ARCH-599
Data Acquisition and Control in the Built Environment

Units: 3
Semester: Fall
Grading Type: Letter-Graded
Course Type: Regular class
Location: Watt Hall
Day and Time: Tuesday 9:00AM - 11:50AM
Instructor: Joon-Ho Choi
Office Location: WATT Hall #318
Office Hours: Thursday 12:00PM – 1:00 AM
Contact Info: joonhoch@usc.edu, 213-740-4576

IT Help: Enrique Barajas
Contact Info: ebarajas@usc.edu
Contact Hours: TBD.

Course Description
Students studying in the field of building science and environmental design should have an analytical skill for quantitative investigation and decision process for building system controls. This course is aimed at giving graduate students an exposure to data acquisition tools, data analysis and control, which would be applicable to supporting building environment research problems and solution findings. This course will provide an overview of the construction and implementation of data acquisition, data mining, quantitative analyses and system controls, including data collection interface design, and in-depth analysis using data mining and statistical tools, and environmental system control. It will help students to develop a framework for addressing a research problem and solution based on data measurement and analysis technique for control applications, especially in building environments.

Learning Objectives
After taking this course, a student should specifically understand the following concepts and skills:
  - Data acquisition methods
    o Constructing data acquisition systems
    o Defining sensing interval and filtration methods
    o Correct location / position of sensory device installation in the built environment
    o Data cleaning and process
  - Data analysis methods
    o Understanding how to use major data mining tools
    o Finding a proper algorithm to fit your own data
    o Understanding how to investigate and analyze the collected data
  - Building system controls
- Understanding how to generate a system outcome as a function to control
- Constructing a control logic to fit for your own control system
- Employing advanced algorithms / computational logics to control your own system.

**Required Readings and Supplementary Materials**
- Introduction to Business Statistics [Student Edition]
- Computational Intelligence: An Introduction (2nd Edition) - 2007
- ASHRAE 55 Standards: Thermal Comfort - 2010
- ASHRAE Handbook
- ASHRAE High Performance Building Handbook
- Illuminating Engineering Society (IES) Handbook

**Prerequisite(s)**
N/A

**Co-Requisite/Concurrent Enrollment**
N/A

**Recommended Preparation**
Any building HVAC systems, computer programming, and statistical analysis experiences and/or preparations are recommended.

**Course Notes**
Lecture notes, syllabus, handouts, reading assignments, and any other course materials will be posted on Balckboard. Practice with control hardware for homework or assignments will be incorporated with the course.

*Teaching Method:* This class will be conducted as a seminar and will mix lecture presentations by the instructor with student presentations, class demonstrations, slide presentation, project review and guest speaker, as well as system construction with applying acquired knowledge to a real built environment. An environmental chamber in Watt Hall will be used as a testbed and students will be required to do their course projects and assignments using the facility to concurrently learn and put the acquired skills and knowledge into practice. There is no required text, but several reference books will be recommended for course work. Since the course is for a graduate level, students can choose any data type or source based upon their research interests or their conducting projects.

**Technological Proficiency and Hardware/Software Required**
This course is based on a traditional classroom setting. In addition, students may need some hardware practices, soldering, electric circuit fabrication, etc.

**Description and Assessment of Assignments**
Provide enough information about an assignment so a student or reviewer can tell what kind of work is to be done and how it should be completed, i.e. how the learning outcome will be assessed. Include any assessment and grading rubrics that will be used.
## Grading Breakdown

<table>
<thead>
<tr>
<th>Assignments</th>
<th>Points</th>
<th>% of Grade</th>
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</thead>
<tbody>
<tr>
<td>Mid-term project</td>
<td>200</td>
<td>20%</td>
</tr>
<tr>
<td>Final project</td>
<td>300</td>
<td>30%</td>
</tr>
<tr>
<td>Assignment and quizzes</td>
<td>400</td>
<td>40%</td>
</tr>
<tr>
<td>Class participations</td>
<td>100</td>
<td>10%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1000</strong></td>
<td><strong>100%</strong></td>
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## Assignment Submission Policy
Deliverables are defined as any work required from the student that was assigned for acquisition or preparation outside of the regular classroom, e.g. web-based reference documents, homework, take-home quizzes, and projects. All deliverables are mandatory and due at the beginning of class on the required due date. Failure to submit a deliverable on-time and reasonably well attempted shall result in a deduction of 50% of the assigned point value, with an additional 10% deducted for each full-day late until such work is delivered into the instructor’s possession, properly completed. Any deliverable not properly submitted within one calendar week of a required due date may result in a failing grade to the student in this course. Any student who may be absent from class on the due date may submit their work beforehand directly to the instructor, or, on the due date via another student. Exceptions to this policy shall be considered with adequate justification.

## Additional Policies

**Quality:** All deliverables shall be graded for quality and content, 60% and 40% respectively. Chaotic, illegible, disorganized deliverables shall negatively impact the course grade.

**Attendance:** On-time attendance is expected in this course as is required in professional practice. Late arrival and repeated absences shall negatively impact the course grade.

## Additional Notes

**Student Assignments**
This is a project-oriented class. Therefore, students are required to finish each assignment on time for the class. Students will have an individual assignment, a group project, or both. The assignments will develop data acquisition construction skills for a building environmental condition measurements, enhance students’ skills for computational / statistical data analysis, and develop a control algorithm to be applicable to a real building environment.

Students will have 4 assignments and 2 course projects in the course that help you gain a deeper understanding on the computational approaches being taught. In addition, students will have reading assignments from articles handed out in class or available on the web.

The assignments will include:

1) Constructing a data acquisition system interface.
2) Investigating optimized sensing optimal and filtration methods depending on students’ selections of the data and measurement environments.
3) Investigating significant features of collected data.
4) Developing control logic with employing existing (advanced) algorithms.
Software to be used
The course will use several different software packages, predominantly LabView, Minitab and/or Weka. If a student has any special statistical package program to be selected for an on-going research, he or she may use the software instead of Minitab.

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Class</th>
<th>Project</th>
<th>Assignment</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>Introduction, signal / data type and individual features</td>
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<td>#1</td>
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<tr>
<td>2</td>
<td></td>
<td>Principle of sensory devices in building systems</td>
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<td>3</td>
<td></td>
<td>Data cleaning and data filtration</td>
<td>Project (I) announcement</td>
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<tr>
<td>4</td>
<td></td>
<td>Data acquisition board design</td>
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<tr>
<td>5</td>
<td></td>
<td>Data acquisition interface design</td>
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<td>#2</td>
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<tr>
<td>6</td>
<td></td>
<td>Statistical analysis (I)</td>
<td></td>
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<tr>
<td>7</td>
<td></td>
<td>Statistical analysis (II)</td>
<td></td>
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<tr>
<td>8</td>
<td></td>
<td>Mid-term: Presentation</td>
<td>Project (I) presentation</td>
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<tr>
<td>9</td>
<td></td>
<td>Data mining (I)</td>
<td>Project (II) announcement</td>
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<tr>
<td>10</td>
<td></td>
<td>Data mining (II)</td>
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<td>#3</td>
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<tr>
<td>11</td>
<td></td>
<td>Data mining (III)</td>
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<tr>
<td>12</td>
<td></td>
<td>Building system controls</td>
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<td>#4</td>
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<tr>
<td>13</td>
<td></td>
<td>Building system controls</td>
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<tr>
<td>14</td>
<td></td>
<td>Thanks Giving Break</td>
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<tr>
<td>15</td>
<td></td>
<td>Validation / system test</td>
<td></td>
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<tr>
<td>16</td>
<td></td>
<td>Final: Presentation</td>
<td>Project (II) presentation</td>
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Statement for Students with Disabilities
Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP:
http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity
USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one’s own academic work from misuse by others as well as to avoid using another’s work as one’s own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/. Information on intellectual property at USC is available at: http://usc.edu/academe/acsen/issues/ipr/index.html.

Emergency Preparedness/Course Continuity in a Crisis
In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.