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GSAPP A4823 - Intelligent Systems / Interactive Architectures Syllabus
Spring 2013

Session A - 11:00AM - 2:00PM Friday (Lectures and Workshops)
Room: Fayerweather 201

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Interest in physical computing has risen dramatically over the last fifteen years in the fields of architecture, engineering, industrial design, and art. Following the latest trends, it is evident that architects in the future will be increasingly called upon to create building systems, spaces, structures, and landscapes that are computationally enhanced and interconnected. Our environments will also demand some form of intelligent adaptability – a recognition of evolving external environmental parameters, user demands and feedback systems.

A review of the literature reveals that there are no established methodologies for designing architectural spaces as smart or intelligent spatial systems. As such, it is clear that a new multidisciplinary approach is needed to bring together research in the fields of interaction design (IxD), architectural design, product design, human computer interaction (HCI), embedded systems, robotics, and engineering in order to create a more holistic design strategy for livable and productive spaces. Preparing architectural designers for these challenges demands a range of knowledge, skills, and experience well beyond the traditional domain of architectural education.

This class will focus on hardware and software prototyping techniques; primarily focusing on a wide range of sensing and actuation modalities in order to build novel interactive devices. Using remote sensors, microcontrollers (Arduino), and actuators, we will build virtual and physical prototypes that can communicate with humans and the world around them. There will be particular emphasis on the concept of *prototyping* - both digitally and physically - as a means to explore intelligent control strategies, material affects, and the parameters which effect dynamic systems. A series of fast-paced lectures and technical workshops will expose students to topics relevant to this domain including: microcontrollers and programming, sensor technologies for interactive environments, mechanism design, robotics and motor control, fabrication methodologies, parametric design, computer vision and signal analysis, and interactive prototyping techniques. It is expected that by the end of the course, each student will have a range of skill capable of producing machines and prototypes that are configurable, sensate, and active.

Format: Each 3-hour session will consist of theoretical or technical lectures and hands-on demonstrations, as well as periodic pinups and presentations by students.

Prerequisites: While there are no prerequisites, some exposure to Grasshopper and/or programming is preferred.

Evaluation: Based on interim topic presentation, pinups, and the final interactive machine/prototype. Students will work in groups of 2-3 to complete assignments.

Keywords: Computation, Physical Computing, Embedded Systems, Fabrication, and Prototyping

Resources:

Software Requirements

· **Rhino 4.0**http://download.rhino3d.com/rhino/4.0/evaluation/download/(or Rhino 5.0 32-bit)

· **Service Release 9 or higher (for Rhino)**http://download.rhino3d.com/Rhino/4.0/sr/download/

· **Grasshopper (version 0.9.0014 or higher)**
http://download.rhino3d.com/en/Grasshopper/1.0/wip/rc/download/

· **Arduino IDE**http://www.arduino.cc/en/Main/Software and http://arduino.cc/en/Guide/

· **Firefly 1.0067 (or higher)**http://fireflyexperiments.com/download/

Hardware Requirements

It is expected that each student group (can be 2-3 per team) will need to purchase certain hardware devices in order to complete the tutorials/assignments presented in class. A list of required materials will be distributed on the first day of class, although a general estimate for materials would be around $100 for each group. Additional materials may need to be purchased depending on the complexity/design of each group's final project.

Class Date	Lecture Topic	Assignment Due	Workshop Topic
Friday Jan 25th, 2013	Introduction		
day Feb 1st, 2013	Intro to Microcontrollers	Purchase Hardware	Arduino and Circuits
Friday Feb 8th, 2013	Intro to Interactive Prototyping	Project Proposal	Intro to Firefly
Friday Feb 15th, 2013	Linkages, Kinetics, & Mechanisms		Motor Control
Friday Feb 22nd, 2013	Sensor Technologies	Mid Review	Making Sensors
Friday Mar 1st, 2013	Computer Vision & Signal Analysis		Comp. Vision & Audio
Friday Mar 8th, 2013	Final Review	Final Review	

Assessment: Grades will be evaluated based on the formal and experimental ambition of the assignments, the conceptual clarity, cleverness, and precision of execution, and the mastery of technical concepts as evidenced by assignments, review interactions, and class participation.

20% Attendance and Participation

20% Completion of Tutorial Assignments

20% Mid Review, including in-progress prototype of final proposal

40% Final Review, including final prototype and simulation

Class Descriptions

January 25th, 2013- Introduction to Machine Intelligence

This class introduces the basic premises and parameters of the course, in particular the concept of Artificial General intelligence and it's progressions through the history of computation. We will look at: early works such as the Difference Engine by Charles Babbage; to Cybernetics and feedback communication developed by Norbert Weiner; to the founding of AI with projects like General Problem Solver and Claude Shannon's Mechanical Mice; to the state of the art of AI today and what we can expect by intelligent machines in the

future.

Technical Topics: Overview of software/hardware to be used during the semester.

Recommended Resources:

Eastman, C. 1972. "Adaptive-Conditional Architecture". In *Design Participation: Proceedings of the Design Research Society's Conference*: September 1971. London: Academy Editions.

Friedman, Y. 1972. "Information Processes for Participatory Design". In *Design Participation: Proceedings of the Design Research Society's Conference*: September 1971. London: Academy Editions.

Fox, M, and M. Kemp. 2009. *Interactive Architecture*. New York: Princeton Architectural Press.

Gershenfeld, N. 1999. *When Things Start to Think*. 1st ed. New York: Henry Holt.

Haque, U. 2007. "The Architectural Relevance of Gordon Pask". *Architectural Design* 77 (4): 54-61.

Ishii, H., and B. Ullmer. 1997. "Tangible Bits: Towards Seamless Interfaces Between People, Bits and Atoms". Paper presented at Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Atlanta, GA.

Kurzweil, Ray. 2005. *The Singularity Is Near : When Humans Transcend Biology*. New York: Viking.

Negroponte, N. 1975. *Soft Architecture Machines*. Cambridge: MIT press.

Payne, A. 2012."IDE vs IPE: Toward an Interactive Prototyping Environment", in Jörg Peter Chat and Julian Adenauer (eds), *Prototype!*,Form + Zweck Verlag (Berlin), pp 172–82.

Sterk, T. E. 2003. "Building Upon Negroponte: A Hybridized Model of Control Suitable for Responsive Architecture". In *Proceedings of the 21st ECAADE Conference*. Graz, Austria, September, pp 407- 414.

Sterk, T. E. 2003. "Responsive Architecture: User-Centered Interactions within the Hybridized Model of Control". In *Game Set and Match II*. Rotterdam: Episode Publishers.

Weiser, M. 1991. "The Computer For The 21st Century". in *Scientific American* 265 (3): 94-104.

February 1st, 2013- Introduction to Microcontrollers

This class examines the rise of inexpensive, programmable microcontrollers for interactive devices. A microcontroller consists of a microchip on a circuit board with read-write capabilities, memory, inputs and outputs. The Arduino is an open-source electronics platform which is inexpensive, flexible, and easy to use and has had a profound impact on the fields of art, design, and human computer interaction over the last decade.

Technical Topics: Introduction to Arduino and microcontroller programming

Recommended Resources:

Banzi, M. 2008. *Getting Started with Arduino*. Sebastopol: Make Books.

Gibb, A. 2010. *New Media Art, Design, and the Arduino Microcontroller: A Malleable Tool*. Available at:

http://aliciagibb.com/thesis.

Igoe, T. 2007. *Making Things Talk: Practical Methods for Connecting Physical Objects.* Sebastopol:O'Reilly Media.

Noble, J. 2009. *Programming Interactivity: A Designer's Guide to Processing, Arduino, and Open Frameworks.* Sebastopol:O'Reilly Media.

February 8th, 2013- Introduction to Interactive Prototyping

Prototyping is inherently iterative in nature. Massimo Banzi, one of the co-founders of the popular Arduino platform writes, "we strive to find a simpler and faster way to prototype in the cheapest possible way... It is a constant search for faster more powerful ways to build better prototypes". This philosophy touches on one of the primary objectives of the prototyping process which is to be able to design objects in a more fluid, cost effective manner. This class will introduce a visually oriented Interactive Prototyping Environment (IPE) called *Firefly* which directly addresses the shortfalls of traditional prototyping paradigms - ideally creating a more creative and streamlined prototyping process for designers.

Technical Topics: Introduction to the Firefly plug-in for Grasshopper.

Recommended Resources:

Johnson, Jand N.Gattegno. 2011.'Experiments in Live Modelling', *PRAXIS 13: Ecologics*.pp 45–7.

Payne, A. 2012. *Interactive Prototyping: The Firefly User's Guide*. Available at: http://fireflyexperiments.com/resources/

February 15th, 2013- Linkages, Kinetics, and Mechanisms

Kinematics pertains to the motion of bodies in a mechanism without regard to the forces/torques that cause that motion. Kinematic structures are governed by certain specific geometric laws which prescribe how connected components must interact and interoperate. This class will examine historical kinematic models and mechanisms, while exploring more contemporary examples of robotics and kinetic machines.

Technical Topics: Introduction to Mechanisms and Motor Control.

Recommended Resources:

Kinematic Models for Design (Cornell University): http://kmoddl.library.cornell.edu/index.php

Linkage Mechanism Editor & Simulator: http://blog.rectorsquid.com/programming-projects/linkage-2-0/

Linkages and Mechanisms Typologies: http://www.robives.com/mechs

February22nd, 2013- Sensor Technologies for Interactive Environments

This class will examine, in as broad a scope as possible, many different sensors technologies that are useful in an expansive definition of Human Computer Interaction. Examples will demonstrate how to integrate and apply various sensor technologies to make a meaningful and understood measurements. The class will explore commercially available components, as well as do-it-yourself techniques for building your own sensing platforms.

Technical Topics: Introduction to Sensors, Making a Bend/Pressure Sensor.

Recommended Resources:

Fraden, J. 1993. *AIP Handbook Of Modern Sensors: Physics, Designs, And Applications*. Third Ed. Springer: New York. 2003.

Horowitz, P., and W. Hill. 1989. *The Art Of Electronics*. Cambridge University Press.

Scherz, P. 2006. *Practical Electronics For Inventors*. McGraw-Hill, Inc.

March 1st, 2013- Computer Vision and Signal Analysis

Many data acquisition devices and analysis methods produce some sort of array of values of various dimensions, depending on the application. Capturing devices such as microphones and video cameras record data in a structured format, over time - creating a signal which can be analyzed for various patterns. This class will examine different signal analysis procedures and computer vision algorithms, and explore how these can be applied to make successful interactive devices and environments.

Technical Topics: Computer Vision and Audio Analysis

Recommended Resources:

Gleick, J. 2011. *The Information: A History, A Theory, A Flood*. Pantheon Publishers, First Ed.

March8th, 2013- Final Review

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