ASEN 6091 / ECEN 5014
Global Navigation Satellite System (GNSS) Receiver Architectures

Fall Semester 2017
Classroom: ECCR 139
Meeting times: Tues & Thurs: 9:30-10:45

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Office Hours: TBD (and by appointment); Location: DLC209

Course Overview

GNSS is a generic term describing the expanding field of satellite-based navigation/timing systems. The most prevalent of these systems currently is GPS which is owned and operated by the US. However, Russia maintains a system known as GLONASS. Both the European Union and China are developing their own GNSS system designated Galileo and Beidou (Compass), respectively. Lastly, there are a number of regional GNSS augmentation systems including but not limited to: WAAS (US), QZSS (Japan), EGNOS (EU), India (GAGAN) each of which provides GNSS corrections and, in some cases, ranging information.

There are a multitude of GPS receivers on the market today. Often times these receivers are embedded for monitoring and control and often, unfortunately, treated as a "black box". This course goes into the inner workings of a GPS receiver and also discusses features common to all GNSS receivers. The course will cover the analog radio frequency conditioning from the antenna to the analog-to-digital converter, then focus on the various signal processing algorithms used in GNSS receiver (acquisition, code tracking, carrier tracking, and navigation data decoding), as well as present the position/time solution. Such treatment of the operation of the receiver will provide insight into the trade-offs that go into GNSS receiver design.

The GNSS receiver is a specialized Code Division Multiple Access (CDMA) spread spectrum receiver. Thus those interested in CDMA technology will benefit from a "hands on" perspective and gain insight into the specifics of CDMA receivers designed for navigation and timing functionality.

Students interested in the course will be required to have a solid background in using Matlab. Some knowledge in signal processing, particular time/frequency domain transforms, and control theory would be helpful. Lastly, background on GPS or GNSS in general (such as ASEN 5090) is expected, but not required, and will definitely aid in the overall understanding of the technology.

Course Format

The course will follow a blend of traditional lectures with external independent lab/computing assignments. The traditional lectures will provide the basics of low level GPS signal processing building on the internal operation of a GNSS receiver. Comprehensive assignments on the implementation of this receiver processing in Matlab will be given to the students. There will be a midterm which will be a take home 24 hour exam. And then a final course project which will result in a presentation and report on the day of the final exam.

Textbook (suggested)

A Software-Defined GPS and Galileo Receiver: A Single-Frequency Approach; K. Borre, D. Akos, N. Bertelsen, P. Rinder, S. H. Jensen; 2007; ISBN-10: 978-0-8176-4390-4

Reference Material

1) Course Notes (lecture notes will be provided via email)
2) Understanding GPS : Principles and Applications; E.D. Kaplan (Editor); 2nd ed; 2005; ISBN13: 978-1580538947
3) Global Positioning System: Signals, Measurements and Performance, P. Enge, P. Misra, 2nd ed; 2010, ISBN-13: 978-0970954428
4) ICDs for GPS - http://www.gps.gov/technical/icwg/ (Also can gather ICDs for other GNSS)
5) Global Positioning System: Theory & Applications; B. W. Parkinson (Editor), J. J. Spilker (Editor); Vol 1&2; 1996; ISBN13: 978-1563471063 & 978-1563471070
6) Fundamentals of Global Positioning System Receivers: A Software Approach; James Bao-Yen Tsui; 2000; ISBN13: 978-0471381549
7) Spread Spectrum Systems with Commercial Applications, R. C. Dixon, 3rd ed; 1994, ISBN13: 978-0471593423
8) Phase-Locked Loops : Design, Simulation, and Applications; R. Best; 6th ed; 2007; ISBN13: 978-0071493758

Course Schedule

Week(s)	1	Course Introduction & GPS Software Receiver Overview (Assignment 1)
Week(s)	2	Front End Design/Data Collection
Week(s)	3 & 4	GNSS Signal Acquisition (Assignment 2 & 3)
Week(s)	5 & 6	GNSS Signal Tracking (Assignment 4 & 5)
Week(s)	7	Navigation Data Decoding (Assignment 6)
Week(s)	8	Position Solution (Assignment 7)
Week(s)	9	Differential Position Solution (Assignment 8)
Week(s)	10	Midterm & Project Proposal
Week(s)	11-15	Project Work

Final Exam/Presentation Sunday 13-December-2015; 19:30-22:00 (based on final exam schedule)

Course /Grades/Evaluation

50% - Assignments
25% - Midterm (typically take-home 24 hour exam)
25% - Final (Course Project Presentation/Report)

Notes

1) Comprehensive assignments will be assigned approximately once per week at the beginning of the term, expected to be worked individually
2) Each assignment will be based on a 100 point scale
3) A midterm should be expected during the tenth week of the semester, typically format is an individual "take-home" 24 hour exam
4) A final project, based on the material from two thirds (approximate) of the course will replace a final exam.

Material is preliminary and subject to change

Special Accommodations

If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Medical Conditions: Injuries, Surgeries, and Illnesses guidelines under Quick Links at Disability Services website and discuss your needs with your professor.

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http://www.colorado.edu/policies/classbehavior.html and at
http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

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