EzRack

Smart Bike Rack System

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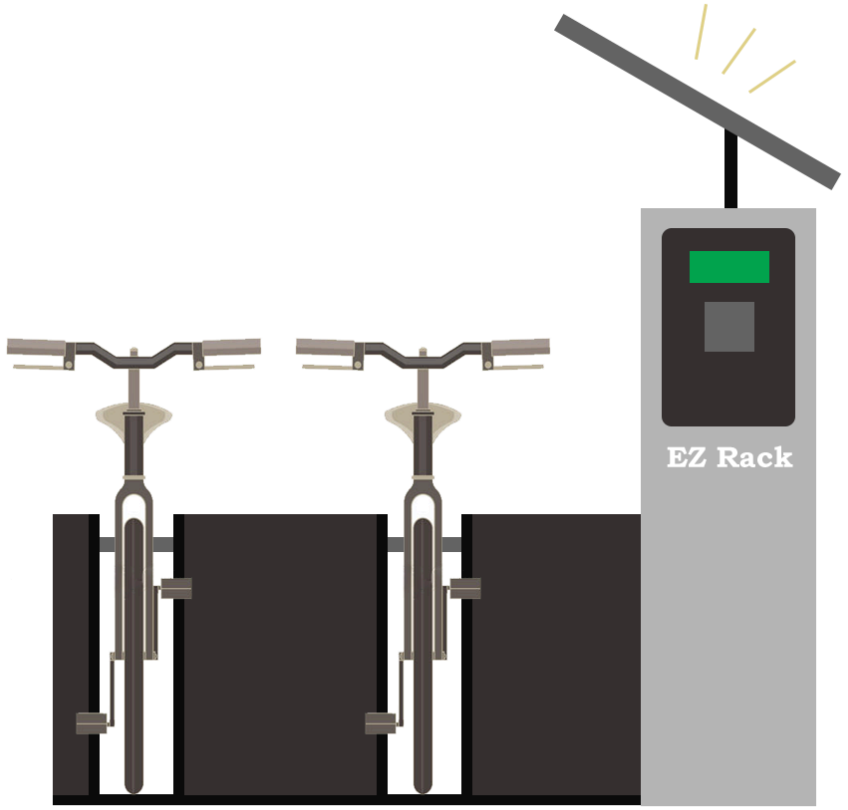
Motivation

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.

Goals and Objectives

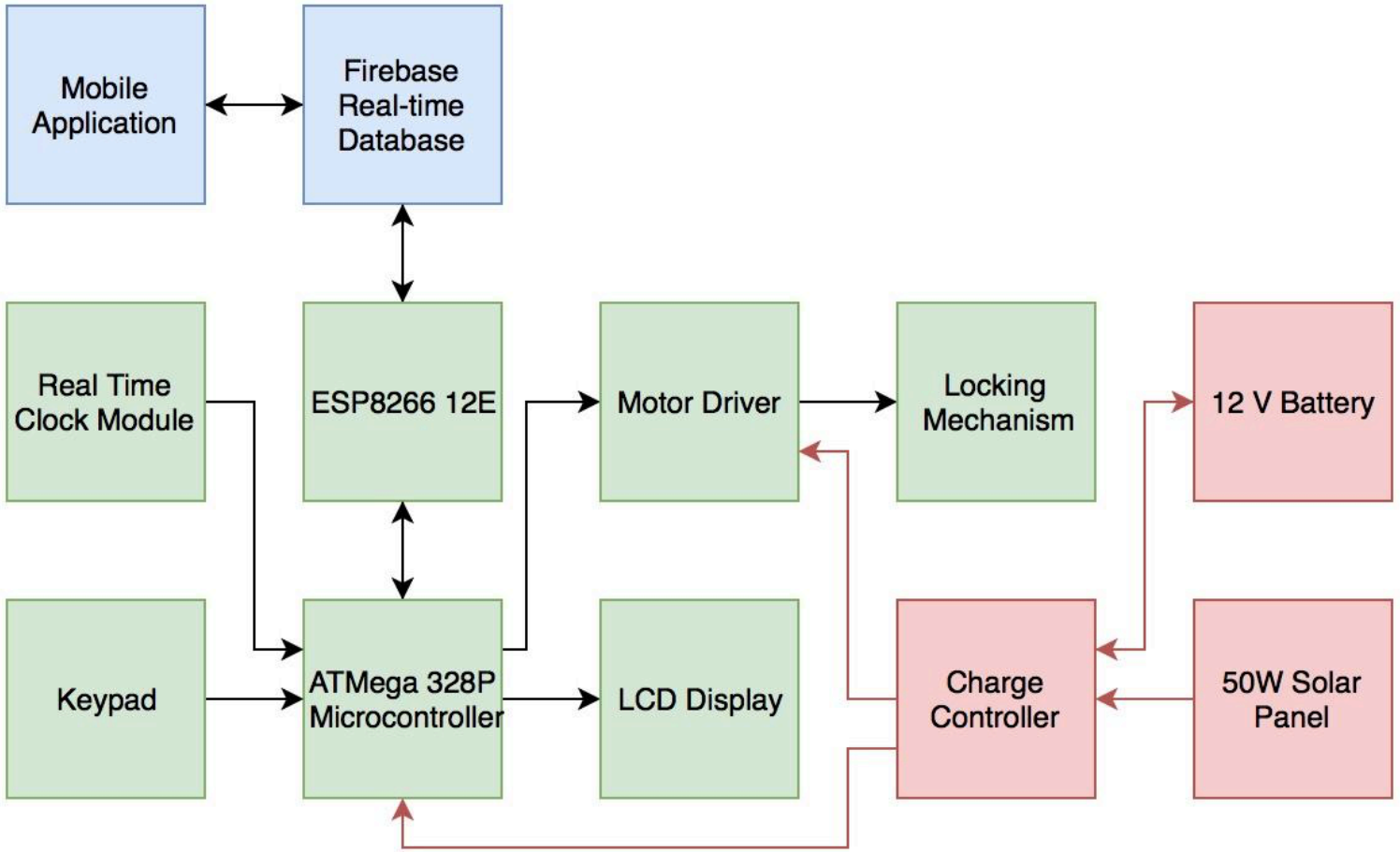
- Provide a convenient place to store your bike
- Eliminate the worry of having to carry a lock and chain
- Provide a means of reserving a slot and checking availability
- Self-sufficient with power provided by a solar panel



Specification

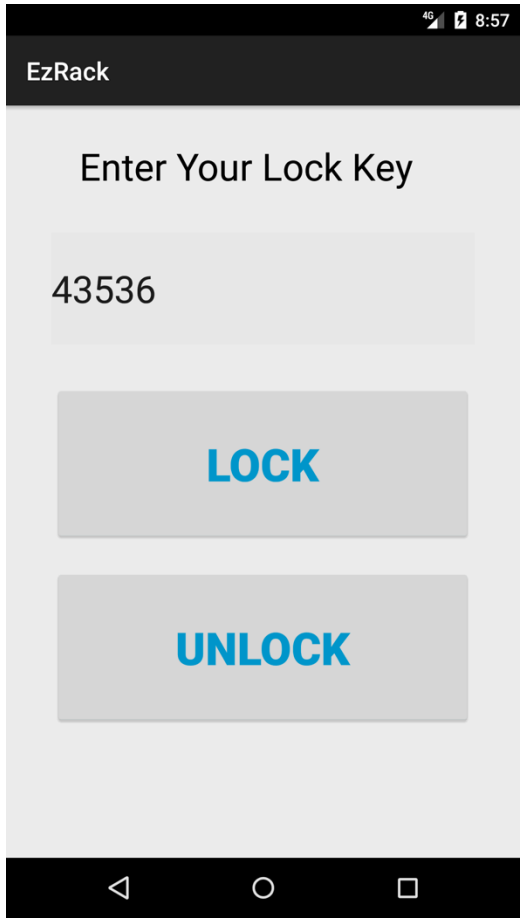
- Must be able to securely lock at least 2 bikes
- Must be able to hold bike wheels with a range of 26” - 28”
- Must free reserved slots after the allotted reservation time has passed
- Must be able to lock/unlock within 2 seconds of user input from the UI
- Power system must supply 12V
- Must be able to operate for 6 hrs without a recharge

System Design Block Diagram



Mobile Application

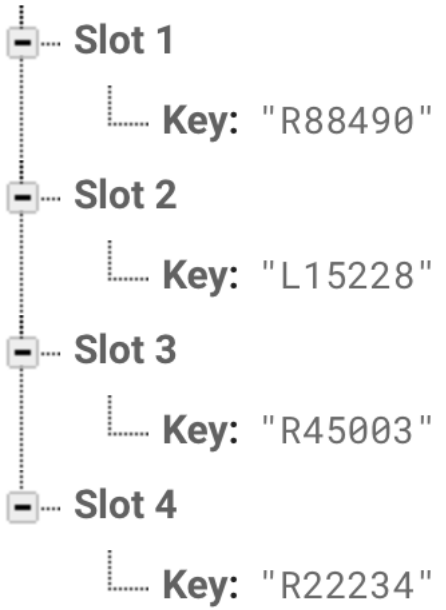
- Android application allows users to reserve, lock, and unlock, their slot directly from their android device.
- Reservations will be held for a maximum of 15 minutes.
- Users may choose to sign in or use the app as a guest. Signing in provides added security.



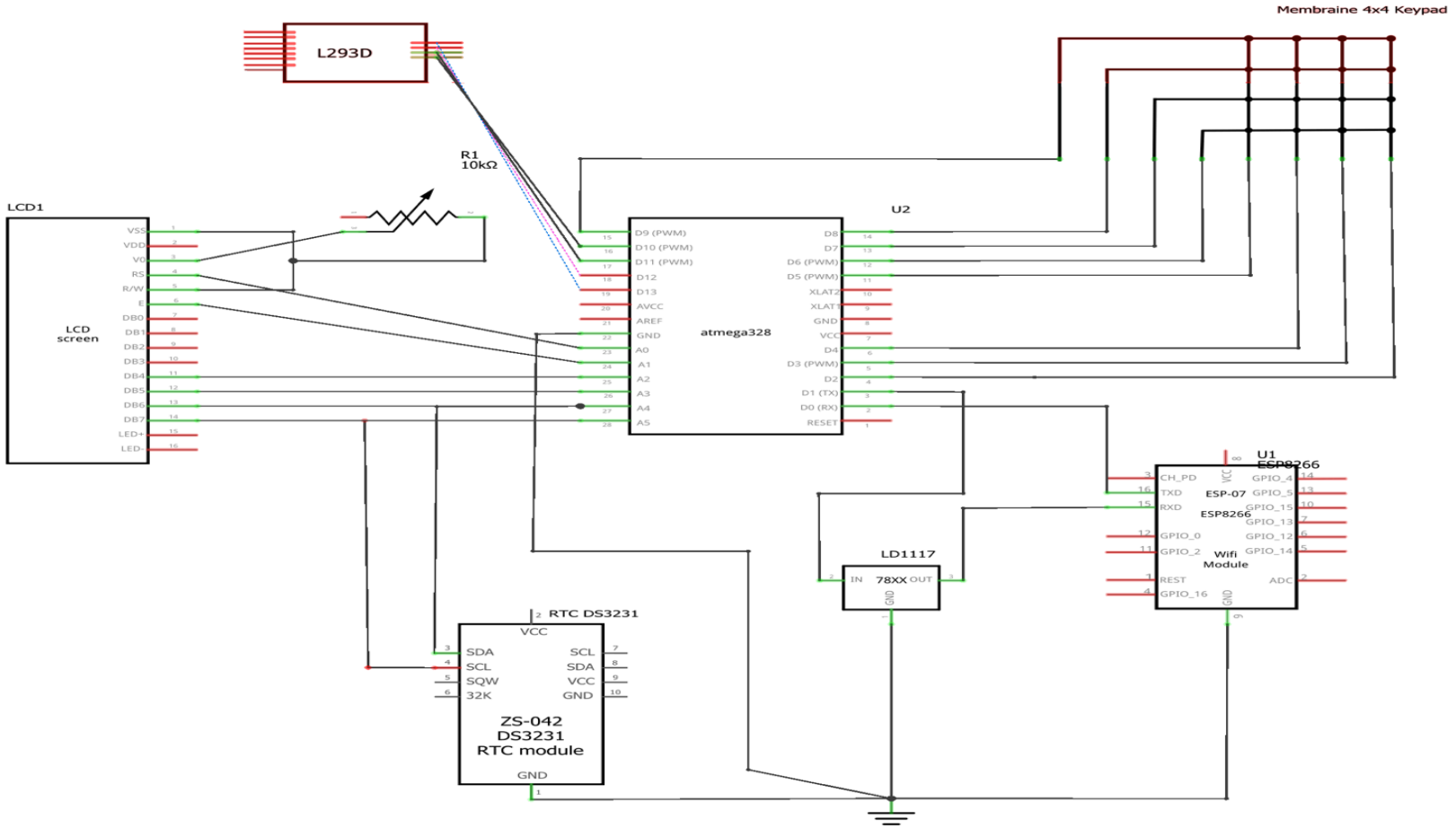
Firebase

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

Authentication: Allows users to sign in using a variety of different accounts and providers including Google, Facebook, email, and phone.



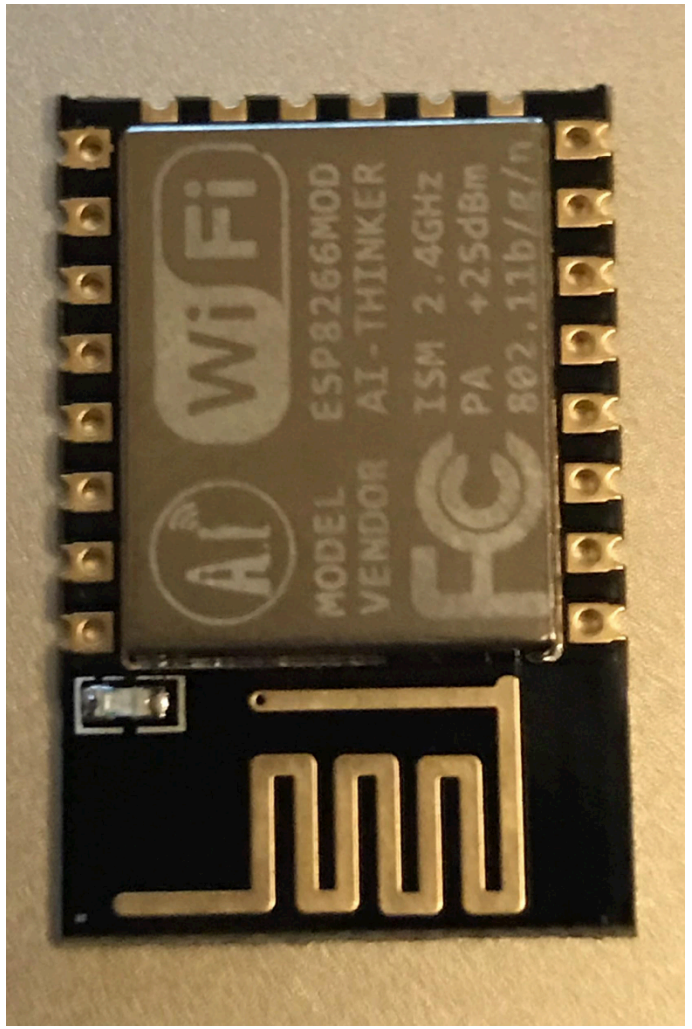
System Diagram



Wi-Fi Connectivity

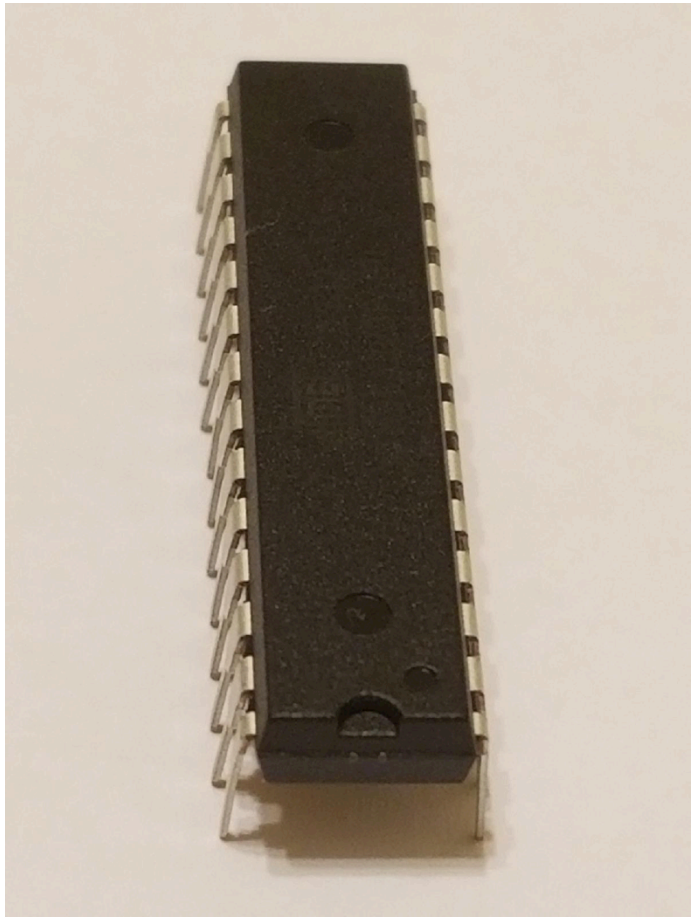
ESP 8266 12e: Used to wirelessly connect to the firebase with the aid of Firebase-Arduino libraries. This sends and receives data from both the Firebase and main MCU.

Specifications	
Wireless Standard	IEEE 802.11 b/g/n
Frequency Range	2.412 - 2.484 GHz
IO Capabilities	UART, I2C, PWM, GPIO, 1 ADC
Cost	$5.89
Operating Voltage	3.3 V



ATMega328P

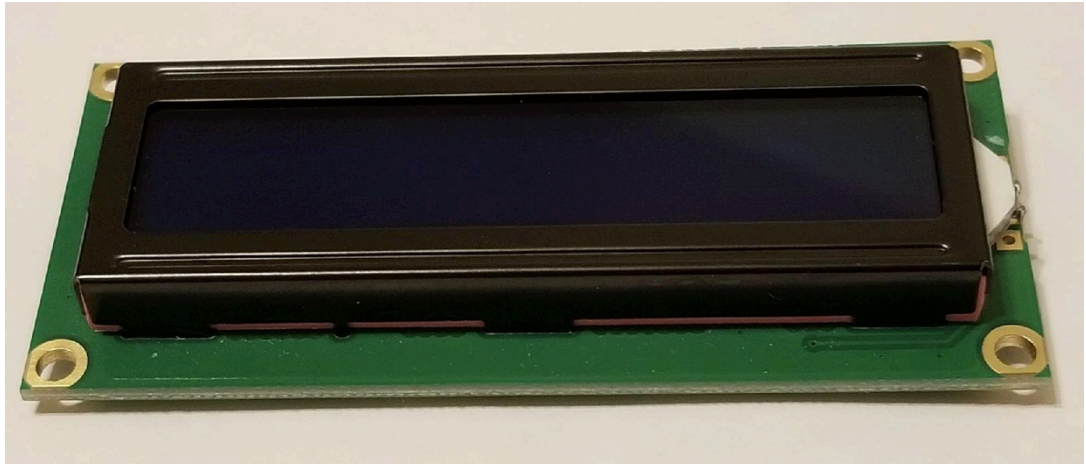
Specifications	
Pin Count	28
Flash Memory	32 KB
CPU Type	8-bit AVR
Number of I/O Pins	23
Cost w/ Bootloader	$4.66
Operating Voltage	1.8 V – 5.5 V



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.

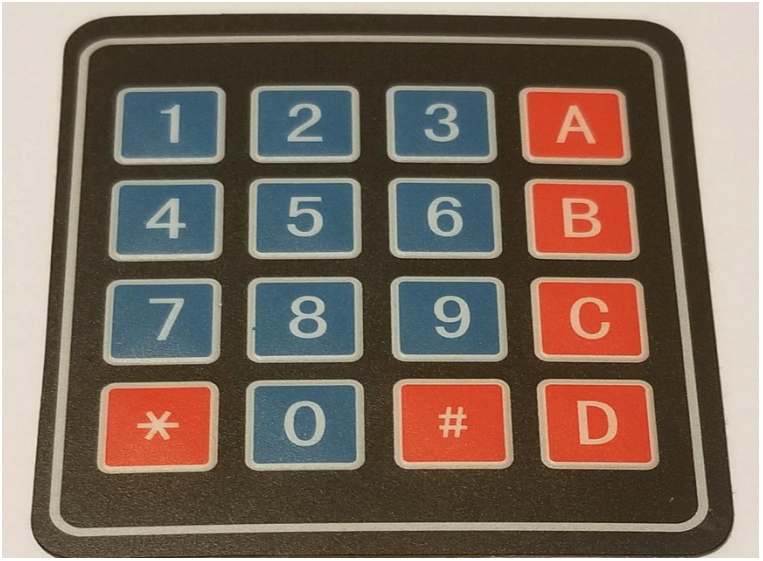
Specifications	
Operating Voltage	5 V
Display Format	16 Character x 2 Lines
Cost	$5.99



Keypad

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

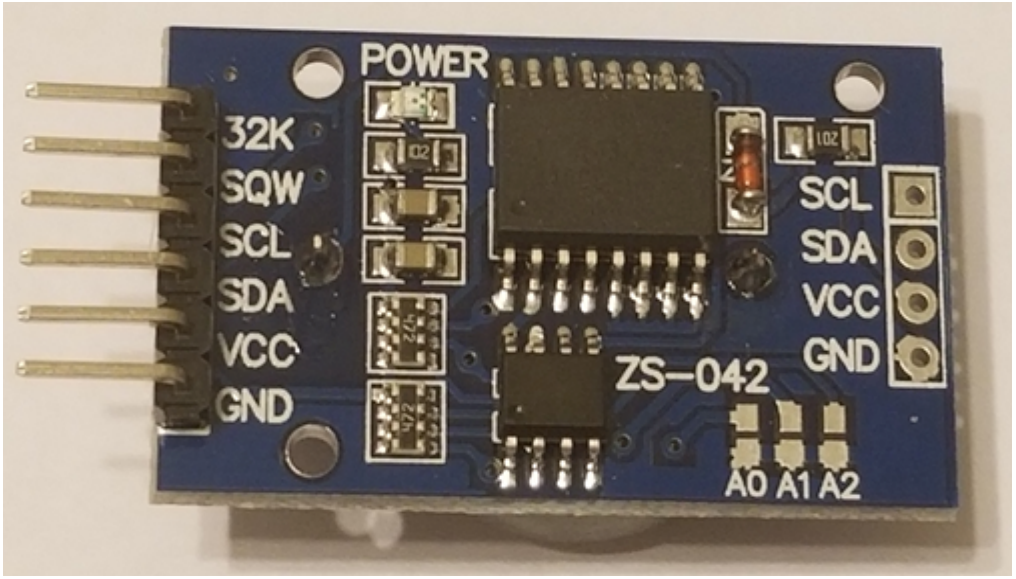
Specifications	
Maximum Rating	24 VDC, 30mA
Interface	8 pin access to 4x4 matrix
Cost	$ 3.40



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.

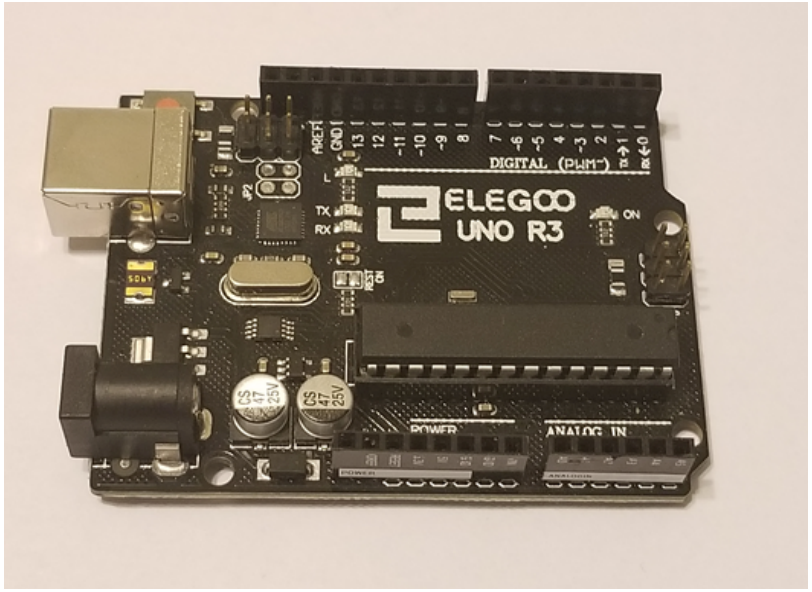
Specifications	
Operating Voltage	3.3 V
Accuracy	±2ppm from 0°C to +40°C
Cost	$6.99



Testing

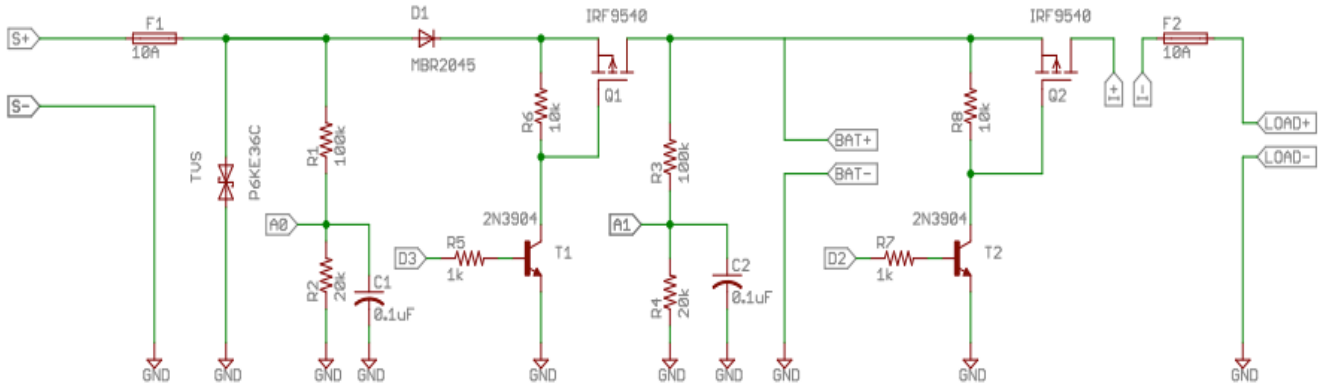
The UNO R3 Development board is used for prototyping and testing.

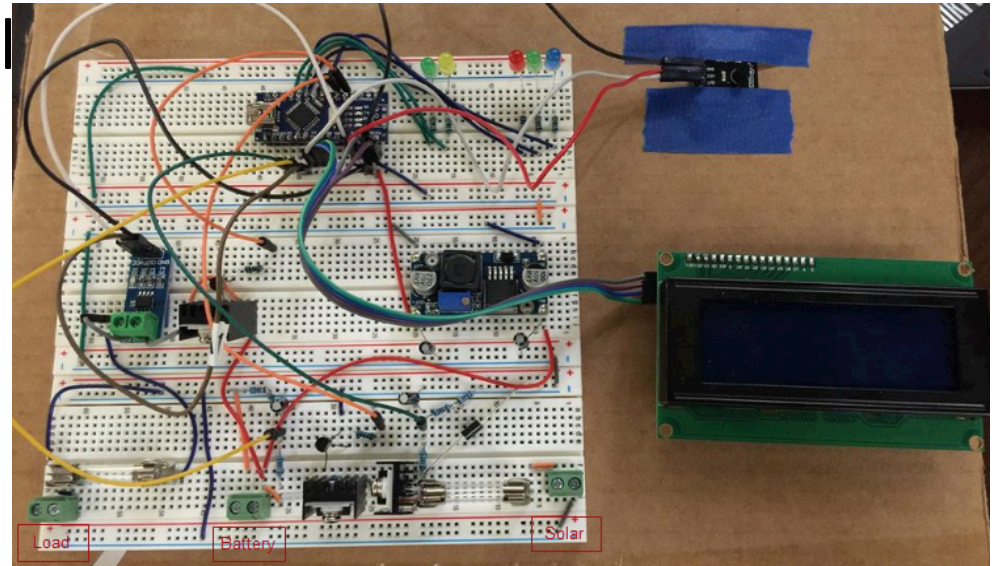
Specifications	
Microcontroller	ATMega328p
Operating Voltage	5 V
Flash Memory	32 KB
Cost	$16.99



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





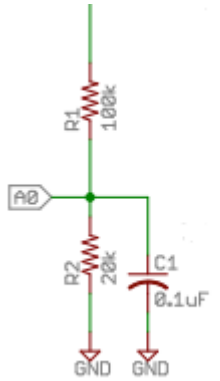
Charge controller MPPT vs PWM

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).	

Charge Controller Sensor

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

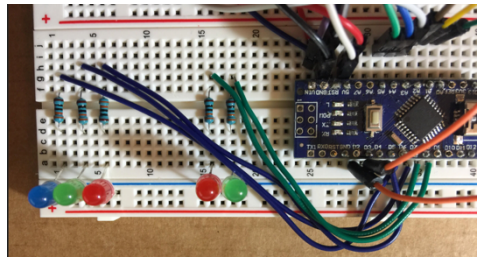
Current Sensor

Note: Assuming arduino nano Vcc = 5V reference. Otherwise ADC count must be calibrated on ADC pins.

Charge Controller Display/LED

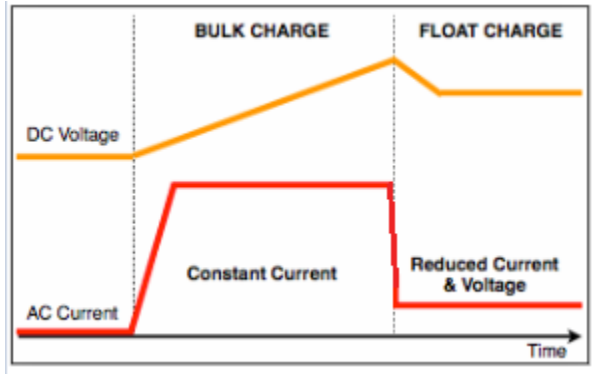
- 20x4 LCD Display
  - Solar Wattage
  - Battery Wattage
  - Temperature
  - State of charge
    - Charging
    - Not Charging
  - Current
  - Load Energy and Power
    - P=V*I; E = P*t

- 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



Charge Controller Charging Algorithm

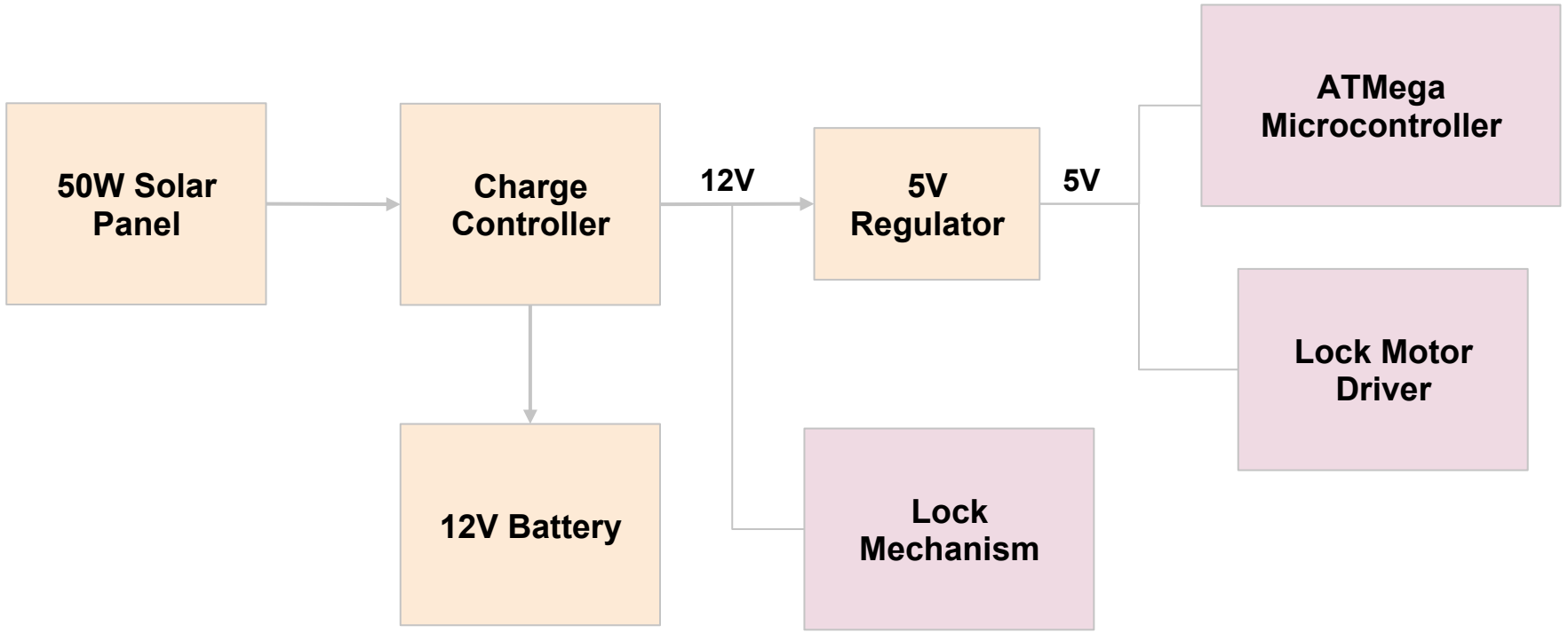
2-Stage Battery Method



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)

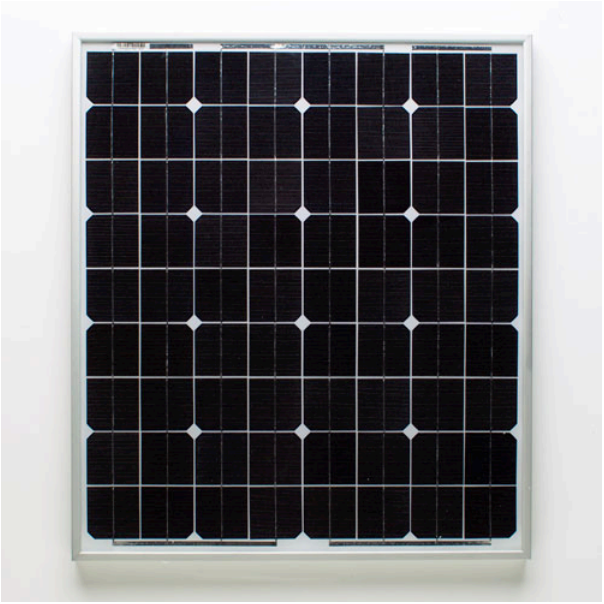
Power System

- Off-Grid Solar Powered
  - Energy Independence = competitive



Solar Power

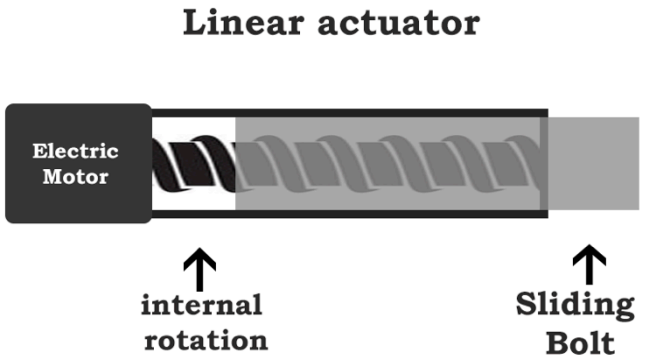
12V Monocrystalline Solar Panel	
Manufacturer	Renogy
Max Power	50W
Operating Voltage	18.5 V
Operating Current	2.70 A
Weight	9.9lbs
Cost	$88.00



12V 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

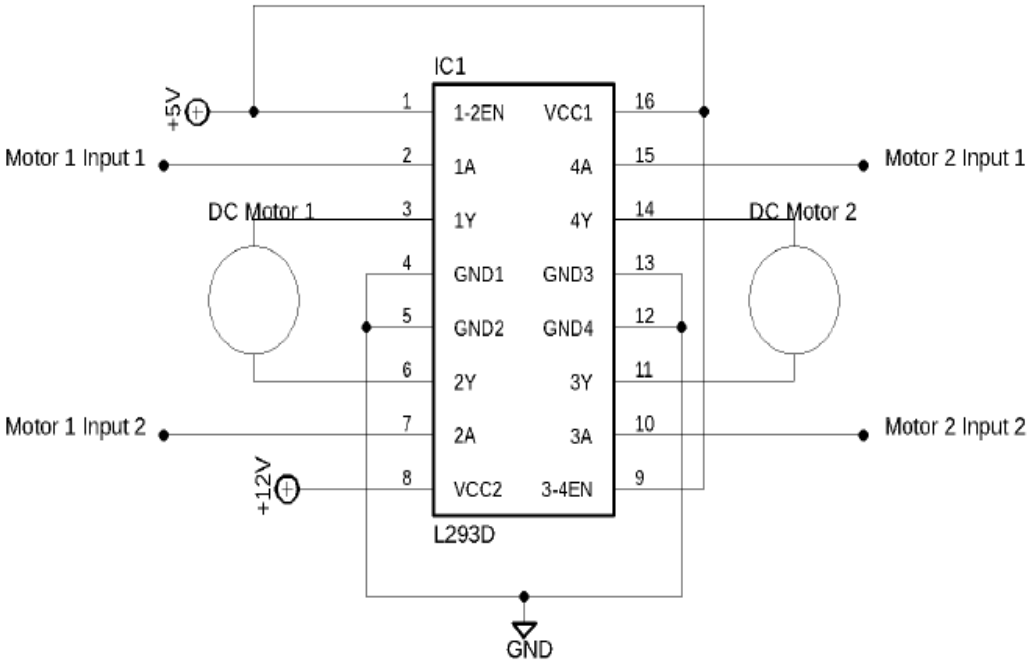
Locking Mechanism

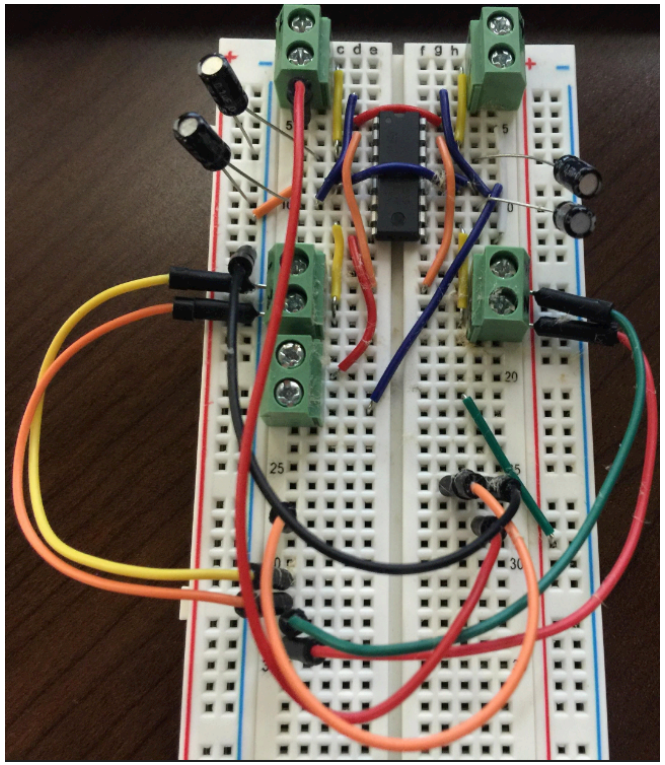
Manufacturer	Progressive Automations	InstallGear
Part Number	PA-14-6-35	IGDLA-2
Voltage	12 VDC	12 VDC
Stroke distance	6”	1”
Retracted Length	10.13”	5.31”
Current (max)	5A	2.6A
Water Resistant	Yes	Yes
Price	**$111.99**	**$9.99**



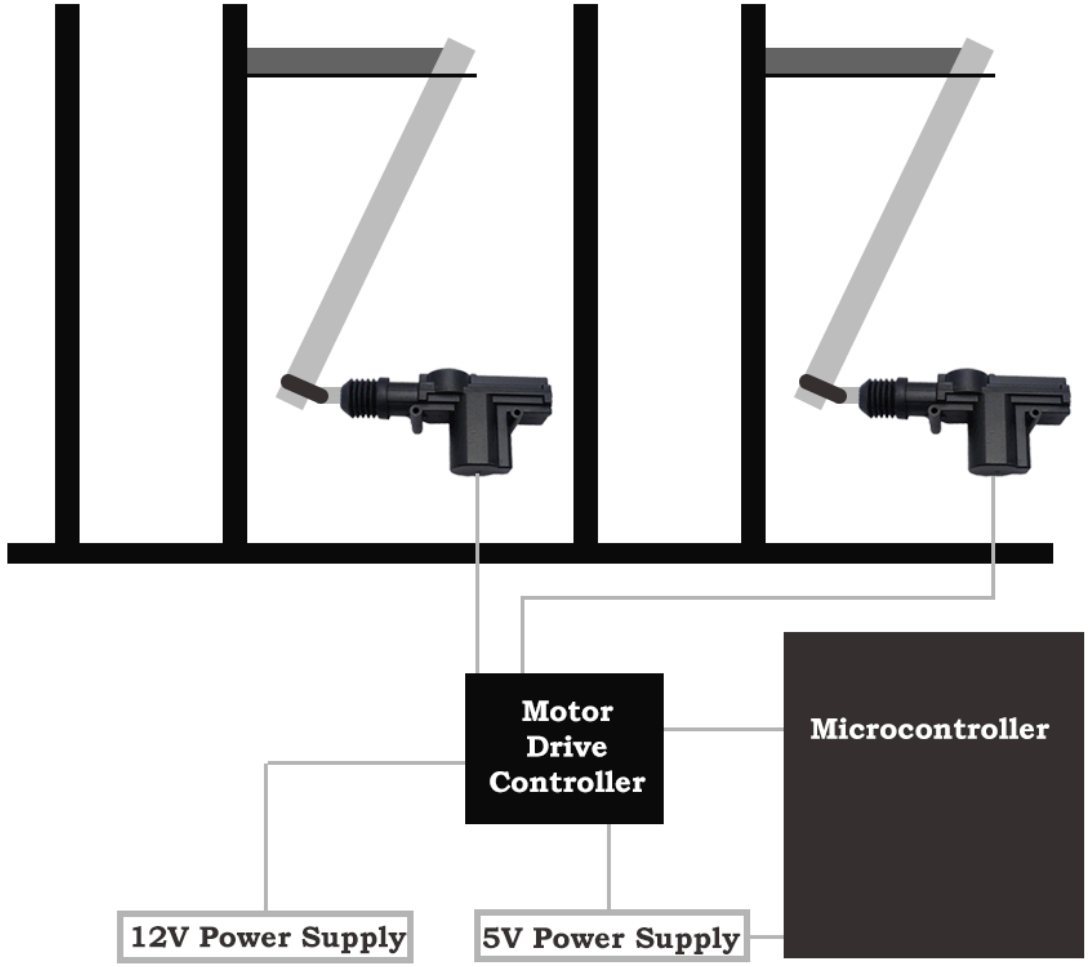
Motor driver

- L293D IC - dual H-bridge
  - Drive up to two DC motors simultaneously
  - Features clockwise and anticlockwise





Locking Mechanism Design



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

Issues

Budget
More funding for more secure components

Wifi Module Connectivity
Replaced ESP-01 with ESP-12E

Charge Controller Design
PWM Vs. MPPT

Work Distribution

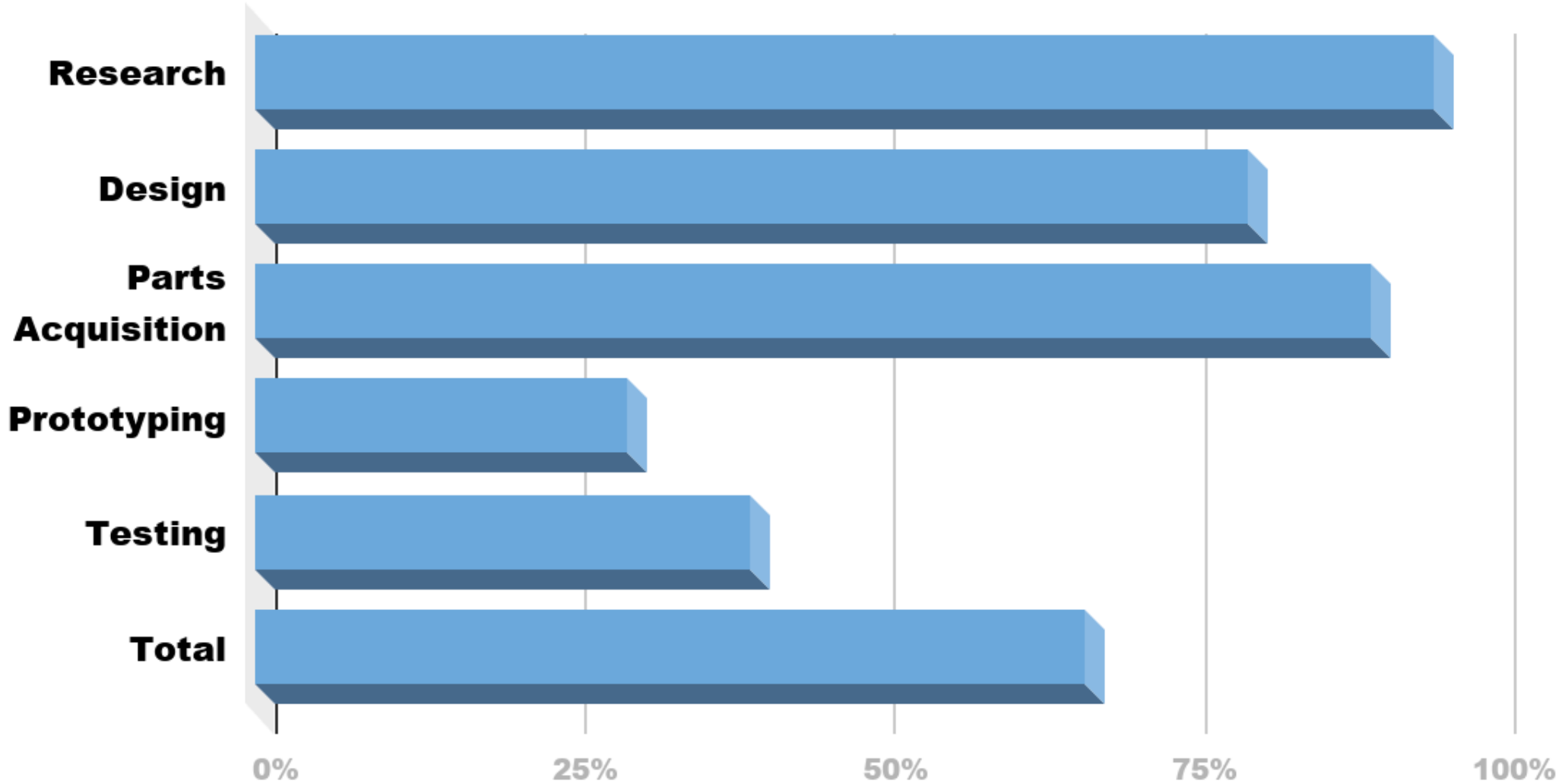
Name	Software: Mobile App	Embedded Systems	Power System	Housing/ Lock Mechanism
Joel	Primary	Secondary		
Vanessa	Secondary	Primary		
Trung			Primary	Secondary
Amanda			Secondary	Primary

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
Floor Bike Rack	$27.77	1	$27.77
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	$100
Building Materials	Various	Various	$80

Total Cost $548.54

Progress


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

Questions?