Start bit** - 0 (after 1 for awhile)
- **Message/identifier sent LSB first**
- **Even parity** - last (8th) bit transmitted will make number of ones in 7-bit identifier/message even
Project 1: Beacon - Serial Stream (cont.)

7-bit identifier sent: 0111010
Project 1: Beacon - FSK

FSK uses VCO to generate two sinuoids of different frequencies that correspond to 0s and 1s in serial stream.
Recall Fourier Transform of sinusoid

\[ f(t) = \cos(\omega_0 t) \iff F(\omega) = \pi(\delta(\omega - \omega_0) + \delta(\omega + \omega_0)) \]

and that our FSK is made up of two (truncated/windowed) sinusoids of different frequencies.
Project 1: Beacon - FSK
Project 2: Fire Fighting Robot

Design a autonomous robot that:
locates, approaches, stops within 8 inches (20.3 cm) of one candle in
direct view of the robot; turns on the extinguishing mechanism; and
extinguishes the candle’s flame without making contact with the candle
Key rules:

1. A white, 1.0 inch (2.54 cm) wide circle with an 8 (20.3 cm) radius, as measured from the candles base, will be marked on the track around each candle.

2. Some part of the robot must be on or inside the circle BEFORE the candle can be extinguished.

3. If the robot is NOT on or inside the circle, and the candle is extinguished, a 50% penalty of the candles value will be assessed.

4. The robot will have 3 minutes to extinguish the candles.

5. The robot must be 100% autonomous.