Project: Reprise of Locker Access System

(Project Plan)

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1. Problem Overview

1.1 Problem Statement

We are doing this project in order to solve problem regarding storage and lockers assignment in senior design lab in Coover 1301. Currently, the lockers are secured with standard combination padlocks. The disadvantage of using this type of lock is that the previous users may still know the combination number. Besides, some students might forget the combination number for their team's locker. Other than that, the padlock is not intuitive or not easy to use especially for first time users. There are no clear instructions on how to use the padlock in to open the lockers. Furthermore, administrators are not able to assign and update lockers easily and efficiently.

In order to solve these problems, we are creating a control system that allows locker access to authorized users by using their ISU card. The locker access system has to be easy to use while maintaining a basic amount of security. We are designing one user panel that communicates wirelessly with locker modules. The entire system will be comprised of two basic elements: a control box, and the locker module. Besides, this control system also allows administrators to access list updates and locker overrides. With this control system, it will be easier and safer for students to store their project and access their lockers.

1.2 Market Research

Penco Smart Locker

We are doing this project with no plans to market it to the public. The purpose is solely for the usage of the Ecpe Department in Iowa State University. Nowadays, there are some products or design that use similar concept of operation to our design. Figure 1 shows the smart locker sold by Penco. The basic operation of this smart locker is almost similar to our project in which users will use their card to open the respective locker. However, this locker does not have any keypad for manual entry. The big difference is that Penco Smart Locker does not use wireless communication unlike our project. The card module is attached to each locker. Administrators will be able to open the locker if users forgot or lost their card. Besides, administrators also have access to each locker by using password protected administration software.

Figure 1: Penco Smart Locker

2. System Overview

2.1 System Description

The entire system will be comprised of two basic elements: a control box and locker module. The control box will integrate a user interface with an LCD screen to show the status of the system, a card reader for scanning student ID cards and keypad for manual entry as well as for administrative functions. The control box will receive input from the user in two ways: swipe ID card or keypad entry. The LCD screen will then give options to the user to which function they would like to perform and then transmit a data signal to the corresponding locker to be opened.

Each locker has one locker module. The locker module will be mounted on the door of the locker. Each module will receive the data signal sent from the terminal but will only respond if it matches the module indicated by the signal. The module will then trigger an electromechanical device in order to open the lock of the locker. Furthermore, the locker module will be able to transmit data to the control box regarding its battery status.

For administrative functions, they can either swipe their ID card or use keypad entry. They will be able to open all lockers simultaneously and individually. There is an SD card inside the control box that will store the information about lockers holder. Administrators will update the information on it by using computer. If they wish to update lockers assignments in the middle of semester, they can use the keypad entry.

2.2 Concept sketch

Figure 2 shows the concept sketch of our design.

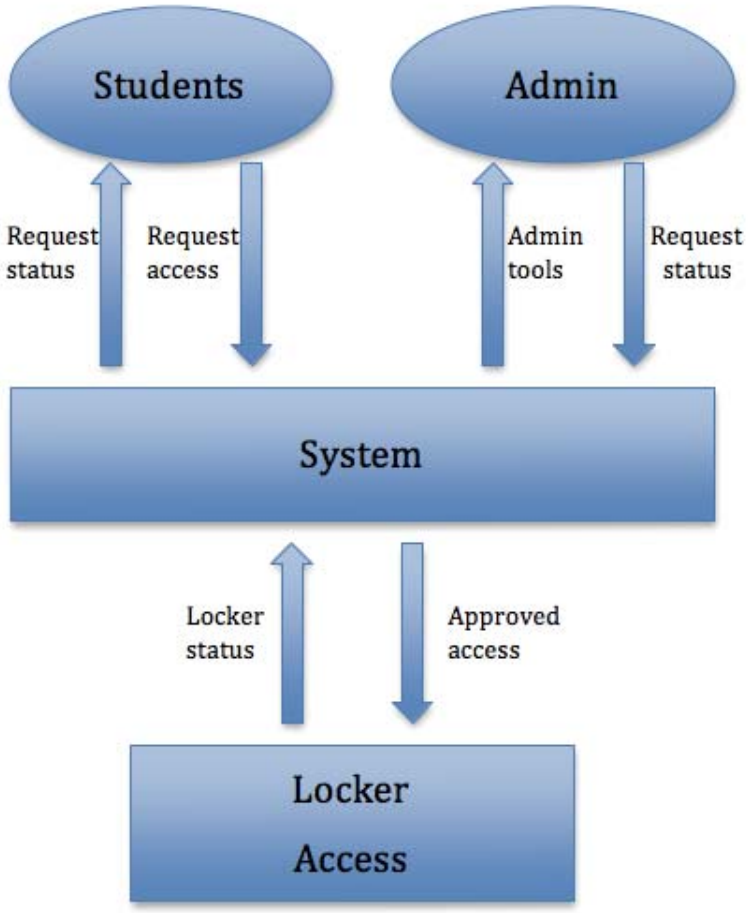


Figure 2: Concept Sketch

2.3 System block diagrams

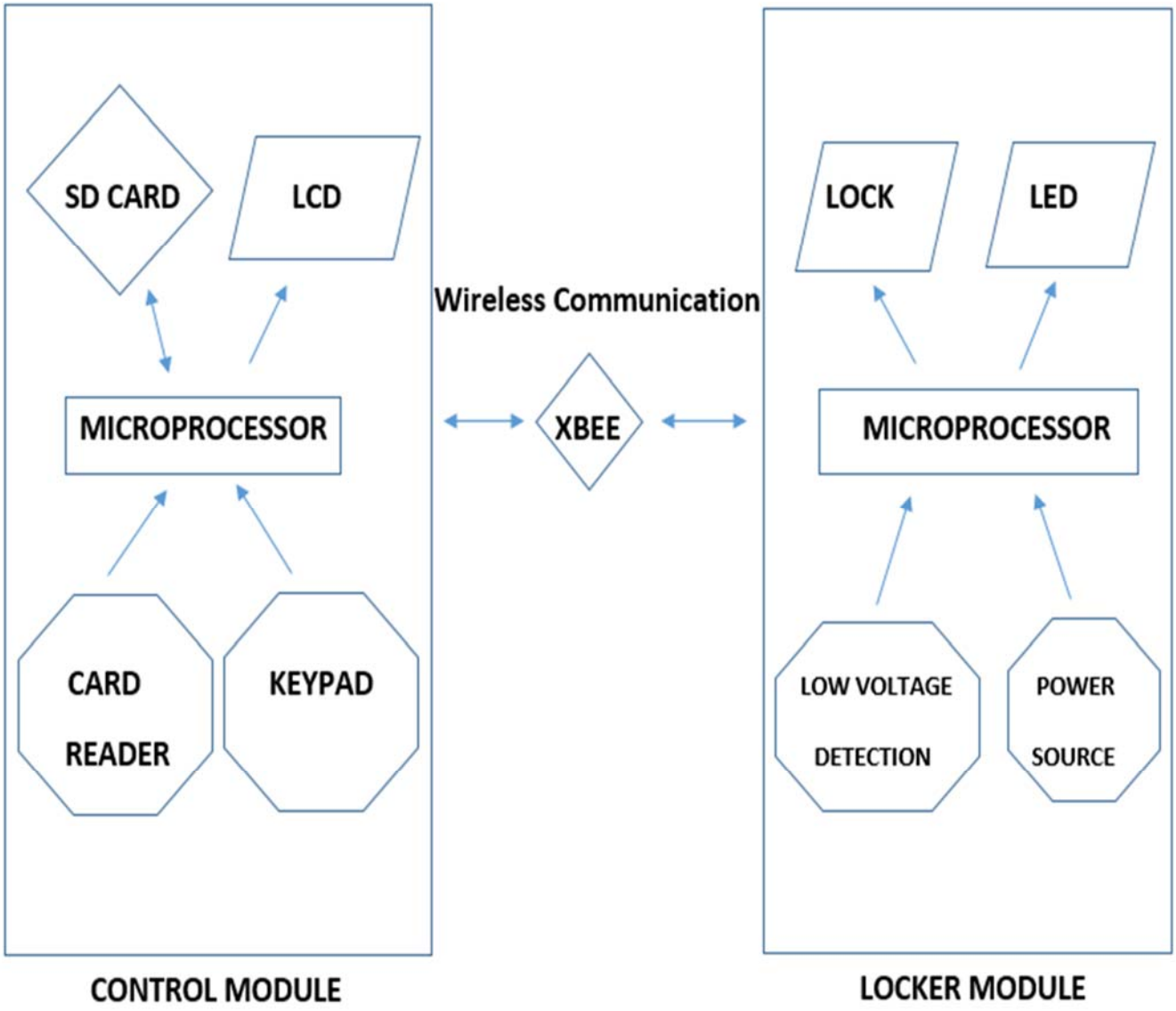


Figure 3: Block Diagram

2.4 Operating Environment

The control box and the locker module will be located inside the senior design room in Coover 1301. The temperature inside this room is approximately 69 to 74 degrees Fahrenheit. The dimension of the room is 44’ x 28’. It has a lot of things inside such as tables, desktop, chairs and so on. These can be the obstacle for the communication between the control box and locker module if they are situated far from each other.

2.5 User Interface

The user interface will operate in different situation for the two intended users which are students and administrative.

I. Students:

Students will have two ways to open their lockers. Firstly, they can swipe their ISU card and secondly, they can type in their ID number on the keypad. If they have their name registered as one of the locker holders, the corresponding locker will be opened. If they are not registered users, there will be no lockers opened and LCD will show error.

II. Administrators:

Administrators can perform multiple tasks with the control box. They can swipe their ISU card or type their ID number on the keypad. They will be able to use the keypad to open the lockers simultaneously or individually. Besides, they also can use the keypad to update information on SD card so that they do not have to take the SD card out so often. Lastly, they can pull the SD card out to update information most probably in the beginning and end of semester.

3. Requirements

3.1 Functional Requirements

- Students are able to access their locker by swiping their ISU card on the card reader or by typing their ID number on the keypad
- The user panel will have a display to show the status of the system
- The user panel allow administrative to access lockers
- Since taking out SD card too often can be a hassle, administrators must be able to use keypad to update information on SD card
- The SD Card must be able to read and store database of names and locker numbers so that administrators can easily update all information needed to make sure all students have access.
- The battery must have a lifetime of at least one semester.
- The display on the user panel must show low battery status for locker module at least at the 20% stage so that administrative can change the battery before it completely die
- The wireless data transmission need to have the ability to transmit from the control box to locker module in the system at the longest distance from the transmitter to receiver the room allows.
- Control box and locker modules interact in two way wireless communication

3.2 Non- functional Requirements

- Dimension-The locker module should be small so that it can fit perfectly and nicely inside the locker
- Color- The primary color of the box is not important currently.
- Weight-Both control box and locker module should be light so that they can be mounted easily on the locker. Plus, light weight will help the mounting to last longer
- Source of Parts-Parts should be available in the shop or if need to be ordered from different sources, they should be available in a short period of time

4. Deliverables:

We are expected to deliver the listed items below:

- To be submitted in December 2013

  -Project plan

-Design Document

- End of April 2014

-A control box

-expandable amount of locker module

5. Work Plan

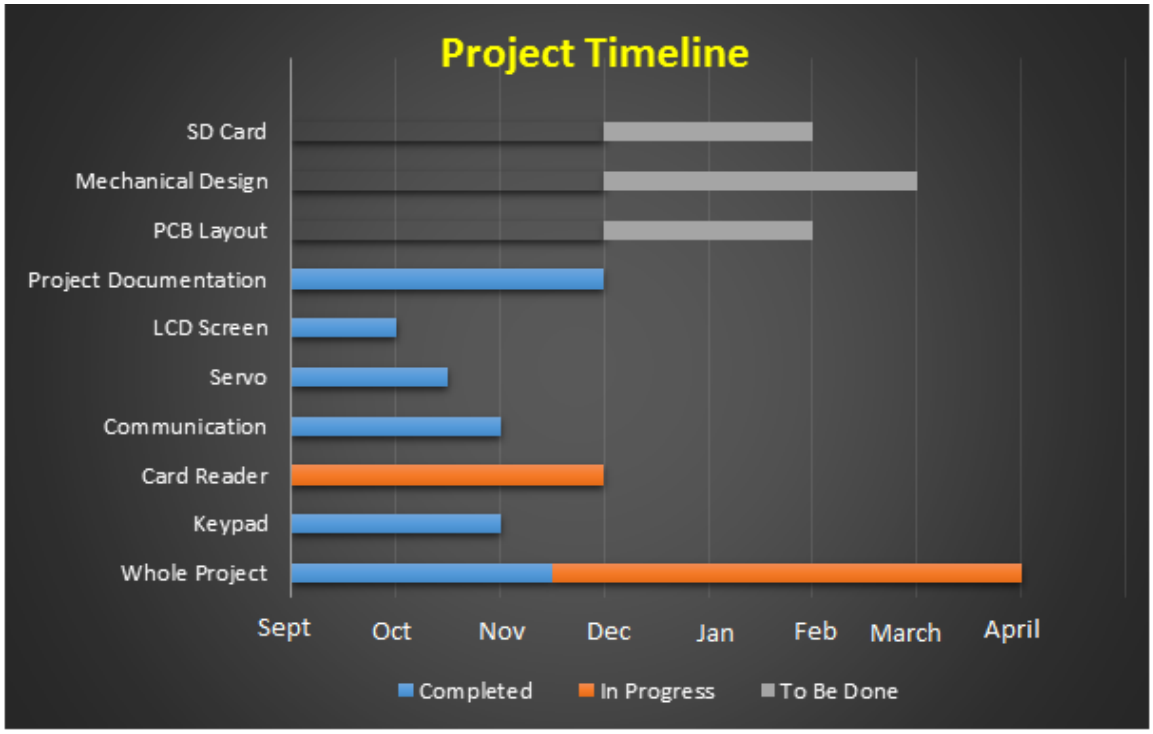
5.1 Project schedule

Below is the tentative for EE491 and EE492 (from September 2013 until April 2014).

Month	Plan
September (week 2-week 5)	➢ First group meeting with adviser ➢ Dividing Tasks ➢ Understanding Project ➢ Start project plan and design document ➢ Set up group website
October (week 6- week 10)	➢ Start doing the implementation for basic functionality (LCD, keypad, wireless communication, card reader and the servo) ➢ Continue with the documentation for project plan and design document
November (week 11-week 14)	➢ Finalize project plan and design document
December (week 15 –week 16)	➢ Presentation for EE491 and continue with implementation ➢ Start with PCB layout and mechanical design

January (week 1-week 4)	➢ Continue with implementation ➢ Project testing
February (week 5-week 8)	➢ Make improvement on the design based on testing result ➢ Order PCB board
March (week 9-week 12)	➢ Final verification and finalize design
April	➢ Presentation for EE492 ➢ Project Demonstration

Timeline



5.2 Risks and Challenges

Risk:

- Safety of each group member is the first priority in this project especially when we are dealing with any electrical devices
- Risk of going over the estimated budget which is $500 if we did not choose components carefully
- Low security in the system, because it is very easy to break the locker door. Furthermore the wireless communication between the locker and the control module is not encrypted, ie (hackers can get easy access to the system).

Challenges:

- Challenges in deciding how to start the design. Since this is our first time doing design that does not have procedures unlike our laboratory project, we find it hard in starting the design in the beginning.
- None of us has a good experience in soldering. Therefore, doing the soldering in the beginning is a bit of a challenge.
- We are not familiar with PCB layout. Thus, it is a challenge for us to learn and master it.
- Different part can lead to different result. Therefore, we encounter challenge in deciding which parts are the best to be used.
- We have no experience with the Arduino platform. So, we have to spend time in learning how to code for that particular platform.

5.3 Estimated Cost

Below is the estimated cost for this project. The listed parts are not final and therefore the cost may change by the time we ordered by everything. In addition, these do not include all the parts that we have yet to decide.

Parts and Materials	Unit price	Quantity	Total
Atmega328	$5.50	2	$11.00
Xbee series 1	$22.95	2	$45.90
Keypad (COM08653)	$13.95	1	$13.95
LCD Screen (ADM2004D-FL-YBS)	$17.62	1	$17.62
SD card	$9.95	1	$9.95
Magnetic card reader	$44.95	1	$44.95
Servo (900-00014)	$10.95	1	$10.95
Lock	$10	1	$10.00
Voltage Regulator (5V)	$0.95	1	$0.95
Voltage Regulator (3.3V)	$1.95	1	$1.95
Npn Transistor	$0.50	1	$0.50
Resistors	$0.25	14	$3.50
Capacitors	$0.45	4	$1.80
16 MHz Crystal	$0.95	2	$1.90
MAX232CPE	$1.85	1	$1.85
Total			**$176.77**

5.3 Work Breakdown

1. Roles

- Leader: Mohammed
- Communicator: Sherry
- Webmaster and documentation: Nurul
- Documentation: Shichao

2. Project Design

- Circuit design (Both control box and locker module): Sherry and Nurul
- Software: Mohammed
- Xbee wireless communication and Mechanical Design: Shichao

6. Conclusion

Currently we are still working on the design and have a work breakdown so that every one of us has their own responsibility towards this project and hopefully can synchronize with our project schedule. We believe that we will do a great job for our client. This control access system will definitely benefit the future senior design students in Ecpe Department.