CS370 Operating Systems

Fall 2024 Term Project   v. 09.21.2024 9am

You have two options.

A. **Research**: You will research a topic of current interest and at the end prepare a term Project Report. You will also produce a presentation for the benefit of fellow students. The presentation will take the form slides and a presentation. The objective of this project is for you to explore the state of the art relating to some of the topics in the class. (see pages 2-4 for details)

B. **Development**: Design and implement a new embedded/IoT application using a single-board computer (like a Raspberry Pi or an alternative), which implements the required features. You must formulate, design, implement and evaluate the system yourself. Your report should provide a good documentation. (see pages 5-6 for details)

Deadlines: The due dates for both options for the deliverables D1 to D5 are given below. They are subject to revision based on logistics.

Deliverable	Date	Points
D1 Team composition and idea proposal	9/24/24 Tu	5%
D2 Progress report	10/31/24 Th	15%
D3 Slides and final reports	11/20/24 W	75%*
D4 Presentations/Posters/Demos	12/2 – 12/5 M-Th	*
D5: Peer Reviews	12/7/2024 Sat	5%

This assignment would be worth 10 points towards your final grade. D3 and D4 combined are worth 75%. This includes your participation in viewing the work of other fellow students and participation in the related events.

Forming the groups: You can take the lead and try to form a group (by advertising it on Teams), or join a group others are trying to form. A group will have 2 or 3 students (4 with permission). You can claim a topic as your own by mentioning it on Teams with the topic clearly identified in the post title (for example "Research Topic 3: Simultaneous multithreading scheduling and performance"). All members of a group must join a formal Canvas group, the progress report and the final report will be group submissions on canvas.

All submissions will be using Canvas, with the exception of the slides that will be shared on Teams. The final report for both options will be in two-column format used by IEEE/ACM.

Citations: Citations (1) relate to work that has been published elsewhere, (2) substantiate your claims, and (3) could be used by readers to dig a little deeper. Remember to number your references and list them in your bibliography in the order they are referenced throughout the paper. If an article is in your bibliography, it must be cited in the main text. Citing at the right location indicates what your source is for a particular piece of information and demonstrates that you have read the article. Make sure that you cite all your references including Wikipedia and Online lecture notes that you may have perused. References that are not cited should not be in your bibliography.

Option A Research: Detailed information

The research term paper will be based on a comprehensive study of a particular topic related to the current state of technology and recent trends. You are required to formulate your own views of the topic once you have understood the concept well. You will also mention how you expect things to evolve in the future.

List of recommended topics: You may choose from the list below. If you want, you may choose slightly different topics after consulting with the instructor.

Multicore Processors:

1. Multicore schedulers
2. Resource management. How to utilize and manage computational resources in multicore systems.
3. Virtualization in multicore systems.

Virtualization:

4. Container Security
5. Security issues in hypervisors (technical details are required).
6. Live migration of Virtual Machines
7. Virtualization schedulers comparison (e.g., Xen SEDF, Credit, BVT)

Multithreading:

8. Simultaneous multithreading: evolution/current status/future
9. Multithreading vs Multicore: systematic detailed examination
10. Testing multi-threaded code

Cloud as a system element: (Note: Do not do a survey of cloud computing.)

11. Serverless architecture
12. Microservices - development and verification
13. Containers/clusters/edge/fog computing: in-depth technical discussion of the current status and recent advances in one or more.
14. Cloud gaming performance evaluation (you must dig out have some concrete numbers and/or mathematical analysis. Focus cannot be on popularity of specific games.)
15. Evaluation of disaster recovery using virtualization

Embedded/real-time/IoT systems:

16. Testing approaches for embedded system software/hardware
17. IoT reliability evaluation
18. IoT security issues and possible mitigation
19. Recent advances in real-time operating systems

Other topics:

20. Blockchain/ Cryptocurrency-oriented operating systems (focus must be on OS related considerations)

21. Completely Fair Scheduler and its performance
22. Newer files systems: technical details of Ext4 and HDFS (you will need to go beyond what we will do in the class. Ask me for a preliminary set of slides).
23. Emerging storage technologies and associated file systems
24. Mobile phone operating systems: technical developments
25. Special topics (as discussed with the instructor, see HotOS for possible ideas)

D1: Detailed Abstract:

The first deliverable of the term paper is a detailed abstract, around 500-1000 words. It should include a brief description of the topic and include a minimum of 5-7 total citations of appropriate papers or references.

It must have the following components:

1. Why is this particular topic important now? Why did you choose it?
2. Why will this be important in the future?
3. A history of how this aspect has evolved in the past. The driving forces behind this.
4. A quick snapshot of the current state of the art for this aspect.

Items (3) and (4) should cite at least 5-6 references.

D2: Progress report: It should report on the progress and what the final report is expected to contain. All the references used (at least 8-10) should be cited. Before submitting the Progress Report, you must join a Canvas group along with your group members. The Progress Report will be submitted as a group document. You must include enough material from the proposal to ensure that the Progress Report can be read without having to look at the proposal.

D3: Final Report:

The finished term paper should be approximately 4000 words and include a minimum of 10-15 total references supporting the paper. The final term paper must be coherent, succinct, and readable. It should include the following:

1. Abstract: Compact one-paragraph overview of the project.
2. An introduction that outlines the rationale, organization, and key contributions of the term paper.
3. A literature survey of the topics that contrasts different approaches to the problem.
4. Limitations in the current approaches that may not be suitable in the future, and potential improvements.
5. At least some non-text elements – figures, tables, mathematical analysis, algorithms etc.
6. A conclusion that includes assertions about the state of the art of the topic that you have surveyed. This will also include 4-5 key assertions about what you expect things to look like in the next 2-4 years.

Also note that a peer review of (a) people in your team and (b) some of projects of other groups will be required.

D4: Presentation: The presentation will take the form of a PowerPoint presentation and/or a video. Details will be provided later after we have the information needed for the logistics .

D5: Peer review of a specific number of presentations (and contributions of members of your team). Details and the form to be used will be provided later.

Option B Development: Detailed information

As part of this Term Project option, you will be developing and evaluating a system built using a single-board computer.

Requirements:

Project must involve a single board computer (such as a Raspberry Pi) with Wi-Fi capability which must have the capability of having an operating system installed on it. The board must be capable of running all the project requirements satisfactorily

The board will communicate with at least one other computer (another board, laptop or networked computer) and with at least one sensing device (sensor (temperature, pressure, location etc.), camera or a computation device supplying data). Optionally it can have an actuator to control mechanical movements. After you have built your system, will evaluate for at least two attributes (potential security holes, power consumption, available resolution, or reliability).

You can use this document from a previous semester as a guide for setting up your board. (It is Raspberry Pi specific. You need to locate similar information for other boards.)

D1. Team composition and idea proposal

You will specify the project objective, select the appropriate board, and specific hardware and software needed. Your proposal must include a one paragraph justification of the choices. A back-of-napkin drawing can be included. Identify from where the board will be ordered (Please ensure that you will receive it within a week or so), and how you will obtain the needed software and documentation, and the expected cost.

D2. Progress report

At this point you must have acquired and installed all the software and hardware needed and should have made some progress in developing the code needed. You need to include proof that you have acquired the board and any hardware needed. The report will describe the status of the project. You should also mention which attribute of your project you propose to evaluate. You must evaluate at least two of these, using quantitative information (that you have to dig out).

- Limitations like resolution, accuracy, or response time
- Potential security holes and how they can be mitigated
- Power consumption estimates/measurements of the device
- Cost and marketability of a device based on your project

You evaluation must be based on some hard data/analysis/experiments.

You must include enough material from the proposal to ensure that the Progress Report can be read without having to look at the proposal.

Before submitting the Progress Report, you must join a Canvas group along with your group members. The Progress Report will be submitted as a group document.

D3. Final report and demo:

You will demonstrate your project to a TA for about 10-15 minutes. You will need to make an appointment. You can use photos and videos if they will help. You will also need to demonstrate your project to fellow students in the class.

The final report that you will submit will be a complete documentation of your project. In addition, the code developed will also need to be submitted.

This report should be between 1500-2500 words excluding references. The report must include several elements, each of which will be a separate section. These include:

- Abstract: Compact one-paragraph overview of the project.
- Introduction
- Problem characterization- This is a technical description of the problem. Your audience is your peers so present it in a way that they can appreciate.
- Proposed solution and implementation strategy. Include i. Methodology and ii. a description of the libraries that you have used and what you did on your own.
- Conclusions
- Bibliography

D4. Summary report in form of slides

A set of slides will be needed to be shared with the rest of the class.

D5: Peer review of a specific number of presentations (and contributions of members of your team). Details and the form to be used will be provided later.

Updates: Any updates will be mentioned below.

9/21/2024: Please use Project Groups channel in Teams for forming groups.