Introduction to Graphical Application Development

CRSN-151C

The Graphical Application Development module of CRSN-151C will introduce you to the basics of various technologies, such as the UNIX CLI, Git, Qt, and OpenCV to work on robotics-related projects, with the end goal of being able to have the confidence to integrate these tools both within your own projects and group projects. Throughout the course, you will learn several important and useful programming skills, such as command-line usage, version control, embedded programming, GUI programming, and basic usage of OpenCV.

Meeting Information

Tuesdays and Thursdays @ 11:40 - 1:15 pm:
Meeting ID:
Passcode: *crashcourse*

Lab Instructors Contact Info

Andrew Gavgavian
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Office Hours and Communication

Office hours will be by appointment in Canvas. These appointments are at a first come first serve period and allow us to have longer conversations rather than just open office hours. In addition, on Thursdays there may be periodic drop in office hours that will occur during the regularly scheduled class time utilizing a waiting room.

In addition to Office hours and class time, Slack will be utilized as a class discussion board to get help from other students with implementation ideas and any other topics. The channel in question is: **#151c-gad**

Learning Objectives

- Become comfortable with contributing to software as a group for future classes and industry.

- Qt + GUI development basics necessary to construct high level GUI based applications.
- Qt Networking functionality necessary for communication design.
- Basic OpenCV/computer vision development.
- Learn how to integrate OpenCV into Qt and utilize both frameworks together.
- Understand and utilize C++ features that assist within graphical development.

Prerequisites

- Working knowledge of at least one object-oriented programming language
- Knowledge of C **and** C++ <u>strongly recommended</u>
    - These programming languages will be used but not covered directly
    - It is OK to enroll if you do not know these, but expect to spend significant time self-learning the languages + asking for help in Slack to succeed in the course.

Materials

All students participating in the Graphical Applications Development section of CRSN 151C must have access to the following pieces of equipment. **Note: a microphone and/or webcam are highly recommended but not required.**

- A computer meeting the following requirements:
    - BSOE Laptop Requirements
        - 8GB RAM Minimum (16GB recommended)
        - 250GB Hard Disk or SSD
        - 2Ghz or greater, dual core or greater x86-64 processor
    - Able to run virtualization software
        - For Intel, VT-d is accessible and enabled in the BIOS
        - For AMD, AMD-V is accessible and enabled in the BIOS
    - Administrator access
- An Engineering Notebook where all notes, pseudo code, diagrams, and thoughts will go.

*Note: Please ensure your hardware is running an x86-64 processor. ARM devices, such as Macs with Apple Silicon, Raspberry Pi, or Pine64 devices will not be able to run the provided virtual machine software. **If you are unable to match these requirements, the computer lab on campus will provide the necessary equipment (Please see one of the course instructors for help in setting this up).***

Course Software

This section of CRSN-151C will use the following pieces of software. All of the software will be provided by the Instructors, except for Zoom and Canvas which are provided by UCSC. A

virtual machine (VM) will be provided to you which contains most of the necessary development tools used in the course. All software for the course is available free of charge.

- **VMWare:** Virtual machine software used to run a copy of Ubuntu, with all the necessary software and build toolchains included
    - **Ubuntu 20.04 LTS (incl. In VM):** A distribution of GNU/Linux which will be run within the provided virtual machine.
    - **Qt Creator (incl. In VM):** IDE (integrated development environment) used to develop Qt applications
    - **OpenCV (incl. In VM):** A library used to develop computer vision applications
- **Zoom:** Video conferencing software used to host online lectures and office hours
- **Canvas:** Academic organization app used by the entire UC system
- **Slack:** Communication and collaboration application used by CRSN-151C

Class Structure and Zoom

Due to the nature of this course, the Graphical Applications Development section of CRSN-151C will be taught remotely to allow for reaching a wider audience. Zoom sessions are held every Tuesday from 11:40 am to 1:15 pm. Each session will be used to cover new topics relating to the programming topics listed below. If any time remains for each lecture, the remainder of the class will be used to answer questions about class material or about projects/prelabs. Thursday sessions will be used as office hours, to enable further questions to be asked. Attendance at the zoom meetings is extremely useful and highly recommended, but not mandatory. All lectures will be recorded and provided via Canvas.

The course will be broken into several components:

Projects

Projects will make up the vast majority of your grade, and comprises several long tutorial-style projects where you will learn about concepts along with programming-along to a baseline project, before then tackling additional tasks on your own. The goal of the projects is to give you a thorough understanding of the course material, and help you to learn how to implement these systems on your own.

Notebook

During the course, you will maintain an industry style Engineering Notebook with the intention of recording your notes from lectures, as well as writing out your thought process while designing and implementing each of your projects. For software, your documentation will consist of pseudocode, flow charts, and any other thoughts that help you construct your programs. The Engineering Notebook helps you to keep your thoughts organized and demonstrate your learning in the course.

The Notebook will be submitted in conjunction with project submissions.

Specifics about the Engineering Notebook will be covered during the class. A detailed rubric and description of how to format your engineering notebook can be found in Canvas.

Prelab Quizzes

Several small prelab assignments will be offered during the course. Some prelabs will be simple quizzes designed to ensure you understand some basic concepts before each new unit is covered in class. Others will be short assignments such as setting up the Virtual Machine, to ensure that your project timeline is efficient.

Each prelab will be offered before an upcoming unit, and will be available from when they are released to the day before the next lecture. There are infinite attempts on each quiz but late quizzes are not accepted.

Grading

The grade breakdown for the course is as follows:

- Projects and notebook checks - 70%
- Quizzes/Prelabs- 30%

Within some projects there may be opportunities for additional work to count towards bonus points.

Late Policy:
Due to the fact that projects build off of one another throughout the quarter, it is important that all students **submit their projects on time**. This allows you to gain the ability to improve towards the next assignment based on timely feedback. Time management is important, and the due dates of each assignment have been specifically crafted such that you have time to work on each and improve without needing to cram.

Nevertheless, situations may arise throughout the quarter outside of your control, if such events do occur, please contact one of the two instructors **before** the due date of the assignment so your individual situation will be considered and submissions adjusted accordingly.

The prelabs and quizzes will not be accepted late and are due before the start of class of that specific module.

Schedule

- **Week 0:**
  - **September 23 (General introduction to all 151c sections)**
- **Week 1 (September 26th - October 2nd)**
  - September 28th (Introduction to GAD section of 151c, review syllabus and notebook requirements)
  - September 30th: UNIX shell basics + Git VCS lecture
  - *Module 0 Prelab assigned, due October 7th @ 3:20 pm*
- **Week 2: Notebooks and VM Setup (October 3rd - 9th)**
  - Notebook standards for software design
  - VM usage basics and an introduction to tooling, Linux basics
  - *Project 0 introduced, due one week after*
- **Week 3 - 4: Qt Intro(October 10th - October 23rd)**
  - Week 3 **(October 10th - October 16th)**
    - Qt basics slides
    - *Module 1 Prelab (VM Setup) due before class Tuesday, October 12th.*
    - **Project 0 due Sunday October 17th @ 11:59 PM**
    - *Project 1 released, due in 2 weeks.*
  - Week 4 **(October 17th - October 23rd)**
    - Introduce Project 1 with examples and demonstrate working versions.
    - Qt Widget Design
- **Week 5 - 7: Networking & Qt Networking (October 24th - November 13th)**
  - Week 5 **(October 24th - October 30th)**
    - Networking Slides + Case Study of *BIG SLAB* Networking
    - *Module 2 Prelabs + Quiz (Networking Terms and Topics) due before class Tuesday, October 26th.*
    - *Project 2 Released and given 3 weeks*
    - **Project 1 Due Sunday October 30th @ 11:59 PM**
  - Week 6 **(October 31st - November 6th)**
    - Project 2 Introduction
    - Qt networking with UDP
    - Qt networking with TDP
  - Week 7 **(November 7th - 13th)**
    - Project 2 Discussion
    - Approaching designing with UDP/broadcast
- **Week 8-9: OpenCV Introduction (November 14th - November 27th)**
  - Week 8 **(November 14th - 20th)**
    - Introduce basic concepts, programming and mathematical (simple), of utilizing OpenCV
    - **Project 2 Due Sunday November 21st @ 11:59 PM**
    - *Project 3 Released and due during finals week*
  - Week 9 **(November 21st - November 27th)**

- ■ Project 3 Introduction
- ■ Discuss how Qt and OpenCV work together and multithreading
- **Week 10: OpenCV Conclusion + All Questions Answered (November 28th - December 3rd)**
  - **Project 3 Due at End of Finals Window (December 8th, 7:30 - 10:30 p.m.)**
  - **All work due End of Finals Window (December 8th, 7:30 - 10:30 p.m.)**

DRC Accommodations:

The Disability Resources Center reduces barriers to inclusion and full participation for students with disabilities by providing support to individually determine reasonable academic accommodations. If you have questions or concerns about exam accommodations or any other disability-related matter, please contact the DRC office, located in Hahn 125 or at 831-459-2089 or   drc@ucsc.edu

Academic Dishonesty:

Academic integrity is the cornerstone of a university education. Academic dishonesty diminishes the university as an institution and all members of the university community. It tarnishes the value of a UCSC degree. All members of the UCSC community have an explicit responsibility to foster an environment of trust, honesty, fairness, respect, and responsibility. All members of the university community are expected to present as their original work only that which is truly their own. All members of the community are expected to report observed instances of cheating, plagiarism, and other forms of academic dishonesty in order to ensure that the integrity of scholarship is valued and preserved at UCSC. In the event a student is found in violation of the UCSC Academic Integrity policy, he or she may face both academic sanctions imposed by the instructor of record and disciplinary sanctions imposed either by the provost of his or her college or the Academic Tribunal convened to hear the case. Violations of the Academic Integrity policy can result in dismissal from the university and a permanent notation on a student's transcript. For the full policy and disciplinary procedures on academic dishonesty, students and instructors should refer to the Academic Integrity page at the Division of Undergraduate Education.

Title IX:

The university cherishes the free and open exchange of ideas and enlargement of knowledge. To maintain this freedom and openness requires objectivity, mutual trust, and confidence; it requires the absence of coercion, intimidation, or exploitation. The principal responsibility for maintaining these conditions must rest upon those members of the university community who exercise most authority and leadership: faculty, managers, and supervisors. The university has therefore instituted a number of measures designed to protect its community from sex discrimination, sexual harassment, sexual violence, and other related prohibited conduct. Information about the Title IX Office, the online reporting link, applicable campus resources, reporting responsibilities, the UC Policy on Sexual Violence and Sexual Harassment and the UC Santa Cruz Procedures for Reporting and Responding to Reports of Sexual Violence and Sexual Harassment can be found at https://titleix.ucsc.edu/. The Title IX/Sexual Harassment Office is

located at 105 Kerr Hall. In addition to the online reporting option, you can contact the Title IX Office by calling 831-459-2462.