ECE 416
Comprehensive Design Review
Team 26 - UPark
March 31st, 2021

University of Massachusetts Amherst
BE REVOLUTIONARY™

Meet the Team (Again!)

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  - Computer Engineering
- Belma Kondi
  - Electrical Engineering
- Nikhil Sarecha
  - Computer Engineering
- Lastone Saya
  - Electrical Engineering
- Prof. Christopher Hollot
  - Faculty Advisor

University of Massachusetts Amherst

UPark - an RFID-based Smart Parking Payment System

University of Massachusetts Amherst

Problem Statement

The UMass Campus has several methods of parking payment services. These methods expect the user to either purchase a permit, carry loose change, or even install a third-party application. Overall, these different forms of payment methods make it cumbersome for the user as well as the administrator to monitor parking transactions. There exists a more convenient way with UPark.

Our Solution

We aim to solve the problem of inconsistency by introducing the use of RFID transponders, in vehicles on campus. These transponders will communicate with RFID readers at distinctive entrances and exits of parking lots across campus and charge the users accordingly. The whole parking payment process is now seamless and contactless, and managed by a centralized parking control system which allows users to track their logs.

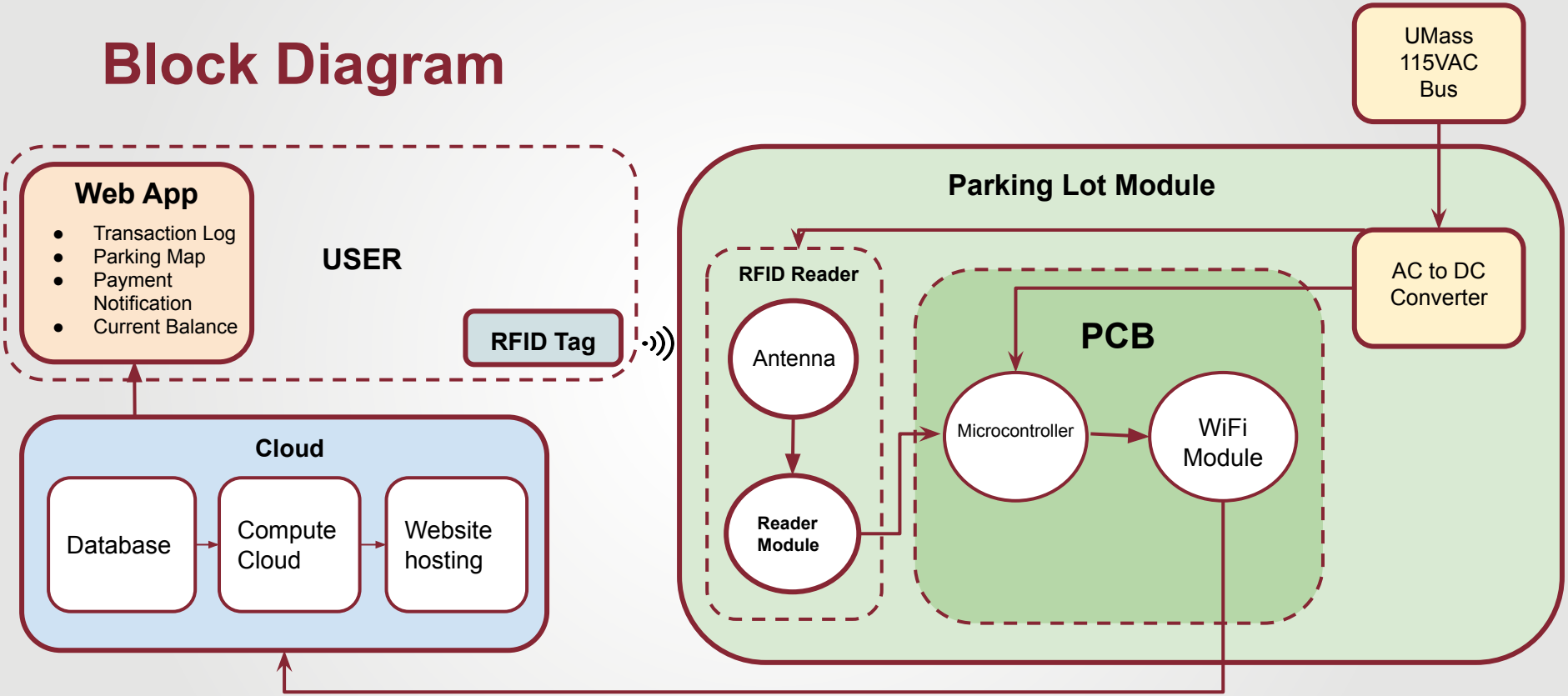
System Specifications

1. System must communicate with a centralized parking control system
2. System must automatically detect vehicles entering/exiting the parking lots with almost 100% accuracy
3. System must include a contactless payment transaction system
4. Transaction logs and vehicle activity across campus can be viewed by the administrator, UMass Parking Services, while individual user transaction logs can be viewed by the customer through a Web Application
5. System must be able to sustain extreme weather conditions between 0 ℃ and 48 ℃
6. System will draw power from the UMass 115 VAC Bus
7. As a proof-of-concept, our system will be built for parking lots with separate entry and exit points

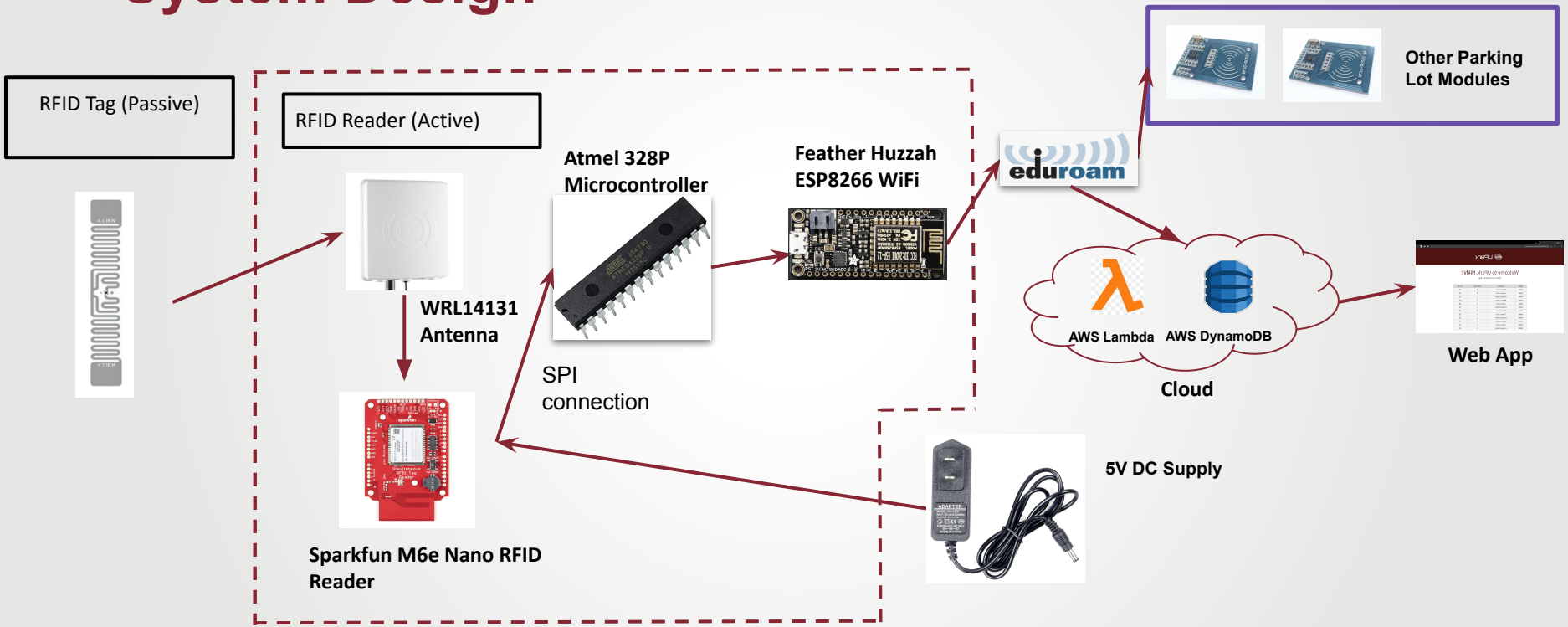
Illustration Of UPark

Represented above are the different entry and exit points of a parking lot. An RFID Reader installed at this location will detect RFID tags, embedded in the UMass Parking Stickers in vehicles entering/exiting to activate a **clock timer** accordingly, which will calculate the cost. With UPark, we aim to eliminate the need for users to stop at the entry point to generate a ticket or be required to pay for parking manually.

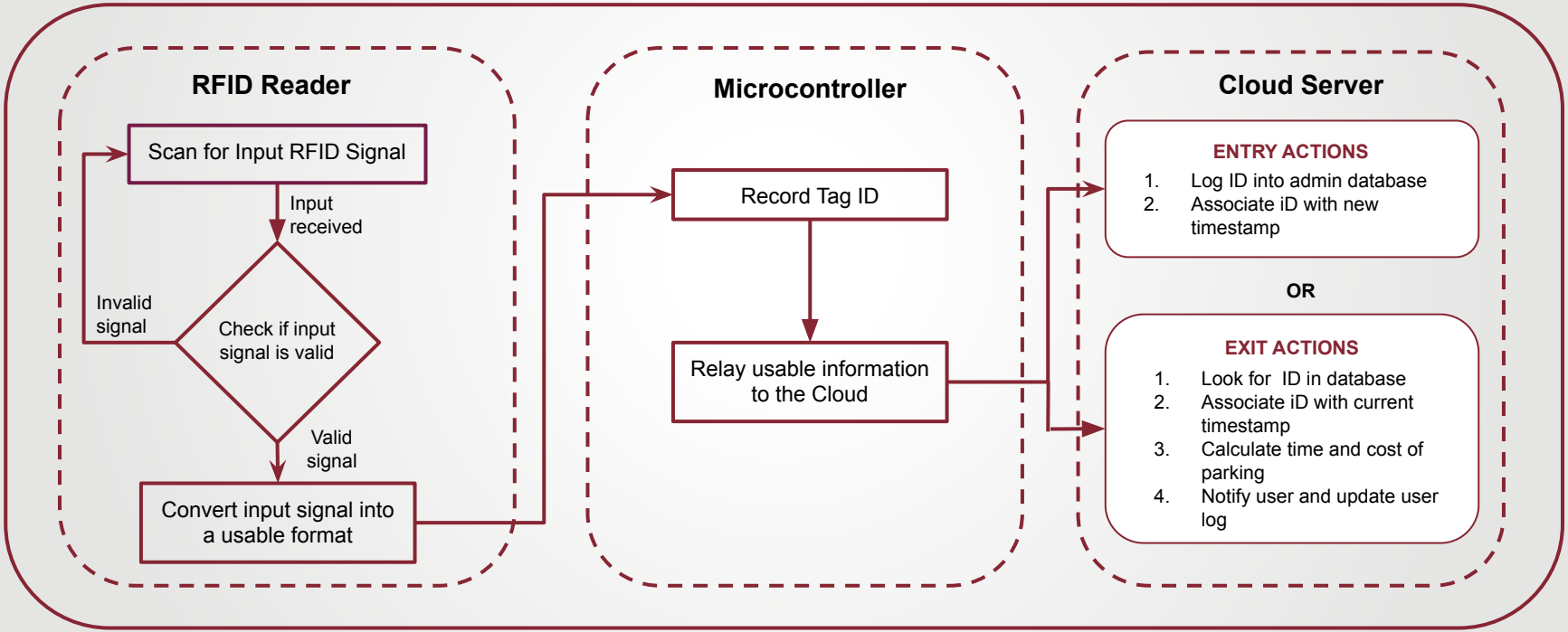
Block Diagram



System Design



Software Diagram



CDR Deliverables

- **End-to-end integration of the two subcomponents to perform the entire cycle of operations for a vehicle entering and exiting a parking lot**

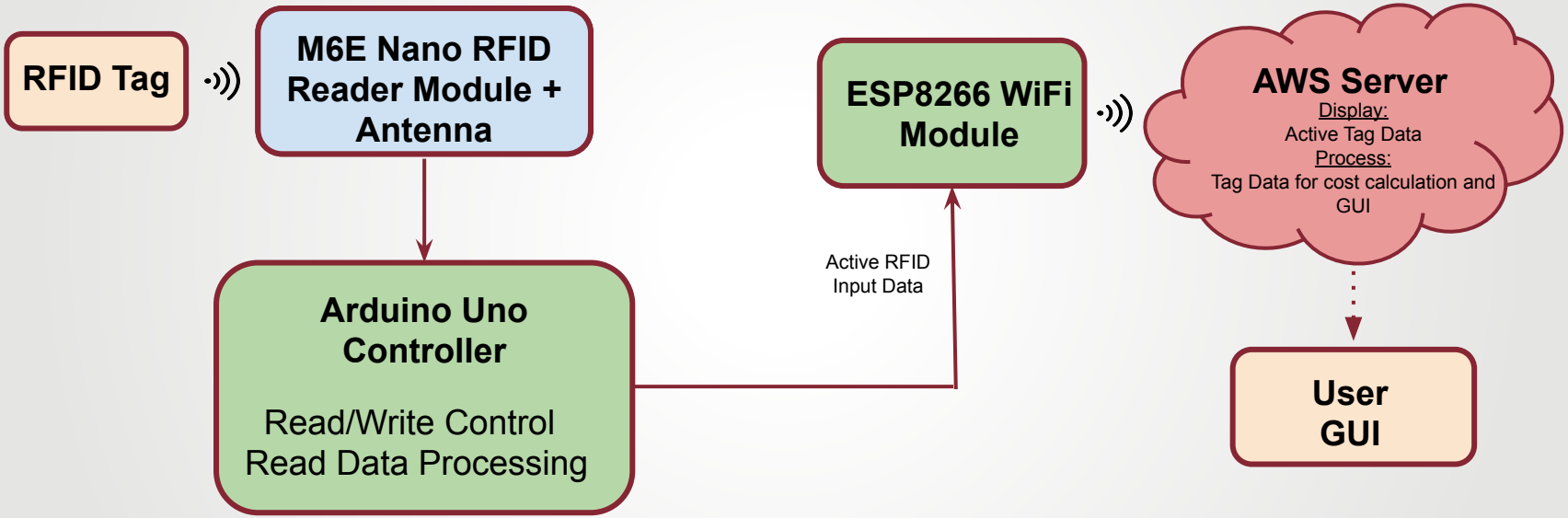
Delivered:

1. Prototype will be able pick up an incoming RFID signal via the RFID module
2. The RFID tag data will be sent over to the microcontroller via serial communication
3. Microcontroller will parse through the tag data and send it through the WiFi module over to the Cloud server to log into database

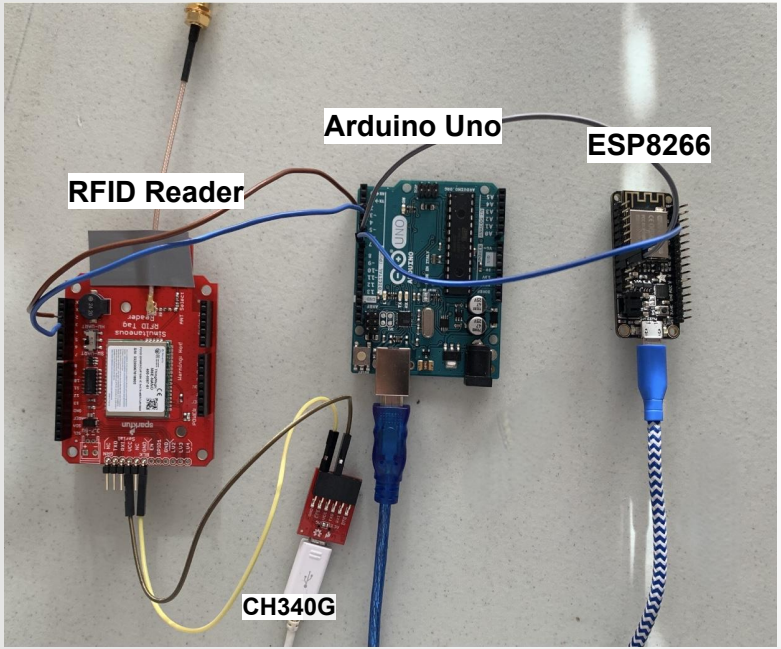
In Progress:

4. Database will determine entry or exit based on previous data log and calculate parking time and cost accordingly
5. The calculated cost will be reflected on admin database and user's GUI profile in real time

Integrated System Demonstration

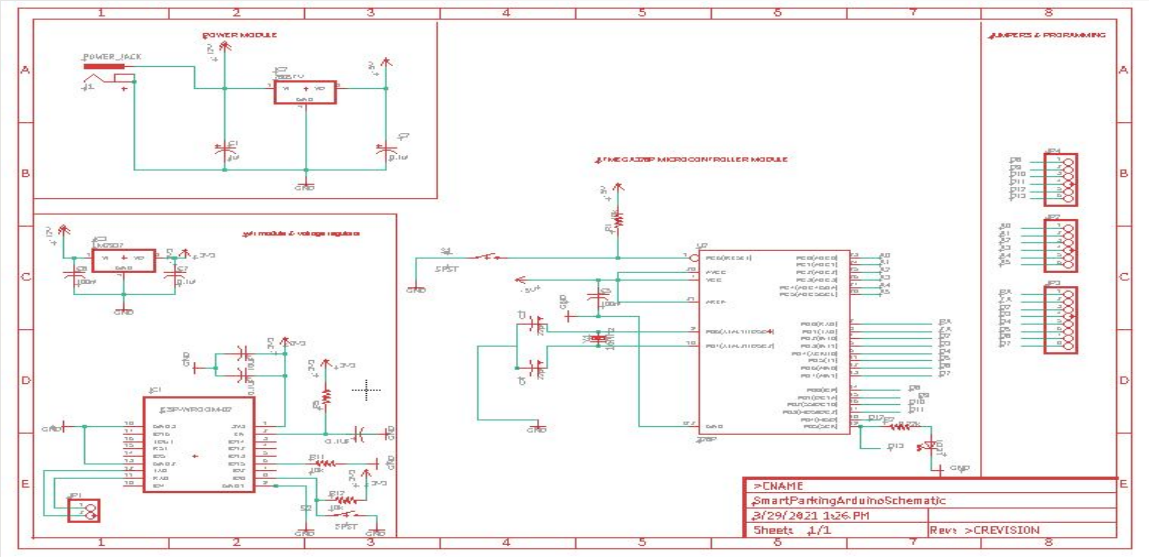


Documentation of Current Prototype



CDR Demo

PCB Schematic

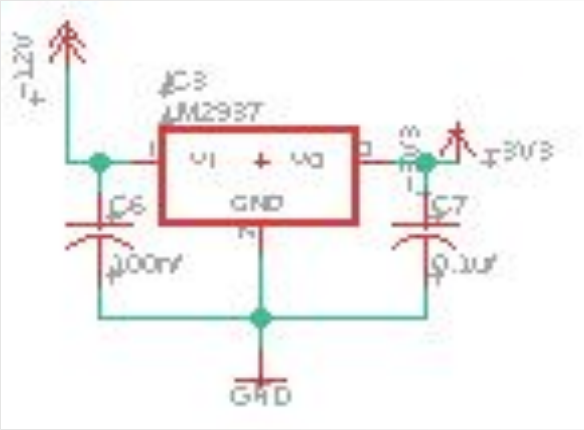


Modules

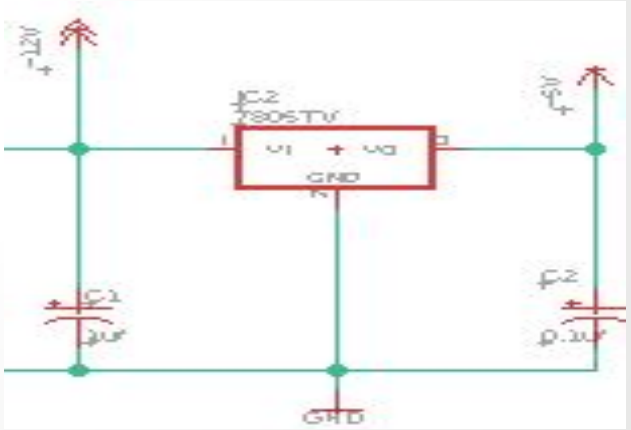
- Voltage regulators
- Wifi Module
- Power module
- Atmega328p

Voltage Regulators

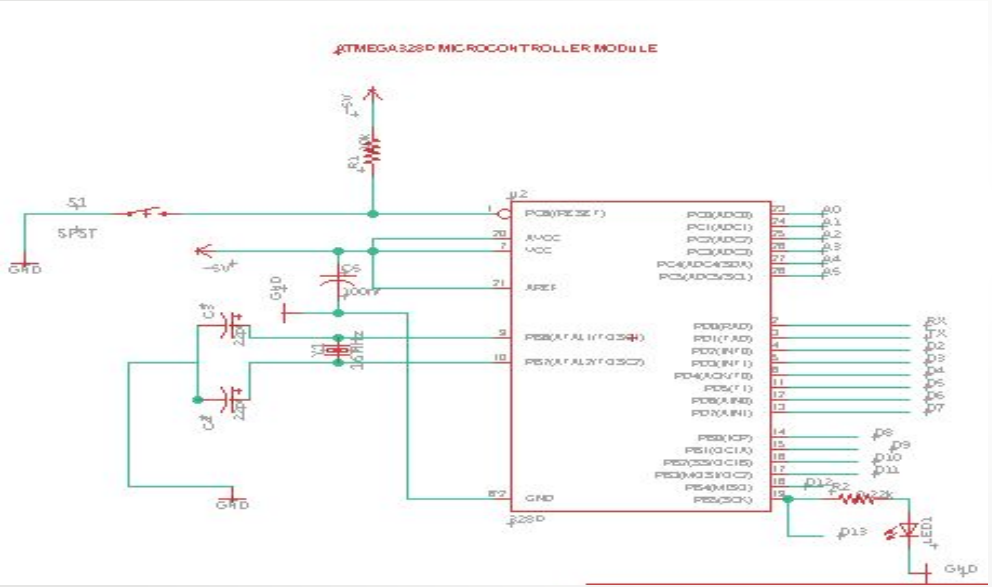
LM2937 voltage regulator 3.3v



7805 voltage regulator with 5v output

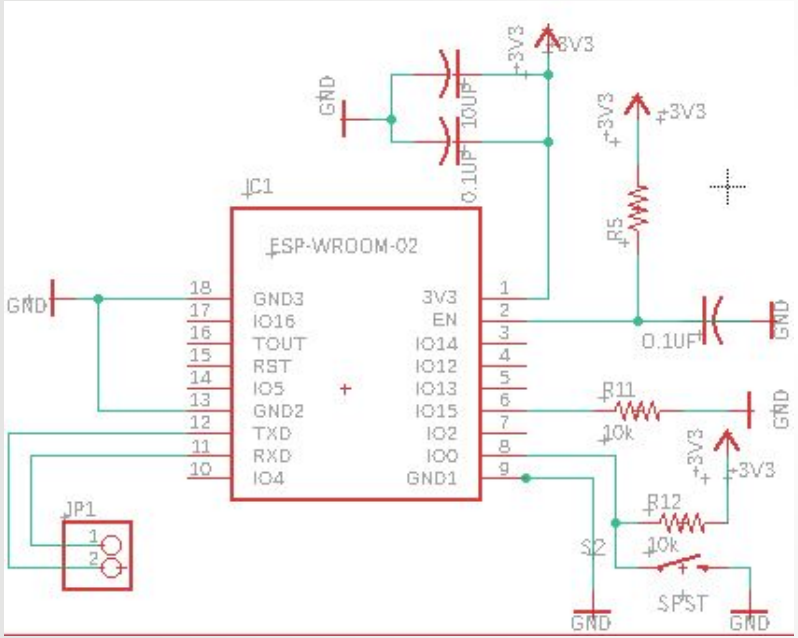


ATMega328p



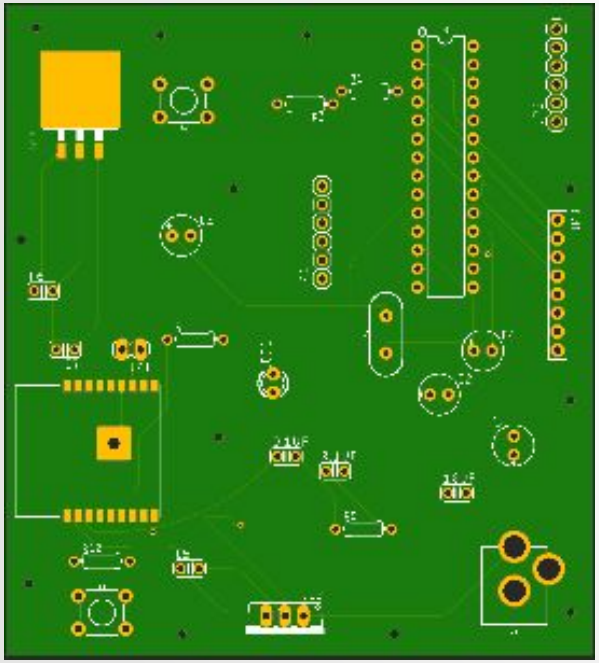
- Operate with a voltage of 5v
- Communicate with the RFID reader and the wifi module
- An LED is installed and connected to pin19 and GND

WiFi Module



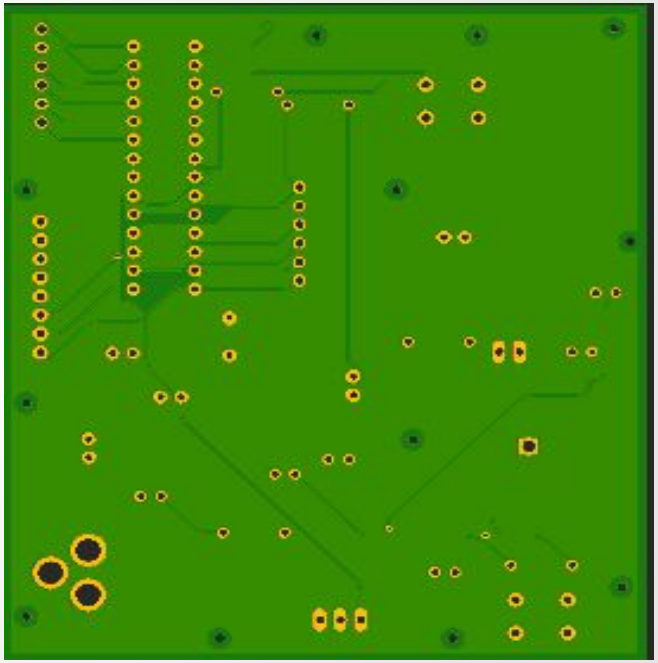
- **JP1 will be connected to the microcontroller with wires.**
- **Switch connected to IO0 replace the boot option**

PCB Final Form



Top Side

Bottom Side



Primary Responsibilities for FPR

1. **End-to-end integration to perform the entire cycle of operations for a vehicle entering and exiting a parking lot**
   - (Entire team)
2. **Transition from the Arduino Uno to bare-metal ATMega 328P**
   - (Belma)
3. **Have PCB tested and integrated into final product**
   - (Lastone)
4. **Optimize cloud infrastructure for necessary backend processing operations**
   - (Rehmat)
5. **Complete building a functional GUI interacting dynamically with AWS**
   - (Nikhil)
6. **Switch from Feather HUZZAH WiFi Module to ESP-WROOM-02**

Hardware Plans for FPR

- Transition from Arduino Uno to ATmega328P
- Have PCB integrated with system
- Switch from ESP8266 to ESP-WROOM-02 wifi module

FPR Plan

- **Current Prototype Includes:**
  - Arduino Uno
  - Feather HUZZAH ESP8266 WiFi Module
- **Final Project at FPR will include:**
  - PCB, with ATMega328P microcontroller and ESP-WROOM-02 WiFi Module
  - Housing unit for the RFID Module, PCB, and Antenna
- **Plan for testing the system for compliance with system specifications:**
  - Attach RFID tags to the side windows of car(s)
  - Gather data of test cases of vehicle moving at different speeds, tags placed at different heights/distances from the reader.

Project Management: Responsibilities

- **Lastone Saya - Altium Lead**
  - RFID Reader and Microcontroller
- **Belma Kondi - Budget Lead**
  - RFID Reader and Microcontroller
- **Rehmat Kang**
  - Microcontroller and WiFi Module
- **Nikhil Sarecha - Team Coordinator**
  - Web Server and GUI

Project Expenditures (Current & Projected)

Current Expenditures	Cost
UHF Antenna	62.47
UHF RFID Tags	17
Sparkfun RFID M6e Board	224.95
Arduino Stackable Headers	1.5
Male Break Away Headers	1.95
Sparkfun Serial Basic Breakout CH340G	7.95
Interface Cable RP-SMA to U.FL	4.95
Interface Cable for RP-TNC to RP-SMA	5.95
Wall Adapter Power	5.95
Shipping	13.1
ESP-Wroom 02	18
PCB	40.13
Total	**403.9**

Projected Expenditures	Cost
PCB Components	$30

Project Management: Gantt Chart until FPR

Names	Tasks	April Week 1	April Week 2	April Week 3
Lastone	Solder electric circuit board and add all the components			
	Transition to the Wroom-2 Wifi module			
	Test the PCB and make sure it works properly			
Belma	Transition from the Ardunio uno to the ATmega328P			
	Assit Lastone in the integration of PCB			
	Final touches for final integrated system			
Rehmat	Integrating the AWS functionality with new RFID Module Integrated Sys			
	Assist Nikhil in dynamizing the GUI for AWS			
	Final touches to make sure the entire system works completely			
Nikhil	Assist Rehmat with integrating AWS functionality			
	Make the GUI dynamic in interacting with data on AWS			
	Make cosmetic changes to AWS			

Thank You!

Any Questions?

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