Project: Reprise of Locker Access System

(Design Document)

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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. Furthermore, administrators are not able to assign and update lockers easily and efficiently.

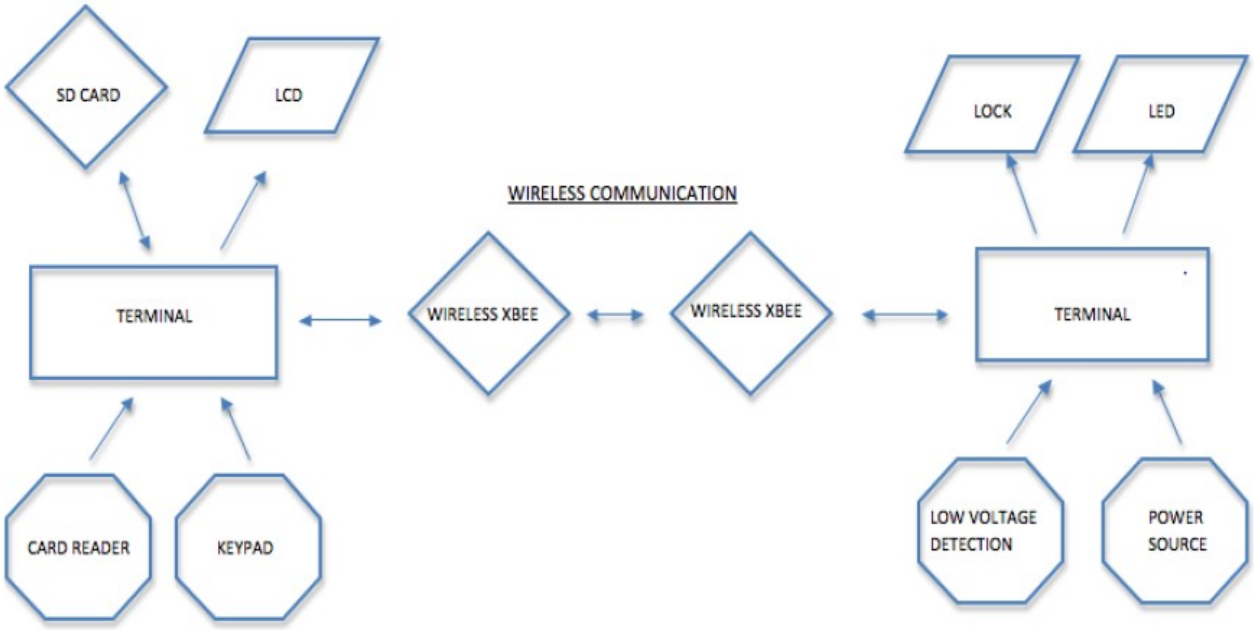
In order to solve these problems, we are creating a control system that allows locker access to authorized users by using their ISU card. The locker access system has to be easy to use while maintaining a basic amount of security. We are designing one user panel that communicates wirelessly with locker 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.

2. System Overview

2.1 System Requirement

- The system will the read magnetic strip on the student ID card and unlock the corresponding door. Besides, it also allows manual entry on the keypad on the control box.
- It must allow administrative functionality including access list updates and locker overrides.
- The user panel must have a display that shows the status of the system. It will give direction to user whenever they use this system.
- The user panel will communicate wirelessly with the locker module. The wireless communication must be in two ways communication so that the user panel can send data to locker module in order to open the door. Similarly, locker module can send information to the user panel regarding the status of the battery in each locker module. The wireless data transmission needs to have the ability to transmit data from the longest distance or at least cover the big range of the dimension of the room.
- The battery must last at least one semester and the locker module needs to give warning when the battery is at 20% or lower.
- The SD card must be able to read and store database of names and locker numbers so that it can be updated easily by using computers.

2.2 System Block Diagram



3. Detailed Design

3.1 Input and Output Specification

Input:

1) Control Module:

A- Keypad (Users will be prompted to enter their student ID number).

B- Card-Reader (Users will be able to swipe their card).

C- SD-Card (student id numbers, locker numbers and addresses will be stored in the SD card).

D- Xbee (Receive data wirelessly from the locker module).

2) Locker Module:

A- Low Voltage Detection (circuit that detect the voltage level of the battery).

B- Xbee (Receive data wirelessly from the control module).

Output:

1)Control Module:

A- LCD Screen (output data in a user friendly form).

B- Xbee (Transmit Data to the locker modules).

2)Locker Module:

A- Low Voltage LED (it will light when the locker has low battery).

B- Servo (Unlock the locker if it receives the signal to do it).

C- Xbee (Transmit Data to the control modules).

The Xbee will be both input and output because it will be receiving and transmitting signals both ways to and from the Control and Locker Modules.

3.2 User Interface Specification

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

I. Students:

Students will have two options 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, there will not be any lockers opened and LCD will show error.

II. Administrators:

Administrators can perform multiple tasks with the control box. They can swipe their ISU card and then type some code on the keypad so that the control box recognized that they are administrators. 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.

3.3 Hardware Specification

Control Module

- **Microcontrollers**

The terminal and both locker and control modules uses ATmega328. All code for our microcontrollers was written in the Arduino Processing C Programmer/Compiler. The ATMEGA328P is a 28 pin DIP that we will be able to remove and reprogram later. This is an important feature since most of the locker and power modules will need to be programmed with their identifiers before they can be installed.

- **RF Transmitter**

The RF transmitter used is Xbee 1mW Trace Antenna – Series 1(802.15.4). This module takes the 802.15.4 stack and allows very reliable and simple communication between microcontrollers. This module can be programmed easily by X-CTU. We set all transmission is done in serial format at 9600 baud, no parity bit, and no stop bit and set all the Xbees in the same IP address. We also used the same Xbee as the receiver and transmitter in the locker modules.

- **Keypad**

The keypad used is a COM-08653 12 button keypad. The pins of the keypad are connected to a single analog pin of the microcontroller by using voltage-resistor method. When one of the buttons is pressed, a specific analog voltage is measured at the microcontroller, which will correspond to the button pressed

- **Magnetic Stripe Reader**

An AP-MSR200 is a simple magnetic stripe reader, which outputs the card number in the form of serial data.

- **Serial Driver**

We used a MAX232 serial driver in order to turn the serial output to TTL. Once it's in TTL form we can read it at the ATMEGA328 serial input.

- **SD Card Reader**

There is one SD card reader attached to the card terminal which accepts an SD card with a pre-formatted comma separated value file on it. This CSV file will be read in by the ATMEGA328.

Locker Module

- **The Lock**

The locking mechanism was supplied by the client and required 1.7lbs of force (not accounting for sheer force) to completely engage the lock.

- **Power Source**

The power source for the locker module is batteries. Right now, we are thinking of using four 1.5 V AA batteries but we will not be able to finalize it until we determined the power consumption of the entire circuit in the locker module. The control module will be connected to power outlet.

- **Servo -** 900-00014

A servo acts as the electromechanical (EM) device to open the lock mechanism. The microcontroller in the locker module will send signal to servo and it will operate until the door opens completely.

3.4 Software Specification

Code Documentation:

Control Module:

All of the initialization needed for connections and devices will be done in the *void setup()* function. At first, we need to initialize the input and output ports of the Atmega328. In our code, *void loop()* stands for the *void main()* with a *while (1)* statement in it. Basically, all of the code should be in the *void loop ()* function. Input from the keypad is taken as a form of 0-5 volts which translates into 10-Bit resolution via a voltage divider. A function *char keypressed(int input)* should take the input from the voltage divider and return the key pressed in a form of character. *int sendData(int address)* is going to be the function responsible of sending data to the Locker Modules. It should take an address as input and return a conformation as a form of integer (ex 1 = done, 2=low battery and 0= connection failed).

The code for reading the ISU card:

```
String read()
{
        Serial.begin(9600); //setup serial
        char serIn[20] = "";
        while(Serial.available()<1){ //Wait for Card to be swiped
        //do nothing
}
        delay(100); // let buffer fill
        for(int i = 0; i<19;i++){ // read the first 20 characters
```

```
        serIn[i] = Serial.read();
        delay(15);
}
serIn[19] = '\0';
Serial.flush(); // clear the rest of the card off the buffer
return serIn;
}
```

This code reads the first 20 characters from the magnetic strip. It discards the first 6 characters and returns the id number in a form of a string. The serial library is already built in the Arduino which makes it easier to read and write to serial ports.

Locker Module:

In the locker module the code is much smaller and simpler. It receives a message through Xbee and opens the locker. The module should return a confirmation that the locker is opened. While idle, it should put the system in sleep mode to save batteries. Sleep mode turns off the devises connected to the terminal using a transistor. It should turn on the Xbee for a second at least each 5 seconds to check for signal and then turns it off again. If a signal is received, it should turn on all of the devices and work according to the signal .The locker module should also detect low battery voltage and send a signal to the Control Module to inform it that it has low battery level.

4. Testing

4.1 Testing Specification

The test specifications of this system are as listed below:

- The wireless communication between the control module and the locker module must be tested so that it sends data to the correct locker. For example, if user wants to open locker number 1, the desired locker must be opened and not any other locker. Other than that, the wireless communication must be still functioning even at the longest distance or range in the room and also when there are many barriers such as tables, chairs and other stuffs in the room.
- The power consumption from the battery need to be tested to make sure it lasts for at least one semester
- The strength of the servo so that it will be able to perform task reliably even when the locker is opened multiple times.

4.2 Prototype Testing Specification

- The prototype testing includes the basic functionality such as reading the input from both ISU card reader and the keypad. In addition, the LCD display must be able to display the outcome such as student ID number, locker that will be opened, the current status of the system, battery level and so on. The wireless communication will be tested so that it is functioning as desired.

- In progress:
  Currently, we tested the operation of the LCD and it is displaying the desired output. We code the Atmega 328 and have the LCD performed

some task. We also tested the low voltage detection voltage. We use LED to indicate when the power source is low (e.g below 1.5V). At this moment, the LED lights up, but it lights up at the wrong voltages.