Desk Reservation System

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Introduction

Objective:

We live in a world with constant distractions. Sometimes we need personal space and time to think. What if there was a solution to reserve a seat in a library to facilitate this quiet time? This is necessary because not only is quiet time fundamentally important in today's society but also seats at our favorite library, Grainger, are hard to come by because of the first-come first-serve system.

The goal of this product is to accomplish the following type of workflow: The student reserves a particular seat in Grainger through their phone. The LCD on the desk then says the seat is reserved. The student arrives at the seat in a timeframe of 15 min and taps their RFID tag on the compact device; this signifies check-in. The student uses the desk upto an hour; there is a proximity sensor verifying that the desk is being occupied. When it is time for the student to leave the desk, the student taps the RFID tag on the compact device to signify check-out. The proximity sensor will confirm if the student left the desk. We would build 2-3 desk modules for our project. This will allow us to simulate a desk reservation system.

This reservation system has four unique components. First, it accepts desk reservations from a mobile phone. Second, it also allows you to reserve an open desk on the fly with your unique RFID tag. Third, we enforce the time spent at a desk; there is a strict check-in, check-out

process and a proximity sensor to verify if someone is occupying the desk. Fourth, if encroachment occurs, we will have a system to show the fees incurred for people overstaying their time.

Background:

Our desk reservation system will be similar to the reservation systems that already exist in other industries. An example is the food industry. Currently, restaurants allow their customers to reserve tables in advance through their respective mobile application[1]. This helped restaurants eliminate the problem of overcrowding and it reduced wait times. Another use of reservation systems is in the airline industry. An example is the Computer Reservation System, which kept track of seats on airplanes and returned the availability of them[2]. We plan on adapting this existing model to a desk reservation system for Grainger. This will streamline desk usage for students working at Grainger, allowing students to spend more time studying than searching for a desk.

High Level Requirements:

- Power
    - Be able to power the system from taking the wall voltage and converting it to the necessary DC voltages for the electronics.
- Desk Module
    - The microcontroller communicates between the LCD Display, RFID module, Wifi module and proximity sensor.
- Database/Mobile Application

- The database communicates between the desk module and the mobile application. The mobile application allows users to reserve desks.

Design

Our design will consist of four subsystems.

Power

This subsystem will power the components in the desk module at their proper voltages.

Wall Supply

The desk module will plug into the wall as the power supply.

Requirement: Be able to provide 120V AC to the module

AC-DC Converter

This will change the voltage from the wall supply to 5V DC, which is needed for powering the electronics of the desk module.

Requirement: Take the 120VAC from the wall outlet and convert it to a 5V(+/- 5%) DC voltage and output it.

DC-DC Converter

This will convert the 5V DC voltage to 3.3V DC because some of the components will require 3.3V DC.

Requirement: Convert 5V DC to output a 3.3 V(+/- 5%) DC.

Requirement: Power 2-3 desk modules for the demo

Desk Module

The desk module contains the microcontroller, proximity sensor, RFID module, LCD display, and WiFi module.

Microcontroller

The brain of our system is a microcontroller, which will handle the communication between the WiFi module, RFID module, LCD display, and proximity sensor. The microcontroller will have analog and digital inputs and outputs. In addition, the microcontroller has to support serial communication protocols(UART, I2C, SPI)[3].

Part: https://www.microchip.com/wwwproducts/en/ATmega328

Requirement: Operating voltage 1.8-5.5V

Requirement: Serial communication

RFID

We will use an RFID reader that will be paired with a 125kHZ card. When scanned, the RFID module will output a serial string containing the unique ID of the card.

Part: RFID Reader: https://www.sparkfun.com/products/11827

Part: RFID Button: https://www.sparkfun.com/products/9417

Part: RFID Card: https://www.sparkfun.com/products/14325

Requirement: Operating Voltage: 2.8 - 5V DC

Requirement: Serial communication

Proximity Sensor

We will use the Ultrasonic Distance Sensor(HC-SR04) as a proximity sensor. This sensor will help us determine if someone has overstayed their time slot.

Part: https://www.sparkfun.com/products/13959

Requirement: Outputs accurate measurements of distance

Requirement: Operating Voltage: 5V DC

Display

The LCD screen will display the status of the reservation.

Part: https://www.sparkfun.com/products/10862

Requirement: Operating Voltage: 5V DC

Requirement: Accurately display the current reservation status

WiFi

The Wifi chip interfaces with the microcontroller and the database. With this, we can send information from our sensors to update the database with relevant information.

Part: https://www.sparkfun.com/products/13678

Requirement: Operating Voltage: 3.3V DC

Requirement: UART communication

Database

The database stores the data regarding reservations, desks and user profiles. It also sends data to and from the desk modules and the mobile application.

Requirement: Take reservations from mobile application

Requirement: Store reservation status in database

Requirement: Remotely communicate with the desk modules

Mobile Application

The application is the user interface for the desk module. It allows our customers to select which desks they would like to reserve and displays their balance for late checkouts.

Requirement: Customers are able to make reservations for desks

Requirement: Customers are able to view account balance

Block Diagram

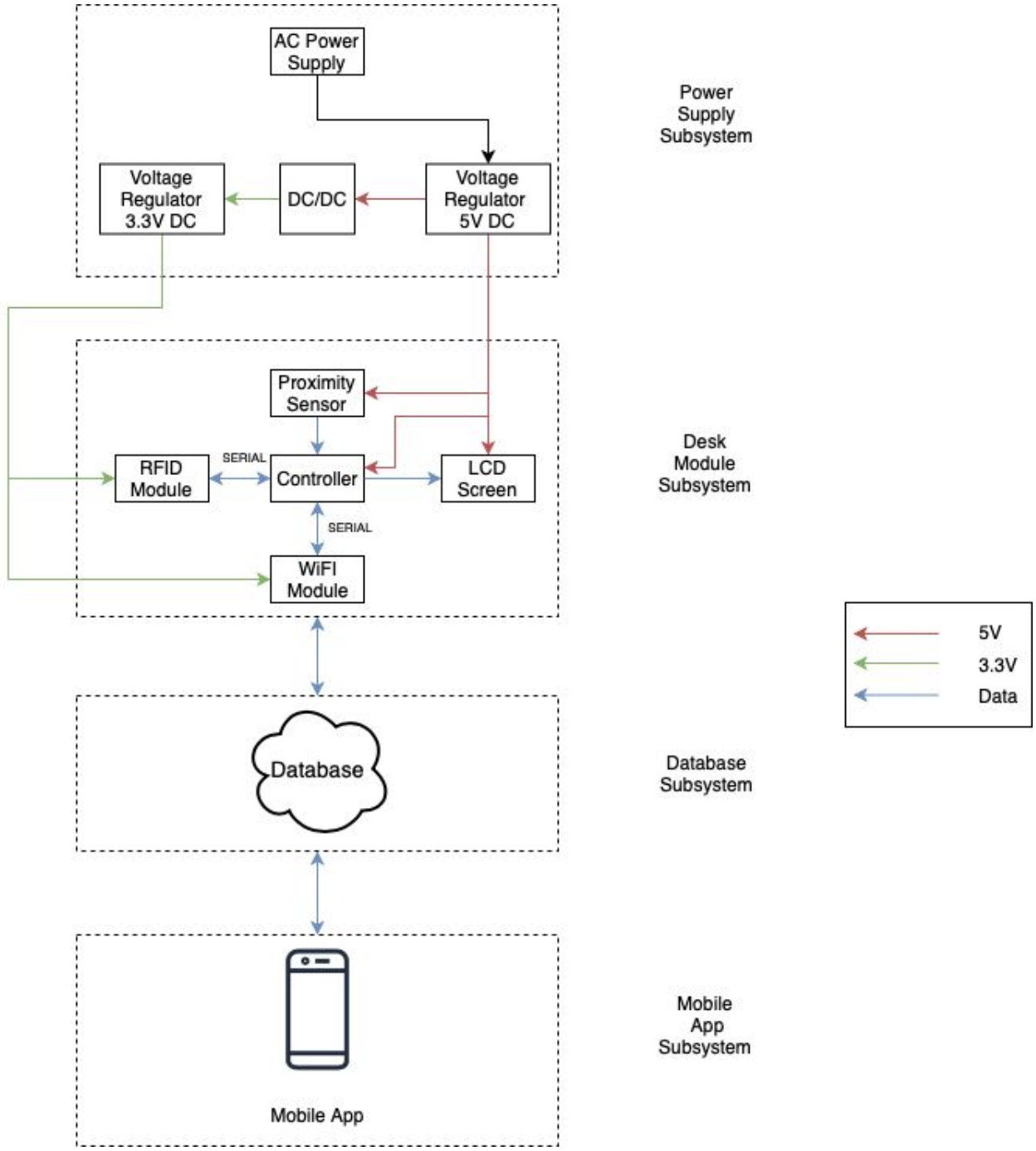

Figure 1

The block diagram is broken up into four sections. Each section represents the four subsystems of our module. The power supply system takes AC supply from the wall and converts it to DC voltage for other components to use. These components include the LCD

Display, RFID module, microcontroller, Wifi module, and proximity sensor. These components make up the second subsystem which is the desk module itself. The Wifi module is an extension of the microcontroller as it will send and receive data with the database. The database subsystem will hold all the data regarding the reservations, desks and user profiles. The user interface of this project is in the mobile application subsystem. The mobile application communicates with the database system, allowing our customers to reserve desks.

Physical Design

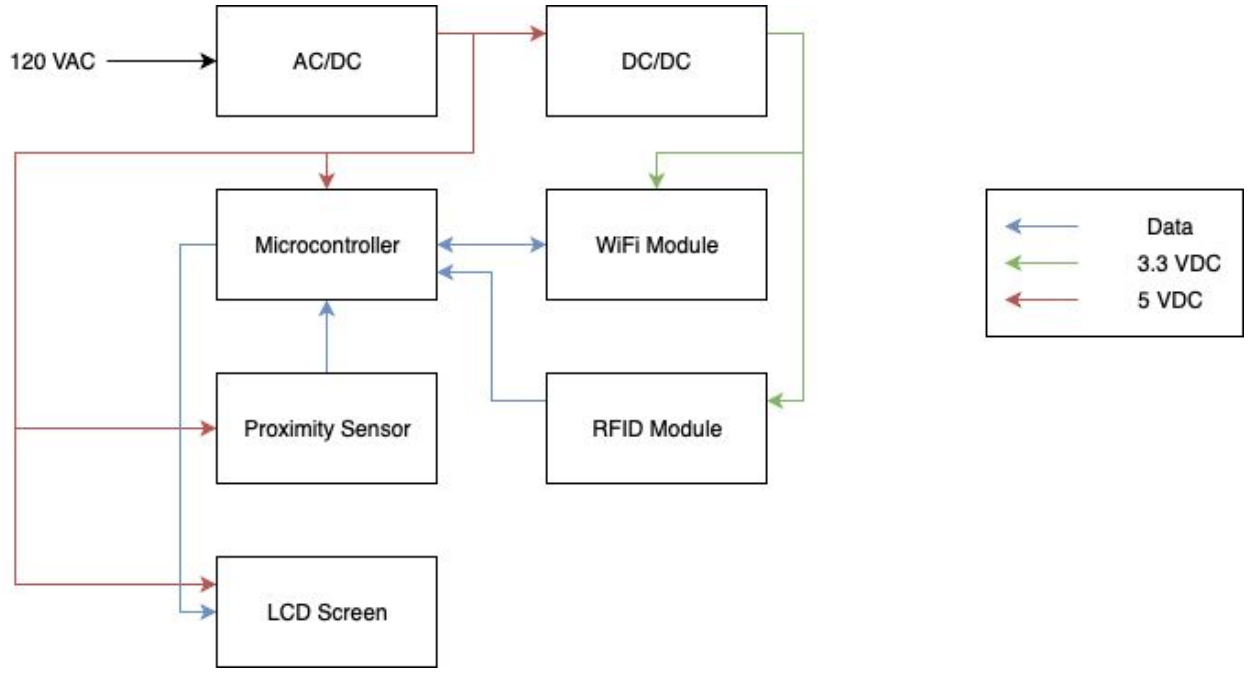

Figure 2

The design shows that we will convert the initial 120 VAC source to the needed 5 VDC, which will power the microcontroller, proximity sensor, and the LCD screen. The 5 VDC source will be converted to 3.3 VDC, which will power the WiFi module and the RFID module. The LCD screen, RFID module, WiFi module, and proximity sensor will connect to the

microcontroller via a data connection. The RFID module, Proximity sensor, and LCD display will be visible externally.

Risk Analysis:

The greatest risk for this project will be creating the desk module system. The module will be on a PCB holding the WiFi module, RFID module, proximity sensor, LCD screen, and microcontroller. The microcontroller will take the information from the sensors and transfer the data to the WiFi module and finally to the database. We will struggle with the PCB design because we have never made a PCB before. On the software side, communication between the microcontroller, WiFi module and the database will be challenging.

Each individual part in the desk module will have unique challenges because they will need to be individually configured and tested. The RFID module has to scan the RFID tag and the software has to link it to the right account with the reservation. The proximity sensor will need to be calibrated so that it can accurately detect the presence of a person working at the desk and not be impacted by nearby obstructions.

Safety & Ethics

Physical Safety:

It is our obligation to ensure the health and welfare of the public[4] for our project. Our system will be placed indoors so we do not have to account for weather. The desk module will be powered from the wall outlet and will be designed to prevent accidental electrocution. This enclosure will also be IP40 to protect against large objects from coming into contact with the

electronics [5]. In addition, we will protect the desk module from abuse and prevent damage from drops.

Data Security:

Respecting our customer's privacy[6] is the foundation of our product. Customers are entrusting us with sensitive data. This data is considered to be personally identifiable information. Our database will be encrypted, and we trust that the database service will safeguard our customers' data rigorously. After a certain period, we will also anonymize reservation data to follow the best industry practices.

References

[1] R. Andrews, "The 9 Best Online Restaurant Reservation Systems Compared," *The Simple Online Restaurant Reservation System*. [Online]. Available: https://restaurant.eatapp.co/blog/online-restaurant-reservation-systems. [Accessed: 18-Sep-2019].

[2]Wardell, D. (1991). *Airline Reservation Systems*. [online] Academia. Available at: https://www.academia.edu/487385/Airline_Reservation_Systems [Accessed 18 Sep. 2019].

[3] Learn.sparkfun.com. (2019). *Serial Communication - learn.sparkfun.com*. [online] Available at: https://learn.sparkfun.com/tutorials/serial-communication/all [Accessed 17 Sep. 2019].

[4] "IEEE Code of Ethics." IEEE - Advancing Technology for Humanity, www.ieee.org/about/corporate/governance/p7-8.html.

[5] "Enclosurecompany.com." (2019). [online] Available at: http://www.enclosurecompany.com/ip-ratings-explained.php [Accessed 15 Sep. 2019].

[6] "The Code affirms an obligation of computing professionals to use their skills for the benefit of society.", *Acm.org*, 2019. [Online]. Available: https://www.acm.org/code-of-ethics. [Accessed: 17- Sep- 2019].