SMART BIKE RACK SYSTEM

Group 13
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MOTIVATION

We aim to encourage people to give up their cars in favor of bicycles for those shorter commutes. Heavily populated areas suffer from congestion, heavy traffic, and pollution which can be alleviated by encouraging commuters to take advantage of a greener solution such as using a bike for reaching nearby locations. Our smart bike rack aims to make bringing your bike anywhere as convenient as possible.

Reduce Traffic

Heavily populated areas suffer from traffic congestion

Increase convenience

Can’t find parking?

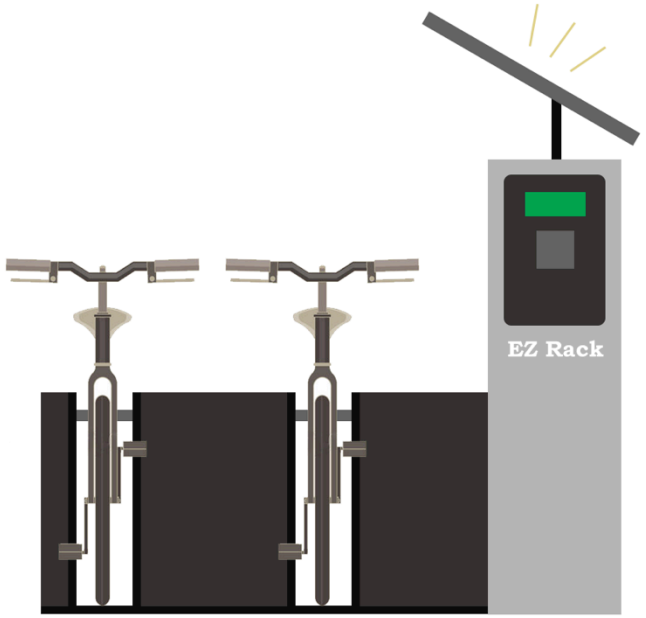
Eco-friendly solution

Less traffic means less cars

EZRACK

GOALS & OBJECTIVES

- Provide a convenient place to store your bike
- Eliminate the worry of having to carry a lock and chain
- Provide a means of reserving a slot and checking availability
- Self-sufficient with power provided by a solar panel

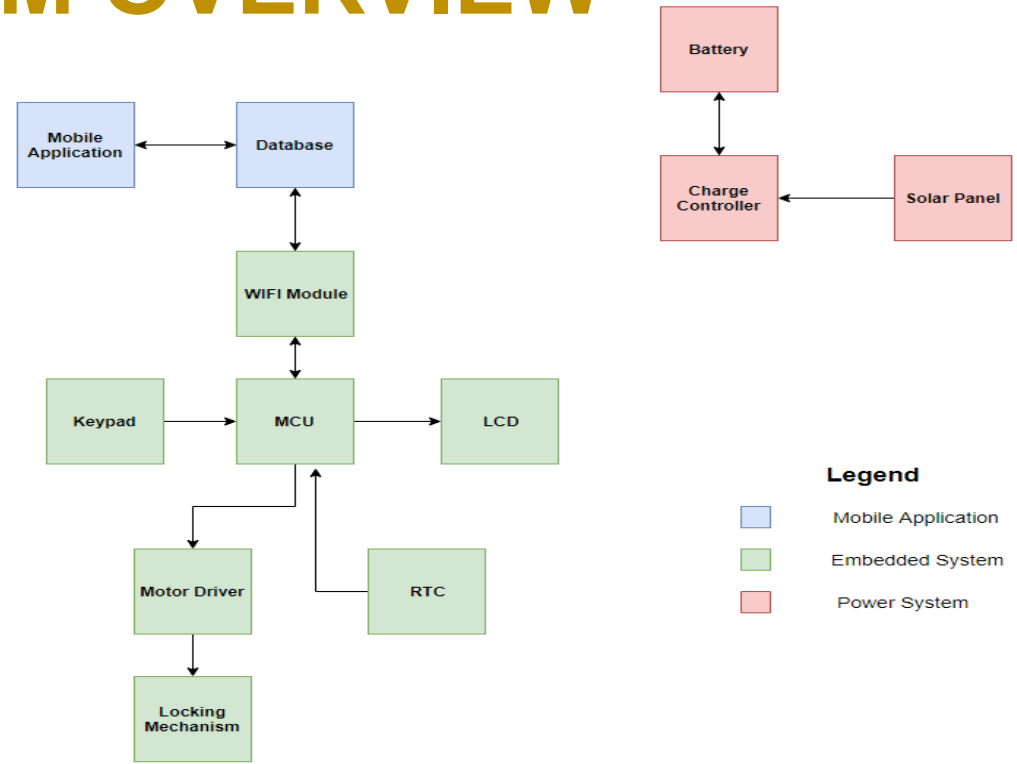


EZ RACK

SPECIFICATIONS

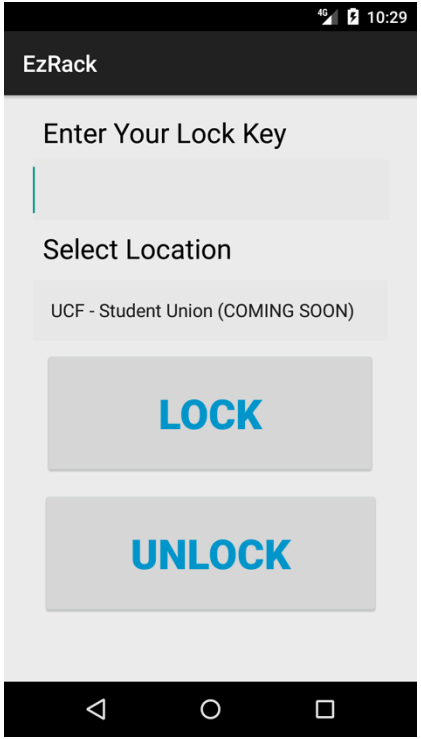
Secure at least 2 bicycles
Lock / unlock within 5 seconds of user input from the UI
Operate at least 8 hours without recharge
Charge controller provides 12V and 5V load

SYSTEM OVERVIEW



MOBILE APPLICATION

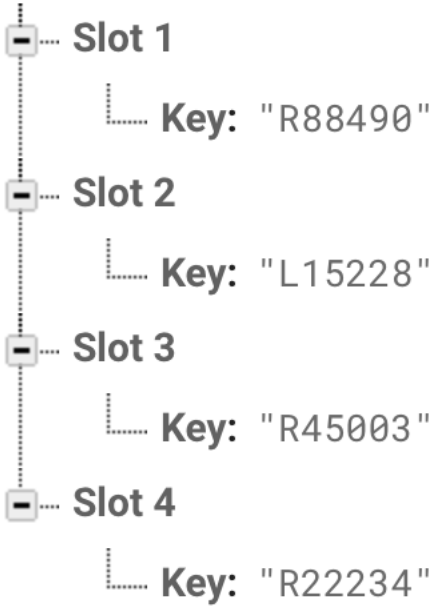
- Android application allows users to reserve, lock, and unlock, their slot directly from their android device.
- Reservations should be held for a maximum of 15 minutes.
- Users will not have to worry about signing in



FIREBASE

Real-time Database: Secure and server less database is used to store the keys and update the slot availabilities in real time.

Ease of Use: Unlike traditional database systems like MySQL, Oracle DB, and MongoDB, Firebase provides storage without the need of any backend, server side code.



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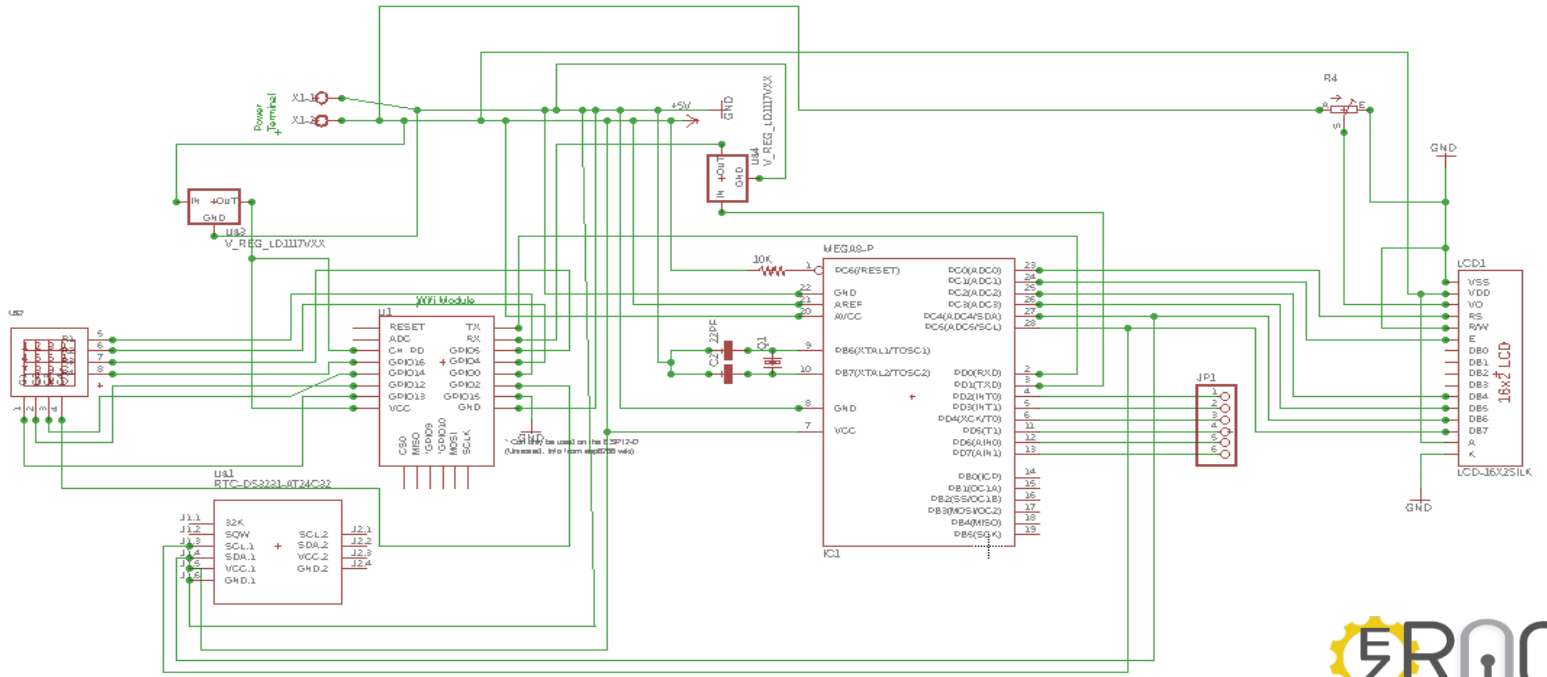
EMBEDDED SYSTEM



WI-FI CONNECTIVITY

Specifications			
	Arduino Wifi Shield	**ESP8266 01**	**ESP8266 12e**
Operating Voltage	5V	3V	3V
Wireless Standard	IEEE 802.11	IEEE 802.11	IEEE 802.11
Frequency Range	2.4 - 2.497GHz	2.412 - 2.484 GHz	2.412 - 2.484 GHz
Cost	Discontinued	$5.00	$3.25

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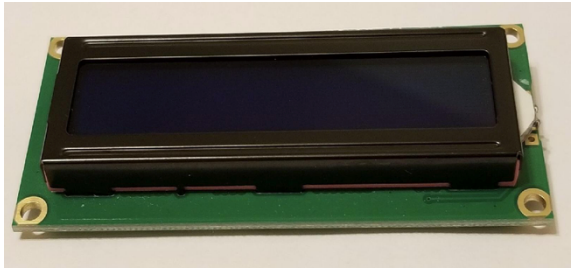
MICROCONTROLLER

Specifications		
	ATMega328P-PU	**ATmega2560**
Pin Count	28	100
Flash Memory	32KB	256 KB
CPU Type	8-bit AVR	8-bit AVR
Number of I/O Pins	23	54
Operating Voltage	1.8V - 5.5V	1.8V - 5.5V
Cost	$4.66	$12.21

SYSTEM DISPLAY

1602A LCD Display Module: Provides a user interface without the need for an android smartphone. Provides user instructions for interfacing with the system.

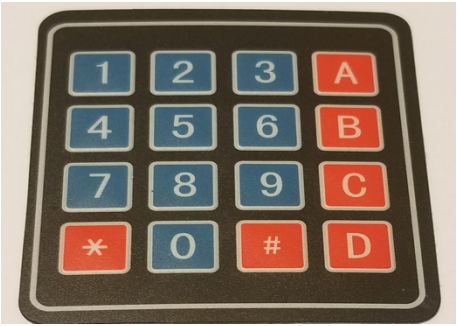
Specifications	
Operating Voltage	5V
Display Format	16 Character x 2 Lines
Cost	$5.99



KEYPAD

Membrane 4x4 Matrix Keypad allows users to interact with the kiosk's user interface.

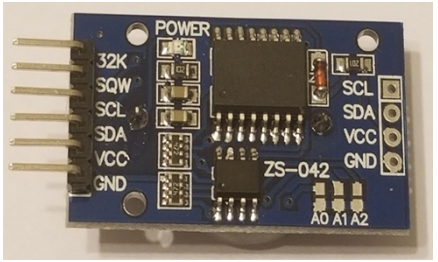
Specifications	
Maximum Rating	24 VDC, 30mA
Interface	8 pin access to 4x4 matrix
Cost	$ 3.40



REAL-TIME CLOCK MODULE

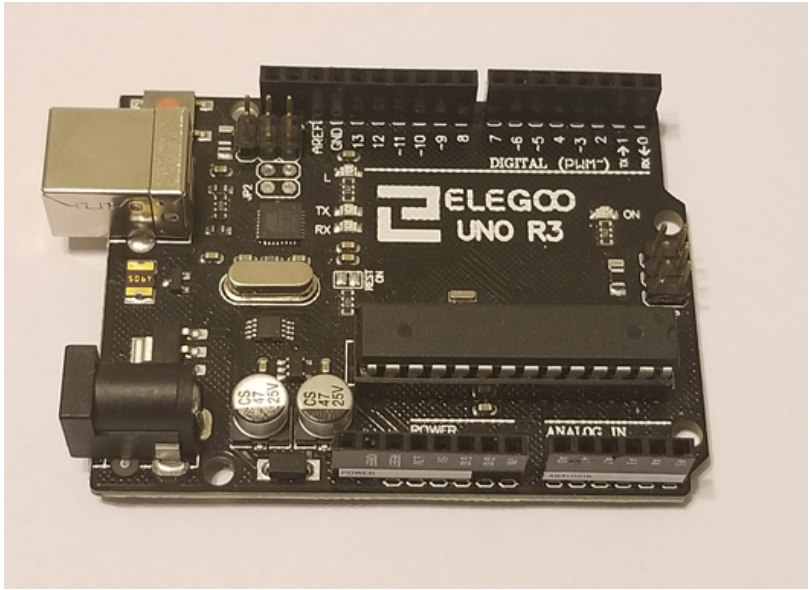
The **DS3231** is used to keep accurate time in the system. It continues to keep time even when disconnected from its main source of power.

Specifications	
Operating Voltage	3.3V
Accuracy	±2ppm from 0°C to +40°C
Cost	$6.99

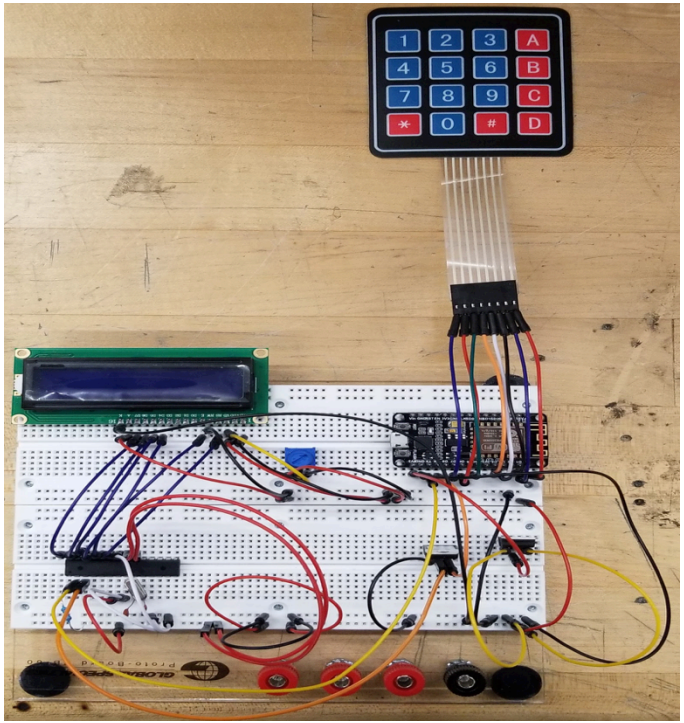


TESTING

The **UNO R3** Development board is used for prototyping and testing.



TESTING



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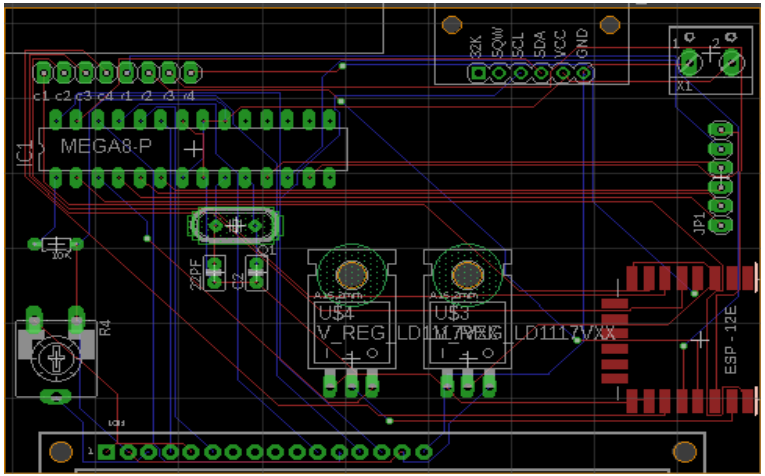
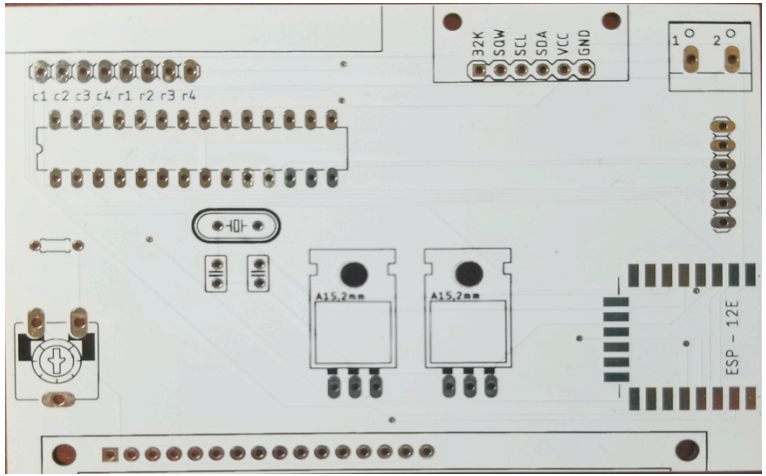
PCB



32K
SQW
SCL
SDA
VCC
GND
X1
c1 c2 c3 c4 r1 r2 r3 r4
IC1
MEGA8-P
JP1
22PF
C2
R4
U$4
U$3
V_REG_LD1117VXX
ESP - 12E



32K
SQW
SCL
SDA
VCC
GND
c1 c2 c3 c4 r1 r2 r3 r4
A15,2mm
A15,2mm
ESP - 12E

CHARGE CONTROLLER

- PWM - 12V
  - Arduino Nano (ATmega328P)
  - 20x4 LCD Module Shield
  - ACS712 Current Sensor
  - LM35 Temperature sensor
  - LM2596 Step Down Buck Converter
    - From 3.0-40V to 1.5-35V (DC)
- Renogy 50W 12V Monocrystalline panel
- 12V 35AH Sealed Lead Acid Battery

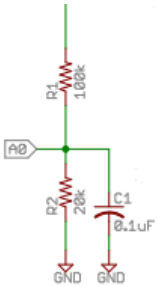
MPPT VS PWM

PWM	MPPT
Switches that connects solar array to a battery.	More Complex (Expensive).
Automatically adjust its charging to older batteries.	Harvest more power from solar array.
Helps avoids with gassing and heating to battery (Float stage).	Better suited for colder conditions.
Good low cost solution.	~150-200W or higher to take advantage of MPPT benefits (Operate above battery voltage; “boost” in cold climate when the battery is low).
Allow rapid recharge.	
Typically recommended for use in smaller systems where MPPT benefits are minimal (Hot Climate).	

SENSORS

If 5V = ADC count 1024

- Voltage Sensors utilize Voltage divider
  - Vin =Vout*[(R1+R2)/R2]
  - Vin = ADC count * 0.00488 * [(R1+R2)/R2]
- Temperature Sensor: if 10mV/C
  - Temp C = (5/1024) * ADC count * 100
- Current sensor



Voltage Sensor

Temperature Sensor

Current Sensor

DISPLAY / LED

- 20x4 LCD Display
  - Solar Wattage
  - Battery Wattage
  - Temperature
  - State of charge
    - Charging
    - Not Charging
  - Current
  - Load Energy and Power
    - P=V*I; E = P*t

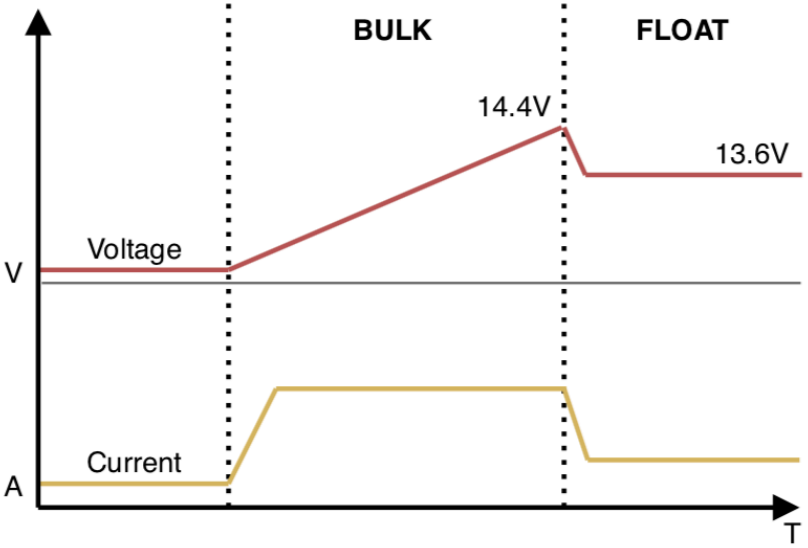
- LED Indicator
  - Battery Status
    - Red -> Voltage is low
      - B_{volt} < 12V
    - Green -> Voltage is Good
      - 12V < B_{volt} < 14.4V
    - Blue -> Fully Charged
      - B_{volt} => 14.4V
  - Load Status
    - Green -> On
      - S_{volt} < 5V
      - B_{volt} > 11.5V
    - Red -> Off

CHARGING ALGORITHM

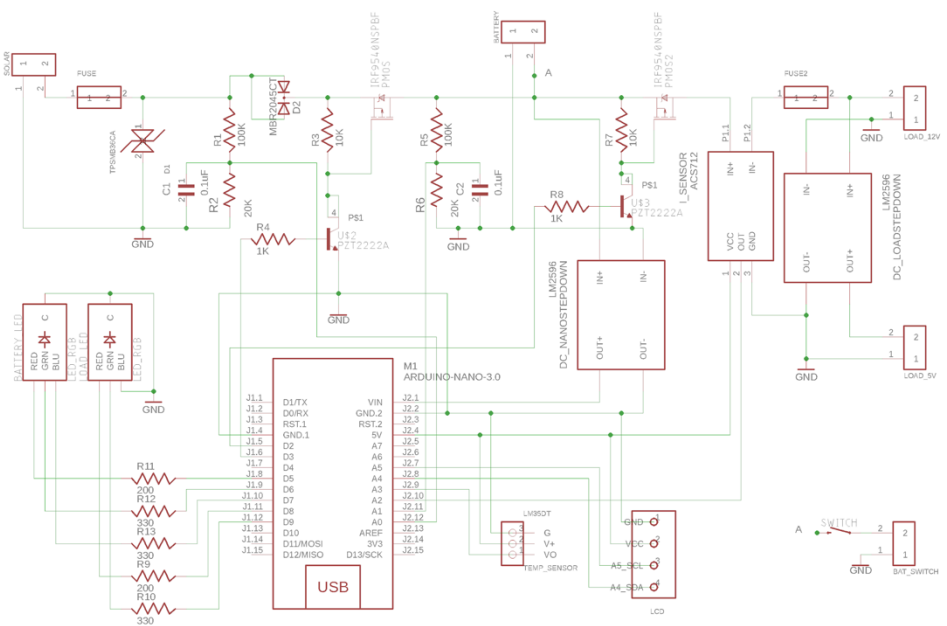
2-Stage Battery Method

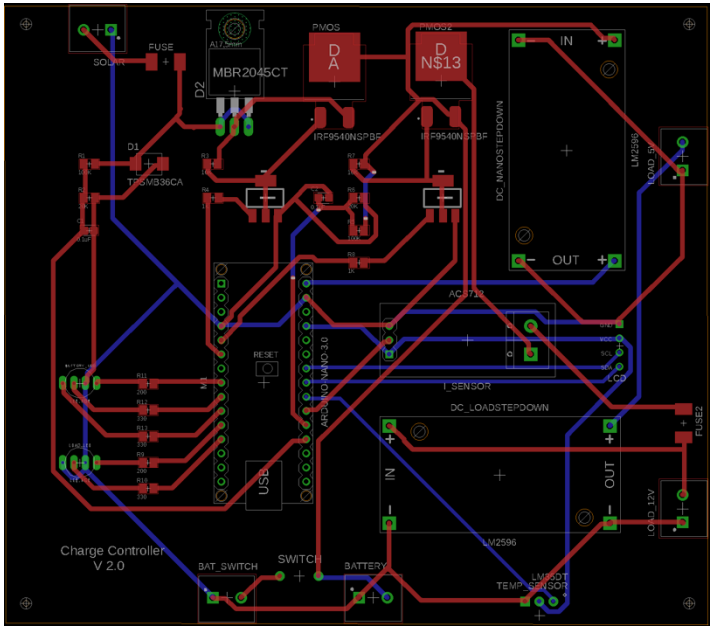
1. Bulk Stage - maximum charge to preset battery voltage value. (BULK_CH_SP = 14.4)

2. Float Stage - battery voltage is reduced after charge is complete. This is to prevent gassing of the battery. (FL_CH_SP =13.6V)



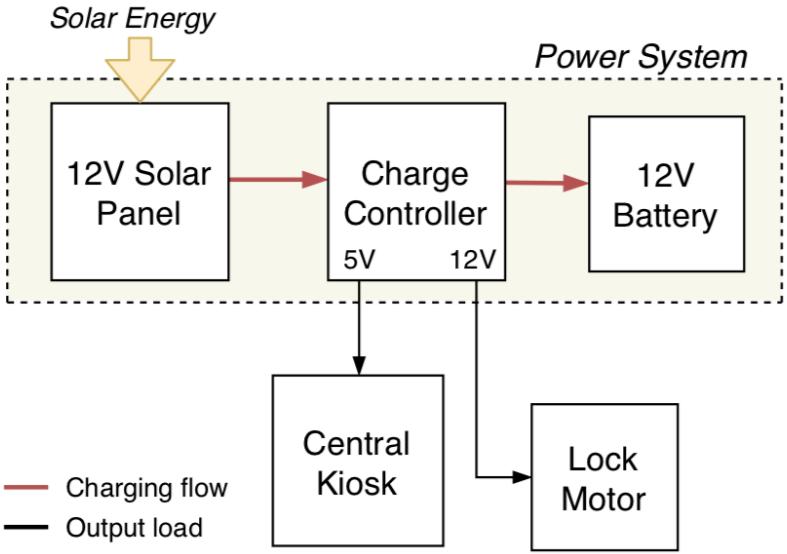
SCHEMATIC & PCB





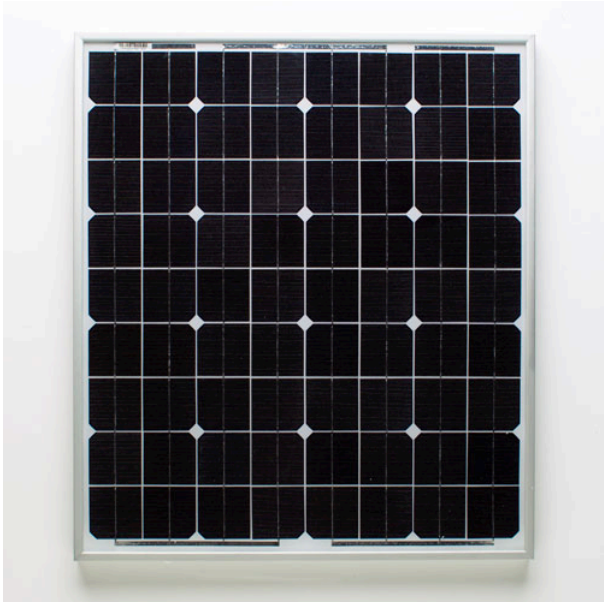
POWER SYSTEM

- Off-Grid Solar Powered
- Energy Independence = competitive



SOLAR PANEL

12V Monocrystalline Solar Panel	
Manufacturer	Renogy
Max Power	50W
Operating Voltage	18.5 V
Operating Current	2.70 A
Weight	9.9lbs
Cost	$88.00

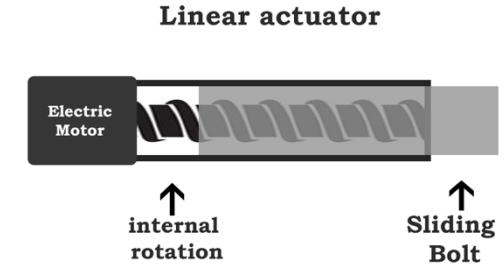


BATTERY

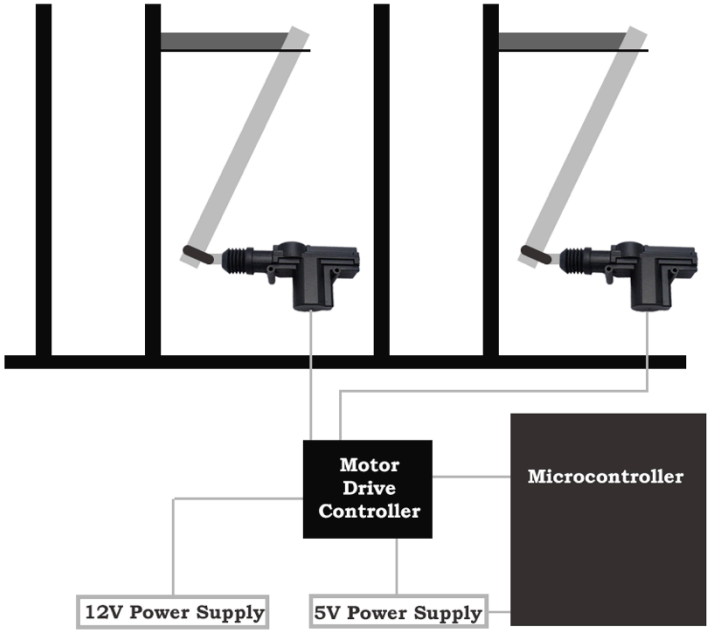
12V AGM Sealed Lead Acid Battery	
Manufacturer	Universal Power Group
Operating Voltage	13.6-14.9 V
Initial Current	5.25A
Amperage	33 Ah
Cost	$64.99

LOCK MOTOR

Manufacturer	Progressive	InstallGear
Part Number	PA-14-6-35	IGDLA-2
Voltage	12 VDC	12 VDC
Stroke distance	6”	1”
Retracted Length	10.13”	5.31”
Current (max)	5A	2.6A
Water Resistant	Yes	Yes
Price	**$111.99**	**$9.99**



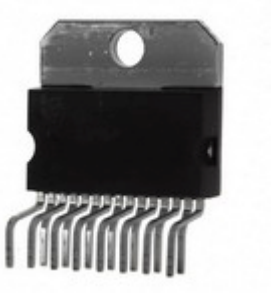
LOCKING MECHANISM



Lock Operation		
	Locked (Pull)	Unlocked (Push)
Input 1	+	-
Input 2	-	+

MOTOR DRIVER

L293N Dual Full-Bridge Driver
Drives up to two DC motors simultaneously
Total max DC current 4A
Features clockwise and anti-clockwise
Total power dissipation 25W
Price $6.99



ISSUES

Budget
More funding for more secure components

Wireless Connectivity
Replaced ESP-01 with ESP-12E

Motor Driver
Replaced L293D with L292N

Charge Controller
PWM Vs. MPPT

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WORK DISTRIBUTION

Name	Mobile App	Embedded Systems	Charge Controller	Housing/ Lock Mechanism
Joel	**Primary**	Secondary		
Vanessa	Secondary	**Primary**		
Trung			**Primary**	Secondary
Amanda			Secondary	**Primary**

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BUDGET

Item	Price/Unit	Quantity	Total Cost
50W 12V Renogy Solar Panel	$132.03	1	$132.03
12V 35Ah Lead Acid Battery	$64.99	1	$64.99
UNO Project Starter Kit	$34.99	1	$34.99
ATMega328P w/ Bootlader 3pc	$13.98	1	$13.98
Keypad	$4.87	2	$9.75
ESP8266 12E Node MCU	$8.39	1	$8.39
ESP8266 12E	$5.89	1	$5.89
RTC	$5.99	1	$5.99
12V Lock Actuator (2pc)	$9.57	1	$9.57
ACS712 Current Sensor Module	$7.20	2	$14.40
Arduino NANO	$7.99	1	$7.99
TVS Diodes	$6.41	2	$12.82
20x4 LCD Module	$12.99	1	$12.99
LM35 Analog Sensor	$6.99	1	$6.99
Various Electrical Components	Various	Various	$150
Building Materials	Various	Various	$150

Total: $640

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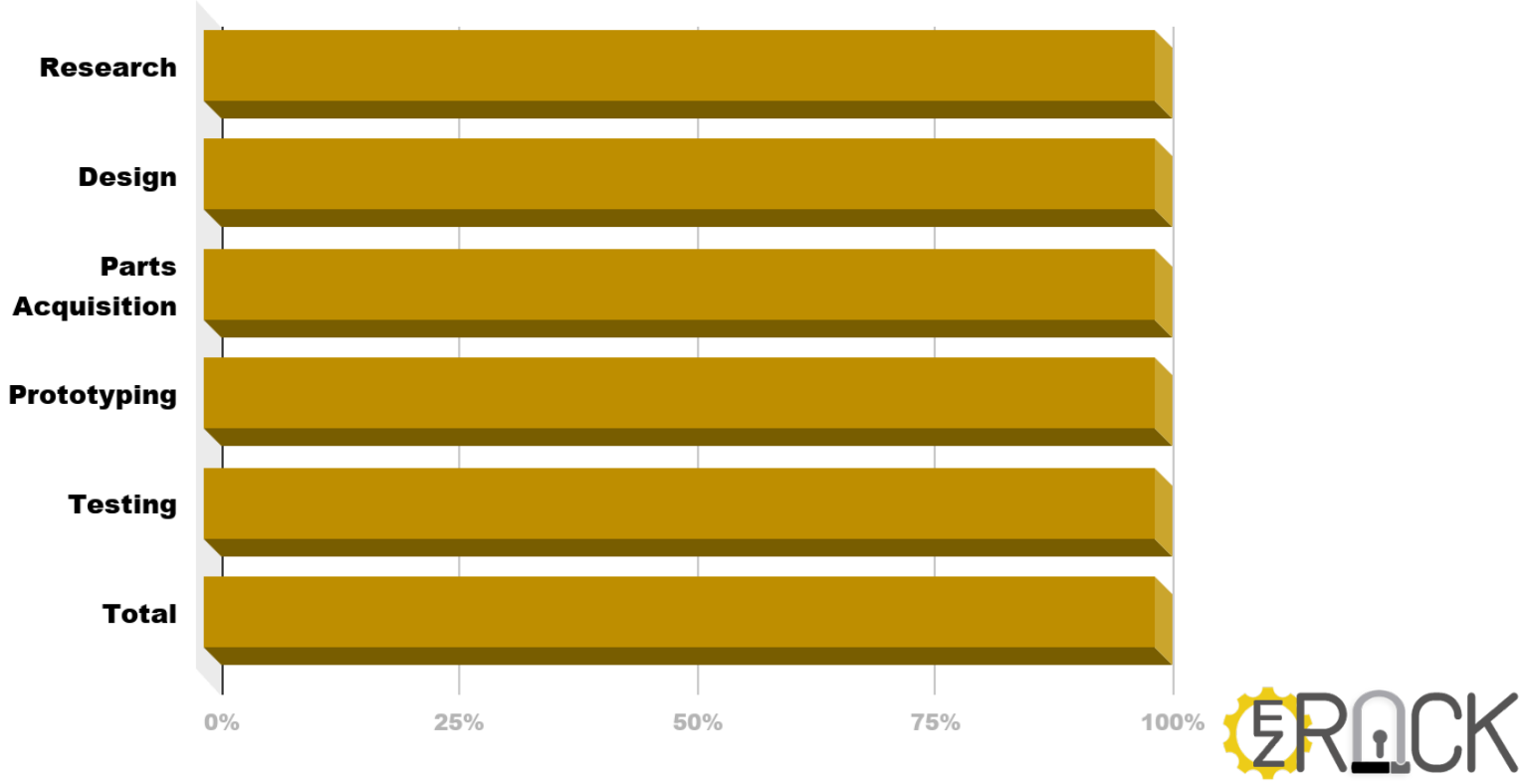
PROGRESS


Research
Design
Parts Acquisition
Prototyping
Testing
Total
0%
25%
50%
75%
100%

Questions?