Small Equipment Checkout System

PROJECT PLAN

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Revised Date : 10/26/2018
Version:2

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List of Definitions

- **C.R.U.D.:** An acronym for Create Read Update Delete. This acronym is typically used to describe software functionality.
- **ECpE:** Electrical and Computer Engineering department of Iowa State University
- **OWFS:** An acronym for 1-Wire Filesystem.
- **ISU:** An acronym for Iowa State University
- **1-Wire® Device:** 1-Wire is a device communications bus system that provides low-speed data, signaling, and power over a single conductor. It is designed by the Dallas Semiconductor Corp and trademarked by Maxim.

1 Introductory Material

1.1 Acknowledgement

This design team, sdmay19-13, would like to thank Iowa State University(ISU), and college of Electrical and Computer Engineering(ECpE) for providing the excellent opportunity for students to form teams and to work on the professional design process. Especially, we want to thank the Electronic Technology Group(ETG), and our client and advisor, Lee Harker, for all the guidance and technical support. We have also appreciated all the contribution from the team, sdmay18-01, who has worked on this project before. Their design shows us many possibilities for this project.

1.2 Problem Statement

Electrical and Computer Engineering are subjected to rely heavily on experimental experience, and students will utilize various components and equipment throughout their learning process. Currently, the most common way for students to check out equipment is to borrow directly from Electronic and Technology Group (ETG)'s part shop. However, this checkout procedure has its own limitations in working time and efficiency.

The current checkout system requires ETG faculty spending time in the part shop to process students' requirement, preparing demanding equipment, and recording manually. This is not just inefficient in time, but also a waste in human resource.

Overall, the final goal of this project is designing a feasible and reliable equipment checkout system that can solve the problems listed above by simplifying faculty's maintain process, and providing more availabilities for students.

1.3 Operating Environment

The accomplished design will be placed outside the ETG's part shop in Coover Hall. The whole system is supposed to work under room temperature for all times. The system can be divided into two parts, one is the shelf with boxes that used for storing equipment, the other one is a touchscreen for user's interface. The shelf is made of metal and will be fixed to the wall, so its stability is the most important concern and will be tested carefully. The touchscreen should have quick and accurate feedback to the user's operations. Since the system will be placed in the public environment, the locker in each box should be able to protect the box from steals and slight damages, and the hardware system should be able to detect any functional error of lockers, then the system can send notifications to administrators through the e-mail system.

1.4 Intended Users and Intended Uses

There are two kinds of intended users: students and administrators.

In order to have needed equipment in time, plenty of students have to schedule their experiences during weekdays, and this may cause the shortage in both laboratory space and equipment. But Small Equipment Checkout System will allow students to borrow equipment by all day and all hours. As the result, students will have more flexible studying time by using this system.

This system will only require administrators to do the maintenance at a very specific time, so administrators will be released from fixed daily office hour. Then, they can focus more on technical support for the ECpE department and improving our lab experience

1.5 Assumptions and Limitations

Assumptions:
All ECPE students and staffs can use the system.
Users will use a touch screen to interact with the system.
Users can swipe ISU card or type in ISU ID to use the system.
The number of boxes is not constant, it can extend as many as the number of boxes.
The system can be used all the time except it is in maintenance.
For each system, one box will be used to store the main control board.

Limitations:
The box should be larger than the size of PCB.
The cost to build a locker will be about $12.06.
ISU students and staffs who are in other departments cannot use the system.

1.6 Expected End Product and Other Deliverables

The Small Equipment Checkout System can be divided into software and hardware system. And the project delivery will include prototype and final product.

1. Prototype - end of the first semester
At the end of the first semester, we will have a prototype that software and hardware systems can work well separately.

- Hardware system
  We will design new PCBs to control lockers. The new design should have an appropriate size to be placed on the door for each box. And it should also be able to control the LED inside the box. The PCB will be powered by Raspberry Pi and need to pass the correct voltage for locker and 1-Wire chip. A sensor should be included in the box to check the door is closed after use, or the alarm will be activated. All PCBs in boxes are supposed to connect Raspberry Pi through one bus line.
- Software System
  The software includes website, database, One wire file system, and identification system. For the prototype, the website should be able to react with users' operation, and

the identification system can identify users by using the A-track system and card reader. The software system also should have a relatively well-developed database to save all the information of boxes

2. Final product - end of the second semester

At the end of the second semester, we should have a perfect and functional system for the ECpE student to use in a real operating environment.

- Integrated System
  For the final product, the software and hardware system should work together perfectly. The lockers and LEDs inside boxes are able to control by the software system. And the software system should have a function for sending notifications to administrators after receiving reports from users for any missing and damages of equipment, and any error of the system.
- Document
  The final delivery should include the detailed design documents. By following the documents the ETG should be able to maintain and connect more unit easily.

2 Proposed Approach and Statement of Work

2.1 Objective of the Task

Since the equipment checkout system E-Clerk, made by the previous team only has three lockers working and there are totally 35 lockers in the current equipment checkout system. The main goal of our project is making all 35 lockers have the appropriate equipment checkout system functionality.

2.2 Functional Requirements

1. Keep, optimize and make up the functionality implemented by the previous team, which are:
For students:

- Log in and out
- View available equipment
- Select an equipment item to checkout
- Determine checkout duration
- View currently checked out equipment (personal)
- Return equipment, close checkout record
- Report system misuse or broken items
- Receive email reminders

For Administrators:

- Log in and out
- C.R.U.D. available equipment
- Determine max checkout durations for items
- C.R.U.D. student users, records, and user privileges
- Receive email status reports
- Create, update, remove lockers
- Add new Administrators

2. Design a new smaller chip to fit into the shelf of the checkout system.
3. Enable all lockers in the current checkout system work.

2.3 Constraints Considerations

Non-functional requirements of the project:

1.Maintainability:
Our product could be maintained by ETG for future usage. ETG will have documents and resources to access the whole system.
2.Security:
Since our product will be accessed by students and administrators during the non-business hour, implementing a powerful firewall for the whole system to prevent attackers is necessary.
3.Reliability:

Our product must have built backup functions that allow administrators to access locked lockers in case of it is in an error state.

Constraints:
The main constraint of our project is the limitation of choices of extended software and hardware. Because what we are working on is the prototype finished by the previous team. If we want to implement more functionalities, we have to choose the software and hardware can work together with software and hardware chosen by the previous team.

Standards:
Since we are inheriting the main implementation of the previous team, the standards we are planning to use is quite the same as their work. We are using the standards pre-built into the servers such as HTTP with Node.js server and MySQL connected with Sequelize.
What's more, our project implementation will be conforming to the 1-Wire® protocols for 1-Wire® devices and to the OWFS (1-Wire Filesystem) standards.

2.4 Previous Work And Literature

The small equipment checkout system that we are working on has a finished prototype with the previous team. What they have already finished is three lockers of the whole checkout system is working right now. They have implemented the checkout process from students' end and editing process from administrators end as well.

The advantages of their project are:
1. Implement the website with the latest website implementation skill.
2. Use powerfully embedded system 1-Wire® Device to control the lockers with requests of users.
3. Use Shibboleth to connect computer network and the internet, which is an efficient tool for users to access the whole system.

The shortcomings of their project are:
1. Does not include a smaller enough chips to fit into the shelf of the checkout system.
2. Current electronic wire design cannot control all lockers of the whole system.
3. Does not include the checking the equipment process during returning the electronic components.
4. Does not implement any secure portion to prevent the checkout system being attacked by hackers, like a firewall.

2.5 Proposed Design

The picture below is our proposed design for the whole project. Based on that, we will design new PCB and wiring plan to control the communication between lockers and 1 wire connection. What's more, we will design a new desktop app for the system to be available to users interacted with and a firewall to prevent our checkout system from attacking by hackers.

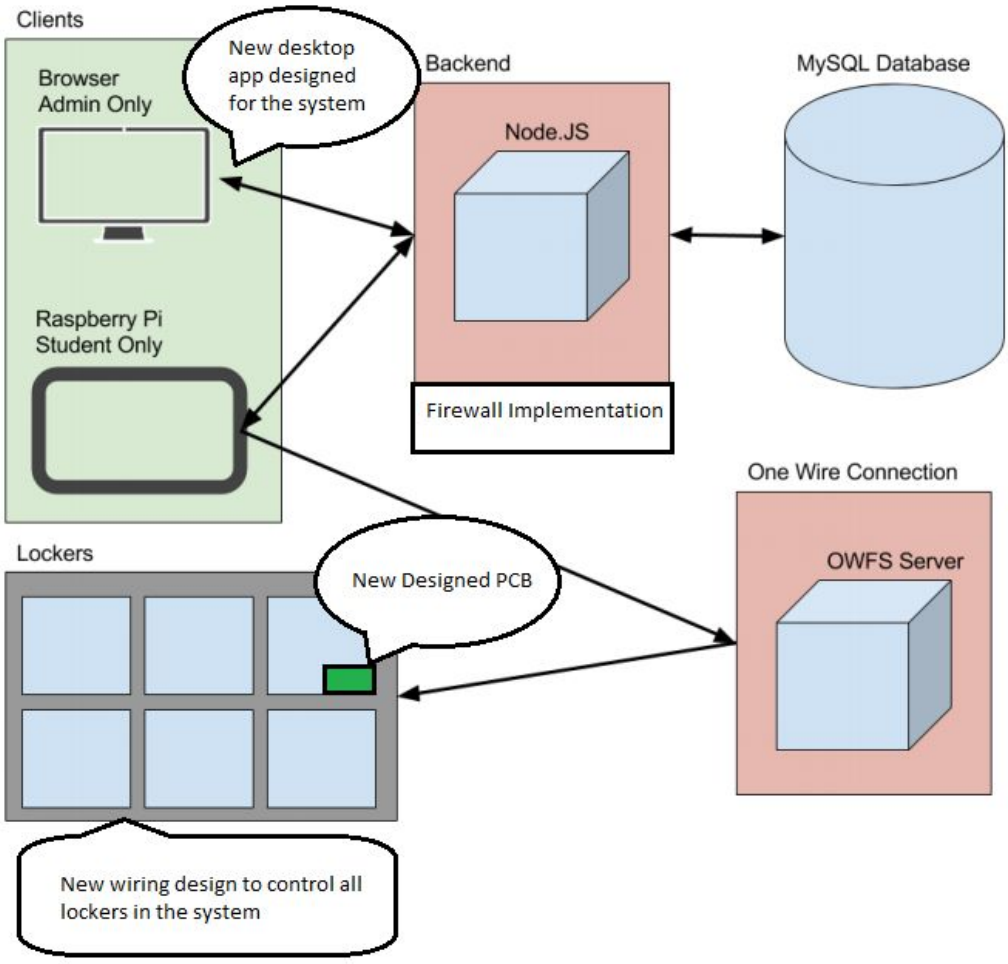

Figure 1: Proposed system design

2.6 Technology Considerations

The main technology consideration of our project is the size of the new designed microchips. Because based on what Mr. Harker talked about in the team meeting, he wants us to create one right fit into the shelf in the checkout system which can also interact with the 1-wire system as previous PCB board do.Therefore, the design of the whole PCB board and the materials of different electronic components we will use on that will be a large problem that we need to overcome.

What's more, for the desktop application we are planning to design, the interaction between the application and the raspberry pi is also a large topic that we need to figure out. For the firewall implementation, since our team is not familiar with the backend implementation of previous team, we need some time to learn about that to get a optimized firewall implementation plan.

2.7 Safety Considerations

There are two kinds of potential risks for this project. One is the security of personal information. We need to collect information from students who borrow equipment from us, which include name and email address. So, protecting those informations is an extremely important task that we need to work with. The other one is the possible physical damage. The shelf which used for stored electrical equipment is heavy and will be fixed on the wall, and it is possible to fall down if students pull it too hard. We will do many strengthening and test befort the product is put in work.

2.8 Task Approach

Since the project has developed by previous senior design team. The first thing we need to do is to analysis what exactly they have done and how to improve their design. The previous team used website for user's interface. We need to spend more time on analysis that, because no one in our team has experience with web developing. Another task is expanding the size of the controlled units. So, we need to be familiar with the 1-Wire system which client suggested to use. By using 1-wire system, we could achieve controlling multiple units by just using single bus line. Then we can build a modularized system, and easily connect more units to system.

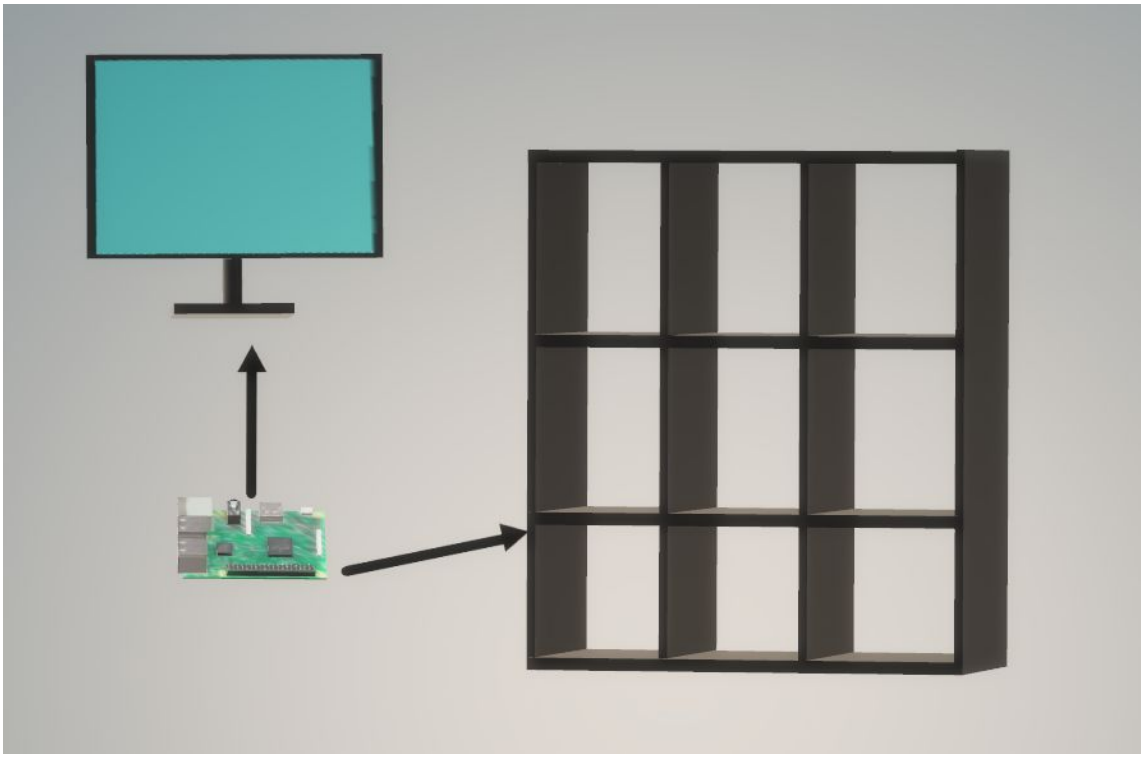

Figure 2: 3D view of system design

Also, previous team build two type of PCBs to control the system. But the size of them are not fitful for our project. We need to recreate or resize PCBs. Because we need to build plenty of PCBs in the locker, reducing the cost of each circuit will be another task for us.

2.9 Possible Risks And Risk Management

Both of our software group members are not familiar web design which includes Javascript, SQL, HTML Layout, PHP, etc. It's very complex, our members may meet unexpected difficulty during the learning.

In this project, we need to design and produce our own PCB board, if there are some bugs we don't find before production or we broke our PCB board, it will take a long time to make a new one.

2.10 Project Proposed Milestones and Evaluation Criteria

Prototype:

Our software will run on a local host, it will have basic functions like initialize the locker, checkout and return, there will be only 3 boxes.

Alpha Testing:

We will test if there any bugs during the checkout processing, if our software can send the signal to the correct box, and if the locker can open itself after receiving the signal.

Beta Testing:

We will ask our friends and classmates to try our system, they can help us find more bugs and give us advices to improve our system, like what more functions it should have.

Final Product:

Our software will run on a server, it has a user-friendly interface, and it can control multiple boxes. The locker will have a clean look with well managed cables and hidden PCB boards.

2.11 Project Tracking Procedures

We will write weekly report to keep tracking our process. Every team member will be assigned task with a deadline which follows our timeline for the project. When we stuck on one task and spend longer time than it should be, we will plan our follow tasks with less time to make sure we can finish our project on time.

2.12 Expected Results and Validation

The final purpose to build an autonomous check our system. The students are able to just swipe their ISU ID cards to get verified and then use monitor to check the item that they want to borrow whether is available or not. If the item is not what they expected, just push the report

button on the monitor and the administrator will get the message. If the item is ok, students can just directly borrow it. And the process for returning items is the same as the previous step.

2.13 Test Plan

- We will use voltmeter to test if the lockers, LEDs, and 1-wire chips have the correct voltage supply transmitted by PCBs.
- We will test if PCB have thermal threading in full load condition.

3 Project Timeline, Estimated Resources, and Challenges

3.1 Project Timeline

- Planning
- Researching
- Group planning
- Individual planning
- Ordering parts
- Testing
- Collecting feedback
- Improvement
- Testing
- Getting final version of project

First Semester

Our goal for the first semester of this project is to make sure the each parts working perfectly, including the computer check-in system which belongs to software section and the locker system which is belongs on hardware section. At the end of first semester, our two parts should be working separately. Bei Zhao and Caining Wang will be working on building the computer check-in system and Fengnan Yang, Jiaxin Li, and Yimin Wang will focus on the hardware section design job. If the group is able to achieve the milestone earlier than the plan, we need to aim to build the connection between the software section and hardware section.

Second Semester

As for the second semester, our group need to spend more time on how to making two system working together. We need to set a plenty of test for each part of out project to make sure they are able to achieve our expectation. And we will confirm that our whole system can work in desired operation environment. After passing the functional test, we need to spend one to two weeks to let the ECpE students using it, which can provide enough feedback to us and our group can improve our design project.

The gantt chart below is the project timeline of our team.

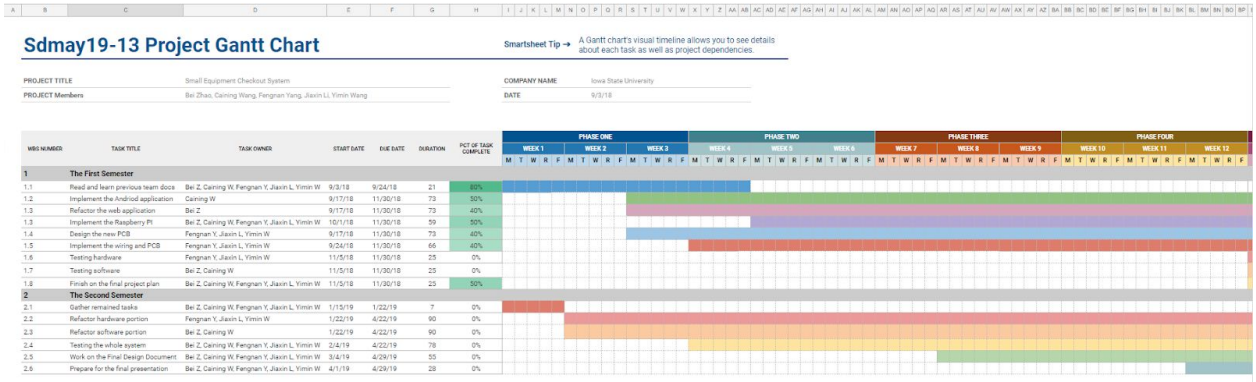

Figure 2: Gantt Chart of project timeline

3.2 Feasibility Assessment

The whole system should be reliable and efficient to support daily activities of ECpE students.

3.3 Personnel Effort Requirements

So far, we still researching and learning some basic operation system and electronic components. Once our group meeting have new information, we will renew this part as soon as possible.

3.4 Other Resource Requirements

It is very important to minimize the cost of whole system which is should no more than $500.

3.5 Financial Requirements

So far, our group still focus on basic design. After finish the design part, we need to spend some money to build our real system such as PCB. We will keeping renew this section.

4 Closure Materials

4.1 Conclusion

In conclusion, in the first place, we need to be familiar with the job which the previous design group had achieved as soon as possible. Second, our group need to come up many new ideas about building the project. Our design group will separate to two parts, hardware section and software section. Software group need to build a friendly computer operating system to get the requartment from the use and send the signal to the processor of the locker. Hardware group is focus on receive and process the signal which is send from the computer check-in system and make sure the locker can achieve the requartment of the user. If we meet the complex issues during the design the project, we can context our advisor, graduate students, or professors to support us to finish the project.

4.2 References

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4.3 Appendices