

CS8803-MCI: Special Topics in Mobile Computing and IoT

Course Information

Course Prefix and Number: CS 8803-MCI

Course Name: Special Topics in Mobile Computing and IoT

Instructor: Ashutosh Dhekne

General Course Information

Description

This course will teach a variety of ideas, concepts, techniques, and algorithms, that are all crucial to understanding and developing spatial context which includes localization and sensing for mobile and IoT systems. The course will begin from first principles and ramp-up to real-world systems and technologies. Keywords related to this course include wireless localization, RF sensing, GPS, drones, sensors, motion tracking, location privacy, etc.

Required Course Materials

No textbooks are required. Students might need to use a scientific calculator.

Pre-Requisites

This course uses a large breadth of knowledge. The following courses or their equivalent are highly recommended.

CS2200 – Systems and Networks

CS2110 – Computer Organization and Programming

CS3251 – Computer Networking I

CS3210 – Operating Systems

Course Learning Objectives

The overarching goal in this course is for students to understand how to derive spatial context for improved mobile computing and IoT systems and learn about the various real-world applications that spatial context enables. The course is developed in a manner so that students will gain understanding of the latest advances in localization and sensing in mobile

computing by reading research papers published in top venues, understand the foundational concepts through assignments and homework questions, and gain practical knowledge through group projects. In this course, students will:

1. Learn about GPS from a theoretical perspective, map out GPS coordinates to a map, and appreciate the variations observed by a GPS receiver. Students will articulate ways to improve user-perceived GPS accuracy, and argue about external factors that can affect accuracy. Students will learn about how GPS provides important spatial context and the limitations of GPS.
2. Learn about spatial context in indoor settings, through techniques including received signal strength fingerprinting, time-of-flight based ranging, passive listening based time difference of arrival techniques, and angle of arrival techniques. Students will compare different wireless technologies including Wi-Fi, Bluetooth, and UWB for spatial context. Students will develop solvers for these localization techniques and appreciate the tradeoffs between the different approaches.
3. Review the use of inertial sensors in determining the orientation of the mobile phone or an IoT device to provide intrinsic spatial context. Develop rotational matrix-based methods for using accelerometer and magnetometer to obtain the roll, pitch, and yaw of stationary objects. Learn about the integration of gyroscope for smoother orientation estimates. Develop an intuition for sensor fusion approaches including traditional inertial sensors and ultra-wideband distance measurement sensors.
4. Discover how RF signals are generated from mathematical basics, combining concepts like Fourier transforms and matrices. Apply these concepts in the context of wireless signals to study reflection profiles and the effect of moving reflectors on the signal's profile, as a foundation for RF sensing. Students will gain insights into how study of wireless signal propagation provides information about the environment that cannot be seen by the human eye.
5. Students will learn how localization and sensing ideas from mobile computing can be applied to the larger IoT ecosystem providing spatial context. Students will gain understanding of how localization and sensing touches the lives of different people across the globe. Students will also develop an understanding of the sustainability ecosystem that these spatial contexts enable across the globe.

Course Educational Outcomes

At the conclusion of this class, students will have obtained a broad understanding of how mobile phones and IoT systems can obtain spatial context and how it enables a vast set of novel applications. Students will appreciate how spatial context through localization and sensing holds the promise for improving the human condition today and in the future. The

course will have provided the students with the tools required to make an impact in this ecosystem with foundational understanding and practical experience.

Absence Policy (Late Work)

Late assignments will be accepted (up to 2 late days) with compensation from days available for another assignment. So, if you are late in one assignment, you will be borrowing time from a future assignment and must submit the next assignment early. The last assignment cannot be submitted late, unless a previous assignment was submitted before time. There will be no make-up work provided for missed assignments. Of course, emergencies (illness, family emergencies, etc.) can occur. In those instances, discuss with me and contact the Dean of Students office. The Dean of Students is equipped to verify emergencies and pass confirmation on to all your classes, while preserving your privacy. These cases will be approved for late work without penalty on a case-by-case basis.

Attendance Policy

Attendance is highly recommended but not explicitly required. The classes include demos with state of the art sensors, physical devices shown during class that you can touch and feel and experience. Therefore, the in-person experience highly valuable. However, we acknowledge that our students have complex lives outside of the classroom, which sometimes create circumstances that make it difficult to attend lectures in-person.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. All students enrolled at Georgia Tech, and all its campuses, are to perform their academic work according to standards set by faculty members, departments, schools and colleges of the university; and cheating and plagiarism constitute fraudulent misrepresentation for which no credit can be given and for which appropriate sanctions are warranted and will be applied. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>. Also, please review [Appendix A: Graduate Addendum to the Academic Honor Code](#).

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Core IMPACTS

Not applicable.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me to inform me of your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Campus Resources for Students

Georgia Tech has excellent resources that students can use for being successful in this course. Here is a list of resources you might find useful:

1. My lab: KACB 3124. You will have access to my lab for a full motion capture studio, several electronic parts, and simple electronic assembly. You may also borrow mobile phones, robots etc. from my lab to be used for projects.
2. Georgia Tech library: offers free access to research papers. Both ACM and IEEE accept institutional login using your gatech.edu credentials. Papers submitted to ACM conferences will be open access from now on and since Georgia Tech is a part of the ACM Open, you will not have to pay any article processing fees if you submit your work to ACM conferences.
3. [The Hive](#): This course may include use of electronic hardware. All such resources are typically available in my lab. But if you need access to soldering iron, oscilloscopes, multimeters etc. you may access the Hive which is student managed and provides an excellent resource for your electronic needs.
4. 3D printing: Several places on campus offer 3D printing services to students. Visit the Hive or the [Invention Studio](#) can be used for this purpose.
5. If you need loaner laptops, the library offers them for short term loan. The same is also true for a limited number of VR headsets.

Student Well-Being

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. A [comprehensive list](#) of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being ([student-resource-guide \(gatech.edu\)](#)).

Collaboration, Group Work, and Use of Generative AI

Paper reading and assignments are to be done individually. Use of generative AI is permitted as specified in individual assignments. I have developed a detailed guidance which defines five levels of AI use and when solving questions from the individual assignments, students must pay attention to the expected level of use for those questions.

Project is to be done in a group of 3 or 4 students. The expectation is that every member of the group puts in approximately the same amount of time and effort. Final presentation is to be given by all members of the group. The instructor and the TAs for the class can ask oral questions about specific aspects of the project to individual students.

Course Grading Policy

This course is graded on a letter grade. Audit is not permitted.

Weightage

Paper Reading – 20% (small quiz before class on the day’s reading, 10 graded paper quizzes total)

Assignments – 30% (Six in-depth assignments, will need some coding and answering some questions)

Project – 50% (Semester-long project with periodic check-ins)

Grading Scale

A final letter grade will be assigned based on the following

90%-100%	A
80%-89%	B
70%-79%	C
60%-69%	D
59% and below	F