Module Description:
Did you ever wonder how a physician measures your heartbeat or other vital signs, a submarine identifies underwater obstacles or your Xbox and Kinect seem to recognize you and your every move? Your beating heart, a rock 300m underwater and your skeleton are not visible to a naked eye, so how can these invisible signals be measured? This course will explain how this is accomplished and, in the process, will introduce you to the world of signals, their processing and some exciting applications. This is a hands-on course; lectures will be combined with team exercises involving a variety of sensors. For example, you will experiment with a heart monitor app on your smartphone, you will build your own sonar to measure distance to objects using sound, and you will design an interface to control your computer with gestures instead of mouse/keyboard. The course will culminate with an exciting team project involving Microsoft Kinect.

Course Schedule:
LECTURE: 4 hrs/week, M-W 3-5pm, PHO 111
HOMEWORK: about 4 assignments (problem solving and writing)
PROJECT: team project with 3 deliverables – project proposal, brief report and in-class presentation

Reminder: Last day to add/change class: Sep. 10
Last day to drop a course: without “W” – Sep. 16, with “W” – Oct. 1

Textbook:
No textbook

Reference material:
Lecture slides, handouts, webpage links, videos on course web site

Instructor:
Janusz Konrad, Professor, ECE Department, jkonrad@bu.edu, 353-1246, PHO 443
Office hours: Mon 11-12, Thu 10-11 or by appointment via email

UTFs:
Jonathan Kim, tcxjkm@bu.edu
James Christianson, jamesrc@bu.edu

Prerequisites:
Basic algebra and calculus
Basic physics
Familiarity with computers
Curiosity and willingness to experiment!

Goals:
To provide students with:
- Basic understanding of how real-world signals, often invisible, are captured, numerically represented and processed by a computer.
- Overview of applications of digital signals in medicine, cybersecurity, human-computer interaction, gaming, art,
- Hands-on experience with signal capture, understanding and usage – all in the context of Kinect camera

Course Outcomes:
As an outcome of completing this course, students will be able to:
1. Understand how physical signals can be represented digitally as bits stored on a computer.
2. Understand the impact of signal sampling and quantization on digital signal’s accuracy.
3. Understand signal smoothing and its impact on noise.
4. Understand how a pulse monitor, sonar range finder, and Microsoft Kinect work.
5. Build a simple pulse monitor from electronic components.
6. Test accuracy of the pulse monitor against a smartphone pulse monitoring application.
7. Experiment with face recognition software and test its vulnerability to attacks.
8. Experiment with gesture-based user authentication software and test its vulnerability to attacks.
9. Discover biomedical, cybersecurity and gaming applications that have profound societal impact.
10. Discover examples of ethical problems related to biomedical, cybersecurity and gaming applications.
11. Assess the societal impact of engineering and the engineer's responsibilities in this regard.
12. Complete a team project using Microsoft Kinect.
13. Present the project to classmates.

Academic conduct:
Collaboration is permitted on both homework and projects. If there is collaboration on homework, each collaborator must turn in his/her individual solutions, analysis, etc. The student handbook defines academic misconduct as follows:

"Academic misconduct occurs when a student intentionally misrepresents his or her academic accomplishments or impedes other students’ chances of being judged fairly for their academic work. Knowingly allowing others to represent your work as theirs is as serious an offence as submitting another's work as your own."

Please see the student handbook for procedures that will be followed should academic misconduct be discovered.

Course grading:
Assignments: 40%
In-class participation: 20%
Project (proposal, report, presentation): 40%

Homework:
There will be analytic (problem-solving) and writing (essay) assignments on topics related to engineering. The purpose of essays is multifold: to discover applications of digital technology in service of the society, to increase your awareness of ethical issues in engineering, and to exercise your communication skills. Assignments need to be handed in by due date.

Team project:
The project will be executed by teams of students. The project must involve a Kinect camera as the input device and produce a visual, acoustic, or some other output, such as changing cursor position on the screen by hand movements, painting colors on the screen through hand tracking, traversing directories and opening/closing files using gestures, controlling sounds through hand movements. There will be 3 deliverables of the project: project proposal (topic, brief description - page), project report (detailed description of accomplishments – up to 5 pages), and in-class project presentation (10 minutes). Project guidelines, suggested topics, and software pointers will be provided before the project starts.

Office hours:
Office hours, as listed on previous page or by appointment, are meant to help students with course material. Please do not hesitate to stop by if you have any questions about the course (material, homeworks, project, etc.)

Course web page: http://learn.bu.edu
All course material will be posted here (lecture slides, other handouts, homework, project guidelines) Also, please check for announcements, calendar, etc. Most up-to-date information will be available there.