Carnegie Mellon University School of Art

Course: 60-439 - Advanced SIS/ETB:
Critical Robotics: Useless Robot, Uncanny Gesture

Times: TTH 8.30am - 11.20 am

Location: Doherty Hall-D200

Facilities: CMU ArtFab @ Doherty Hall
Digital Arts Studio @ Dougherty Hall

Contacts: Instructor: Ali Momeni (momeni@cmu.edu), Assistant Professor

SYNOPSIS OF CLASS

This course introduces students to theories, practices, and communities surrounding the critical investigation of robotics. "Useless Robot" and "Uncanny Gesture" allude to two conceptual axes for the course: first, design, fabrication and deployment of robots that *do not serve a narrowly defined purpose*, but rather serve as inviting platforms for humanistic investigation of the human-robot relationship; second, creation of forms, gestures, narratives, and choreographies that investigate the affective and experiential potential of human-robotic exchanges, as opposed to functional or goal-oriented ones.

This course unfolds along two parallel trajectories: research (literature review, lectures, demonstrations) and design (individualized projects that span the entire semester). The first half of the course will introduce students to a wide range of theories and techniques within robotics that draw from engineering and computer sciences, as well as philosophy, psychology and economics. Students will study theoretical, mechanical and computational frameworks for robotics, while concurrently researching alternative practices that employ robots within performative contexts motivated by aesthetics. Topics of interest include: mechanical movements and automata, real-time sensing technologies, wireless communication, emergent behavior, and agent-based systems, as well as early theories explored in cybernetics, artificial intelligence, and science fiction.

The course employs two common technological platforms for hands-on investigation experimentation with self-aware machines:

- Pololu m3pi: An Arduino and/or mbed based two-wheeled robotics platform
- The Electric Imp: "A complete solution to connect devices to the internet, wirelessly", a la "The Internet of Things"
- ABB Robots and Robot Studio

Both platforms require familiarity with C or C-like programming languages. This course will also make extensive use of Cycling '74's Max, the Arduino micro-controller platform, as well as the computer aided design (Rhino) and machining tools (RhinoCam). Students who are not familiar with the Rhino, Max and Arduino environments are required to seek intensive personal training through online tutorials and videos, *prior to the start of the semester*. The course instructor can facilitate access to these pedagogic resources upon request by email.

Collaboration
Robotics is a complex interdisciplinary practice that requires expertise in a wide range of domains. In order to maximize the each student's potential for creating meaningful work during the semester, students are *strongly encouraged* to work collaboratively. Projects undertaken in teams are therefore entirely within guidelines of the course, to a greater number of participants/contributors yields greater expectations for the ambition and execution of the project. Collaborative projects must be presented as such during the initial project-proposal-day; discussion of potential roles for each participant should be included in the presentation.

ACCESS TO FACILITIES
During the course of the semesters students will gain training on various fabrication machines. Upon completing training, each student will gain access to an online reservation system that allows him/her to book hours on various machines. Students are required to acquire a key for CMU ArtFab Lab (Doherty C200)

SEMESTER OVERVIEW and ASSIGNMENTS
The primary course objective is to propel the creative agenda of each student by allowing him/her to create a final project that is born of his/her practice. The course is therefore divided into three phases, titled: *research/learn, design/make, refine/document;* these phases are outline below. The next section of this document outlines a full weekly schedule for the course; throughout this document, all DUE material are highlighted in orange.

1. Weeks 1 - 6:
    - Lectures and Demonstrations on Robotics, Mechatronics, Cybernetics, and Artificial Intelligence
    - Research and Design Assignments 1 through 4
2. Week 7-14:
    - Week 7 (Feb. 25): Final project proposal and timeline DUE (week 7, Feb. 25)
    - Weeks 8-13: Work on Final project
    - Week 14 (Apr. 15): Final Critiques DUE
3. Week 15-16:
    - Lectures, demonstrations, workshops on installation, documentation, and writing on one's work
    - Collective creation of an all-semester documentation video
    - Week 16 (Apr. 29): Definitive final project documentation DUE for evaluation

WEEKLY SCHEDULE of CLASS and ASSIGNMENTS
Week 1 (Jan 13, 2013):

- Tuesday: Introductions to class, syllabus, ArtFab Lab facilities; discussion of robotics and gesture

- Thursday: Assignment 1 DUE: robot with one sensor and one actuator

Week 2 (Jan 21, 2013):
- Tuesday:
  - Research Assignment 1 DUE: [Winfield: Chapters 1, 2, 3, 6]
    "A Very Short Introduction to Robotics" (cmu libs, amazon)
  - Introduction Teensy, Max, Maxuino environment
- Thursday: Design Assignment 2 DUE: robot with two sensor and two actuator

Week 3 (Jan 28, 2013):
- Tuesday:
  - Research Assignment 2 DUE:
    - Weiner: "The Human Use of Human Beings", pp. 15-28
    - Hofstadter: pp. 590-599
    - Pickering: pp. 37-48
    - Brooks: "Intelligence without representation"
  - Software behavioral simulations environments (Breve)
  - Cellular Automata, Boids, Physics Simulation
- Thursday:
  - Design Assignment 3 DUE: first prototype of one sensor robot/two sensor robot interaction
  - Work session with first prototypes

Week 4 (Feb 3, 2013):
- Tuesday:
  - Research Assignment 3 DUE:
    - Braitenberg: "Vehicles: Experiments in Synthetic Psychology"
    - Lambrinos: "Extended braitenberg architectures" (fairly technical, try to understand the overall approach)
    - Persson: "Understanding Social Intelligence", pp. 21-28 of "SOCIALLY INTELLIGENT AGENTS: Creating Relationships with Computers and Robots"
  - Arduino and MBED based mobile robotics platforms (3pi and m3pi)
- Thursday:
  - Design Assignment 4 DUE: second prototype of one sensor robot/two sensor robot interaction
  - Work session with 3pi robots

Week 5 (Feb 10, 2013):
- Tuesday:
  - Research Assignment 4 DUE: Five example project profiles posted as individual postings on the blog, with two accompanying paragraphs each: one descriptive, one interpretive/dialogical (these postings must also be submitted to

blackboard as a single assignment whose contents are five links to each blog post)
    - Industrial robots, ABB Robots and Robot Studio generative toolpaths with HAL/Rhino
    - 9.30am: lab visit to CMU Personal Robotics (PI Siddhartha Srinivasa)
    - 10:30am: lab visit to CMU CREATE (PI Illah Nourbakhsh)
- Thursday: Work Session on project proposal

Week 6 (Feb 17, 2013):
- Tuesday: lab visits:
    - 9:00am: Collaborative Machining center: shop manager Larry Hayhurst
    - 9:30am: CMU Nanorobotics Lab (PI Metin Sitti)
    - 10:30am: CMU Biorobotics Lab (PI Howie Choset)
- Thursday: Work session; one on one conversations with instructor regarding Project Proposal

Week 7 (Feb 24, 2013):
- Tuesday: Design Assignment 5 (Project proposals and timelines) DUE; 5 min presentation (see below for details)
- Thursday: Project proposal discussions and critiques

Week 8 (Mar 3, 2013):
- Tuesday: TBA (Ali Away)
- Thursday: Work session on final project (Ali Away)

Week 9 (Mar 10, 2013):
- Tuesday: Spring Break 2013!
- Thursday: Spring Break 2013!

Week 10 (Mar 17, 2013):
- Tuesday: Mid-Semester update DUE; 5 min presentation (posted as an embedded Google Presentation or Prezi on the blog, 5 minute critique)
- Thursday: work session on final project

Week 11 (Mar 24, 2013):
- Tuesday: Project Presentation: Language is a Virus
- Thursday: work session on final project

Week 12 (April 1, 2013):
- Tuesday: work session on final project
- Thursday: work session on final project

Week 13 (Apr 8, 2013):

- Tuesday: work session on final project
- Thursday: work session on final project

Week 14 (Apr 15, 2013):
- Tuesday: Final Critiques
- Thursday: Final Critiques

Week 15 (Apr 22, 2013):
- Tuesday: Making things Work; best practices in making robust work for exhibition, shipping and remote monitoring; documentation of work with still and video; composition of accompanying text for work
- Thursday: Making things work session

Week 16 (Apr 29, 2013):
- Video documentation workshop: collaborative work session on production of a full course documentation;
- preparation of works for exhibition at coordinated multi-course public exhibition (details TBA)

Project Proposal: This presentation shall cover the project's artistic and technical considerations, and influences, as well as a concrete timeline for accomplishing the task at hand. Specifically, a project time-line should include **three milestones**; concret intermediary steps to completing a project by the end of the semester. The 2nd **Milestone** should correspond with the mid-semester review, and the 3rd with the final critique at the conclusion of the semester. There four Milestones will serve as individualized assignments for each student; they will be evaluated by the student, during in one-on-one meetings with the instructor. This proposal should be posted as an embedded Google Presentation or Prezi on the blog, 5 minute critique, and submitted to blackboard as the due assignment titled "Final Project Proposal"; the blackboard submission should be a link to the corresponding blog post that embeds the proposal.

Class hours will mostly be split between lecture and demonstrations on Tuesdays, and class presentations and work sessions on Thursdays. During the work sessions, the instructor will meet with students one on one to offer critique and additional references. The first class critique shall be during the mid-semester review; a final critique will conclude the class during the 14th week of the semester.

Students are encouraged to edit, adjust, expand and reshape their timelines as the semester proceeds, in consultation with the instructor. Note: Due dates for Milestones as well as a feasible distribution of tasks among the three intermediary steps is NOT subject to change.

ATTENDANCE
Consistent attendance is mandatory. Students are allowed *two* unexcused absences; further

unexcused absences will lower your grade for the session by one letter for each additional absence. Attendance will be taken at the beginning of class. If you arrive later than 15 minutes into the class period, you will be counted as absent. Every *three* occurrences of arriving to class more than 5 minutes will count as an absentee.

If you have a class or work schedule issue & anticipate being somewhat late on a regular basis, please see see the instructor during the first week of the semester.

CRITIQUES

Attendance on critique days is absolutely essential. Failure to attend will impact both your class participation grade and your project grade. On critique days, all students are expected to be set-up & ready to participate at the beginning of the class period.

READING LIST

- Braitenberg, Valentino. *Vehicles, Experiments in Synthetic Psychology*, Bradford Book, 1984.
  Breazeal, Cynthia L. *Designing Sociable Robots*, The MIT Press, 2004.
- Brooks, R A. "Intelligence Without Representation." *Artificial Intelligence* 47, no. 1: 139–159.
  Brooks, Rodney. "The Relationship Betweenmatter and Life": 1–3.
- Dautenhahn, K, A H Bond, L Canamero, and B Edmonds. "Socially Intelligent Agents: Creating Relationships with Computers and Robots" 3.
- Hofstadter, Douglas R. *Gödel, Escher, Bach*, 1999.
- Johnston, J. "The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI (Bradford Books)." Lambrinos, D, and C Scheier. "Extended Braitenberg Architectures."
- Masschelein, Anneleen. *The Unconcept*, Suny Press, 2011.
- Murphy, Robin. *Introduction to Ai Robotics*, The MIT Press, 2000.
- Pickering, Andrew. *The Cybernetic Brain*, University of Chicago Press, 2011.
- Sandin, P E. "Robot Mechanisms and Mechanical Devices Illustrated."
- Selig, J M. *Introductory Robotics*, 1992.
- Wiener, Norbert. *Men Machines and the World About Wiener*, 1954.
- Wiener, Norbert. *The Human Use of Human Beings, Cybernetics and Society,* 1950.
- Winfield, Alan. *Robotics: a Very Short Introduction*, OUP Oxford, 2012.

GRADING

Attendance is mandatory; inadequate attendance will lower your final grade. Class participation is based on conduct and contribution to class blog, presentations, discussions, and critiques.

The course will make use of a class blog, as well as the Blackboard system. Students are expected to share their research findings on the class blog on a regular basis, in the form one or more posting per week. These blog postings contribute to the overall participation portion of the final grade. Students are also expected to post a detailed blog entry for each Milestone in his/her project; these project updates should employ text, pictures, videos as well as other necessary media (e.g. code) to convey the incremental advances made towards the

completion of final project. To assure timely submission of these important incremental assignments, a Blackboard assignment for each Milestone will collect project updates; the assignment submitted to blackboard should simply be link to the corresponding blog posting. Late assignments will not be accepted.

Each assignment will be be graded on a scale of 0 to 2 (with 0 indicating incomplete or insufficient, 1 indicating adequate or sufficient, and 2 indicating *excellent* or *outstanding*).

The final project will be graded on a scale of 0 to 10, with 10 representing excellence in conception and execution.

The final grade for the course will be calculated based on the following formula:

Attendance:	mandatory
Class participation:	20%
Assigned projects 1 to 4:	40% (10% each)
final project:	40%