SOAREBOARD

Group 15

Electrical Engineering

Meet the Team!

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Motivation

Advantages:

Eco-friendly, fast, and convenient transport.

Harnessing solar energy for extended rides.

Affordable, sustainable, and fun.

Be the Change:

Support a cleaner, brighter future.

Empower others to join the green movement.

Join the Journey:

Revolutionizing urban mobility.

Together, we power the future!

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What is it?

- Our SOAREBOARD is a solar powered electric skateboard
- Riders will be able to control the board using an app that is connected through bluetooth

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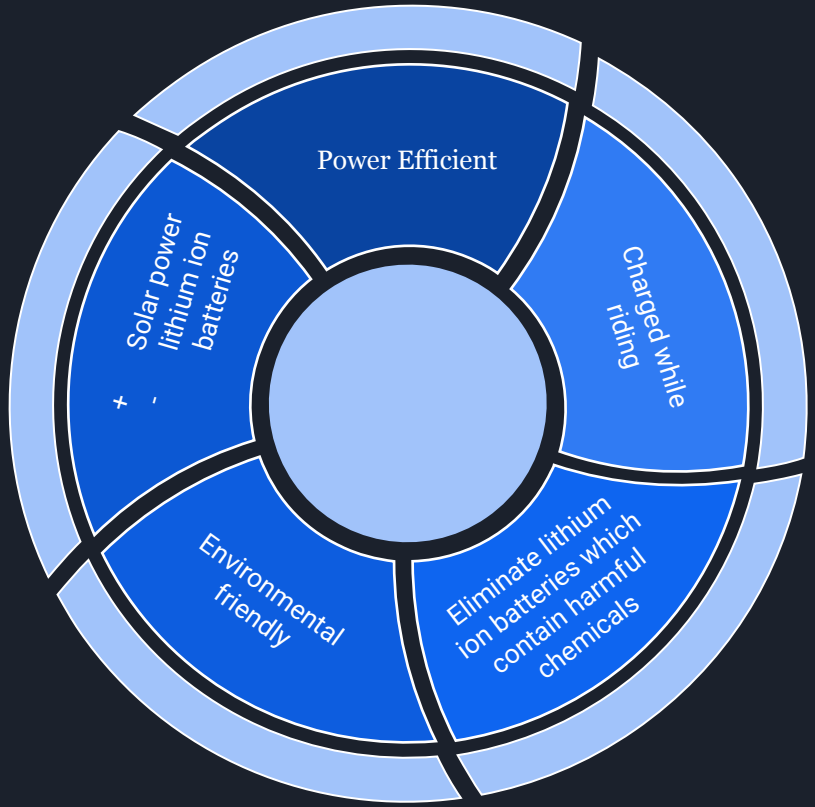
Benefits of Soareboard compared to others



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Previous Skateboards

- Simplistic design
- Have to push a lot
- They are convenient and light, but a lot of work
- Sustainable future due to no carbon emissions

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Motivation

- Want an eco-friendly alternative
- Promote sustainable transportation solutions
- Increased accessibility and affordability
- Versatile and enjoyable experience for all riders with different levels of expertise
- Same speed and convenience as regular e-boards

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Goals/Objectives

- Overall: Create an electric skateboard powered solely by solar power.
- Project Goals:
  - Basic goal - charge the battery with solar cells
  - Advanced goal - Detect and Warn the user when raindrops are detected inside the solar cells location on the board.
  - Stretch goal - enable remote control operation
- Design Goals:
  - Extensive battery for worry-free life
  - High speeds for efficient transportation
  - Safety ensured through wheels and deck
- Enhanced Features:
  - Exterior LED lights for increased visibility and safety

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Engineering Specifications

Component	Parameter	Design Specification
Solar Cells	Accuracy	Charge battery 90%
App Controller	Response time	60 Seconds
Motor and Motor Drivers	Weight	Carry 130 pounds within 10 seconds to start moving
Rain Sensor	Accuracy	2%
Ultra Sonic Sensor	Accuracy	Left: 2% | Right: 2%
App connection to board	Response time	30 Seconds
Motor	Max. Speed	< 19 MPH

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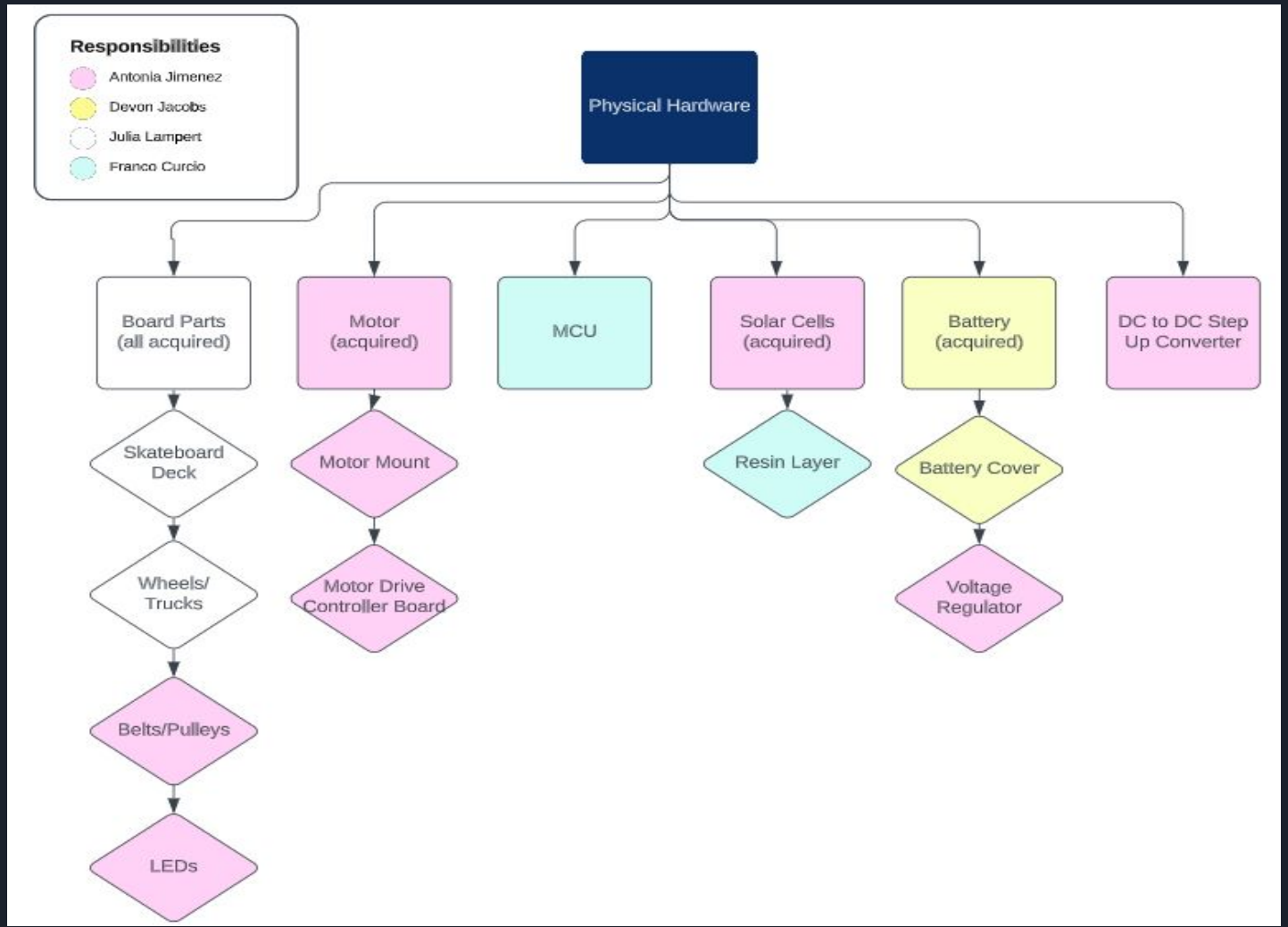

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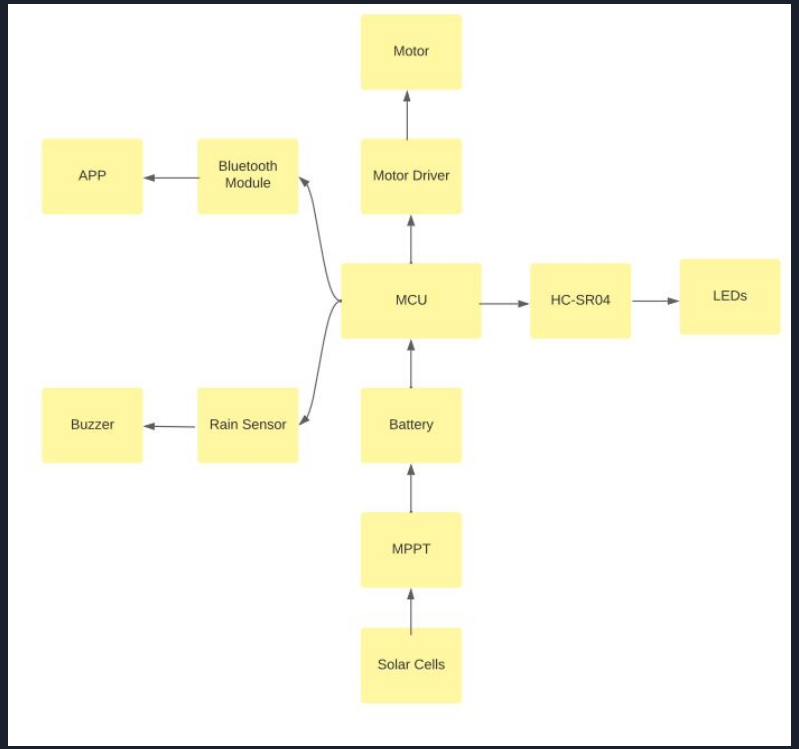
Power Flow Chart



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Microcontroller Technology Comparisons

Microcontroller Technology	Programming Language	Development Environment	Flash Memory	RAM	Clock Speed	Operating Voltage	Cost	Power Consumption
Arduino	C/C++	Arduino IDE	Varies (Up to 512 KB)	Varies (Up to 16 KB)	16 MHz	5V	Low	Low
ESP8266	C/C++	Arduino IDE	512 KB	80 KB	80 MHz	3.3V	Low	Low
ESP32	C/C++	Arduino IDE	Up to 4 MB	Up to 520 KB	Up to 240 MHz	3.3V	Low to Moderate	Low to Moderate
Raspberry Pi	Various	Linux OS, IDEs	MicroSD Card	1 GB (Pi 4B)	1.2 GHz	5V or 3.3V	Moderate	Moderate to High

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Arduino Microcontroller Comparisons

Microcontroller	Clock Speed	Flash Memory	RAM	GPIO Pins	ADC Channels	PWM Channels
Arduino Uno	16 MHz	32 KB	2 KB	14	6	6
Arduino Mega 2560	16 MHz	256 KB	8 KB	54	16	15
Arduino Nano	16 MHz	32 KB	2 KB	22	8	6
Arduino Due	84 MHz	512 KB	96 KB	54	12	12
Arduino Leonardo	16 MHz	32 KB	2.5 KB	20	12	7
Arduino Pro Mini	16 MHz	32 KB	2 KB	14	8	6

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Arduino Uno

Arduino Uno Specifications:

- Connects to BlueTooth module
- Clock: 16 MHz
- Voltages: 7-12V input, 5V output
- Dimensions: 68.6x53.4mm
- Weight: 25g

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Battery Type Comparisons

Battery Type	Energy Density (Wh/kg)	Voltage Range	Cycle Life	Charging Time	Weight (kg)	Cost (USD/kWh)
Lithium - Ion	150-200	36V-48V	500-1000 cycles	2-4 hours	2-3	$150-$200
Lithium Iron Phosphate	90-120	24V-36V	1000-2000 cycles	4-8 hours	3-4	$30-$150
Lead Acid	30-50	12V-24V	150-300 cycles	6-12 hours	5-8	$50-$100

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Battery Comparisons

Battery	Capacity (Ah)	Voltage (V)	Energy Density (Wh/kg)	Weight (kg)	Cycle Life	Charging Time (hours)	Price (USD)
Miady 2000 Cycles 12V 6Ah	6 Ah	12V	70-120	0.75	2000	2-4 hours	$36
Renogy LiFePO4 12V 10Ah	10 Ah	12 V	90-120	1.2	2000	3-5 hours	$120
Expert Power 12V 12Ah	12 Ah	12 V	100-130	1.8	2000	2-4 hours	$80

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Battery

Battery Specifications:

- 12 volts, 6AH, LiFePO4 battery
- 76.8 Wh
- Physical dimensions are 3.54 x 2.75 x 4.33 inches
- 1.65 pounds (~0.75 kg)
- Recommended for small electric vehicles

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Solar Cell Technology Comparisons

Solar Cell Type	Efficiency	Size (mm)	Cost (USD per cell)	Key notes
Monocrystalline	15%-22%	100x100	$5-$10	- Long lifespan - High performance in high temperatures
Polycrystalline	13%-16%	100x100	$3-$7	- Durable - Reliable - Widely available
Thin-Film	10%-12%	150x150	$2-$5	- Flexible - Lightweight

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Solar Cell Comparisons

Solar Cell	Efficiency	Size (mm)	Voltage (V)	Current	Power Output (W)	Price (USD per panel)	Key Features
SUNYIMA 10Pcs Mini Polycrystalline Solar Panels Cells	13%-16%	67.8 x 36.8	5V	60mA	0.3W	$16.95 (for 10 panels)	Compact Size & High Efficiency
ACOPOWER 12W Polycrystalline	12%	337 x 204	12V	1A	12W	$19.90	Corrosion - Resistant & High Voltage Output
ALLPOWERS 10W Polycrystalline	10%-12%	340 x 245	12V	0.56A	10W	$20	High Voltage Output

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Why did we pick SUNYIMA Solar Cells?

1. Polycrystalline solar cells are less expensive, durable and reliable and are widely available in the market.
2. The available space on top of the deck is really limited, so the dimensions are perfect for our project's purpose.
3. Holds 5 volts and a higher amount of current, enabling higher power output and increase energy production.
4. Most importantly environmentally friendly.

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SUNYIMA Solar Cells

Specifications:

- Current: 60 mA
- Working Voltage: 5 Volts
- Dimensions 2.67x1.45 inches
- Polycrystalline Panels

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Motor Type Comparisons

Type of DC Motor	Design	Applications	Efficiency	Speed Control	Cost
Brushed DC Motor	Uses brushes and commutators	Appliances, toys, power tools	Moderate Efficiency (75%-90%)	Control speed using voltage regulation	$20-$100
Brushless DC Motor	Uses electronic controllers	Industrial automation, electric vehicles, computer cooling fans	High Efficiency (85%-95%)	Requires more complex ESC methods	$50-$300
Series DC Motor	Field windings connecting in series with the armature	Heavy-duty applications: electric locomotives, cranes, and elevators	Moderate to high (80%-90%)	Can be controlled using voltage regulation or field weakening techniques	$30-$150

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Brushed Motor Comparisons

Motor	KV Rating	Max Output Power (Watts)	Weight (grams)	Noise Output (dB)	Efficiency (%)	Price (USD)
775 Motor	10,000 - 20,000 RPM/V	Up to 200 W	200	Low	50-80%	$30
RS-550 Motor	18,000 RPM/V	Up to 200 W	170	Moderate	50-80%	$20
540 Motor	12,000 - 15,000 RPM/V	Up to 100 W	180	Moderate	50-80%	$20
360 Motor	5,000 - 7,000 RPM/V	Up to 20 W	60	Low	50-80%	$15

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Motor 775

Motor 775 Power DC Motor Specifications:

- Voltage needed: 12V
- Motor Diameter: 42mm
- Motor Length: 66.5 mm
- Motor Weight: 350g

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Motor Drive Technology Comparisons

Motor Driver Type	Design	Control Method	Efficiency	Cost	Applications
Integrated Motor Driver	Combines functionality of motor driver & microcontroller in one integrated circuit	Offers flexible control methods including: PWM, serial communication, & sensor based control	85%-95%	$10-$100	Small consumer electronics, drones
H-Bridge Motor Driver	Controls direction & speed of a DC motor using four switches	Bi-directional control & speed control using PWM	75%-90%	$5-$50	Robotics, hobby projects
Stepper Motor Driver	Controls motion of stepper motor by sending electrical pulses to motor windings	Precise position control through precise pulse sequences	80%-90%	$10-$80	3D printers, CNC machines

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H - Bridge Motor Driver Comparisons

Motor Controller	Voltage Range	Maximum Current	Motor Channels	Control Interface	Price
L298N Motor Driver	4.5V - 46V	2A per channel (4A peak)	Dual	PWM/TTL	$10
HiLetgo BTS7960 43A	5V-35V	Up to 43A	Dual	PWM, Direction Control, Current Limit	$10
TB6612FNG Dual H-Bridge Motor Driver	2.7V-5.5V	Up to 1.2A per channel (3.2A peak)	Dual	PWM, Direction Control	$13.50

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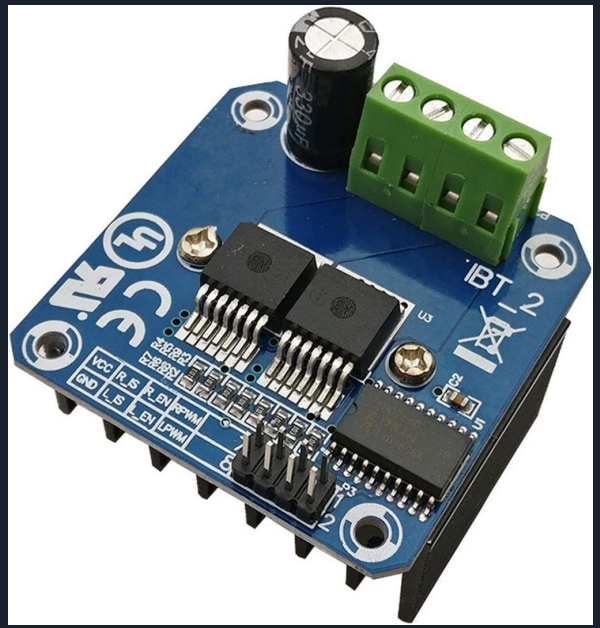
Motor Driver Controller Board



BTS7960 Specifications:

- Works perfect with arduino
- Voltage: 3.3-5V
- Drive Current: Max. 43A
- Drive Voltage: 6v-27v
- Dimensions: 5 x 5 x 5 inches
- Weight: 1.76 ounces

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Why do we need a MPPT Solar Controller?

1. The MPPT controller ensures that our lithium battery is getting the necessary voltage to recharge since the climate conditions will not always be adequate
2. Adjusts the voltage of the solar cell to match the charging voltage requirements of the battery.
3. Ensures optimal power transfer to the lithium battery, maximizing charging efficiency.
4. Protect the battery from overcharging.

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Solar Charger Technology Comparisons

Solar Panel Controller	Input voltage	Output voltage	Output current	Weight	Price
MPPT Solar Controller Titanate Battery Charger Module	12-28 DC V	1.2-11 DC V	1 A	0.35 ounce	$8.83
MPPT Solar Panel Controller	8-28 DC V	5-26 DC V	2-5 A	1.65 ounce	$18.92
Waterproof PWM Solar Charge Controller	< 50V	12V - 24V Auto Adapr	10A	2.39 ounce	$20.99

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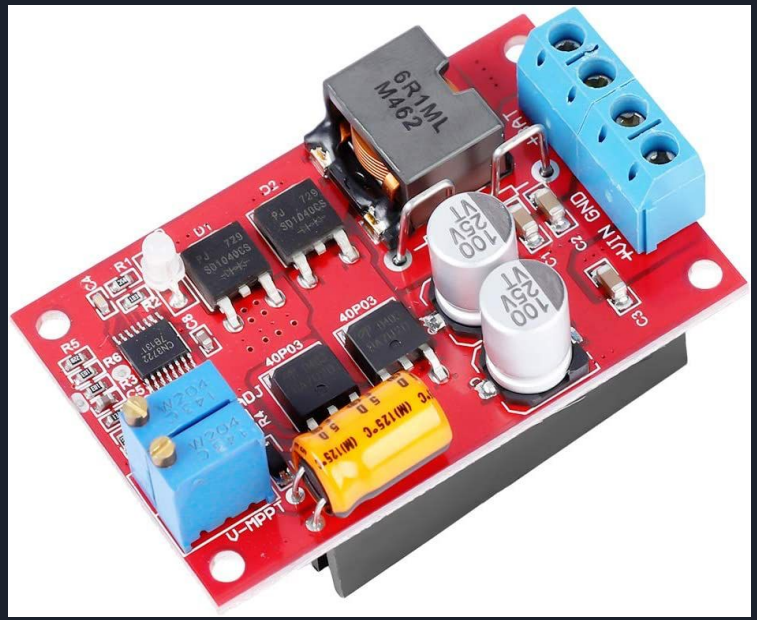
MPPT Solar Charger



MPPT Solar Panel Controller Specifications:

- Works perfect with arduino
- Voltage: 8-28V
- Output Voltage: 6-26V
- Output Current: 2A-5A
- Charging Indicator: YES
- Dimensions: 2.24 x 1.5 x 0.98 inches
- Weight: 1.44 ounces
- Efficiency: 93%

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A Second MPPT?

- In order to use Arduino without a computer powering it, portable power source is required
- A secondary MPPT allows us to further utilize solar cells to power Arduino effectively
- Ensures that Arduino receives safe amount of voltage & current

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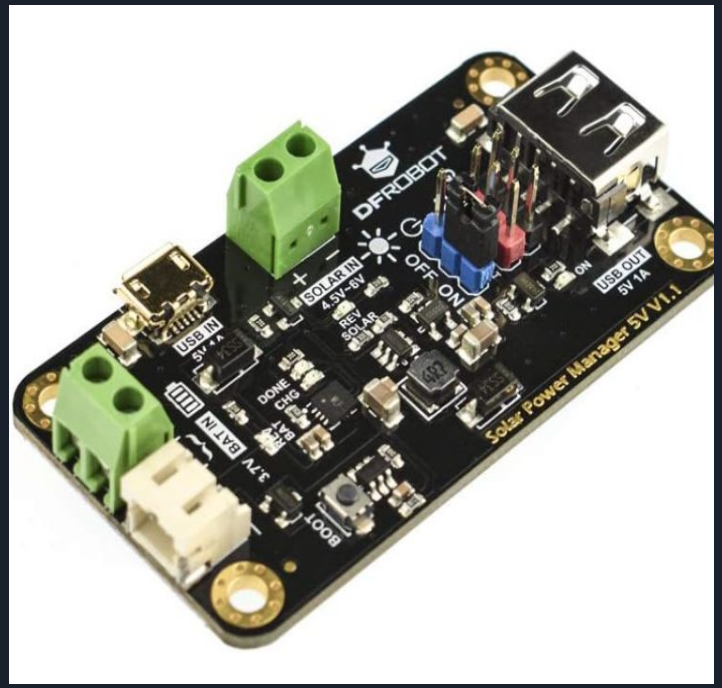
MPPT Powering Arduino



DFROBOT MPPT Solar Controller Specifications:

- Compatible with Arduino
- Supports Solar & USB Charging
- Input Voltage: 5V
- Max Input Current: 900 mA
- Output Voltage: 5V
- Efficiency Rating: 74%
- Provides protection features such as overcurrent and over discharge protection.
- Used with single solar cell + 3.7 LiPo battery

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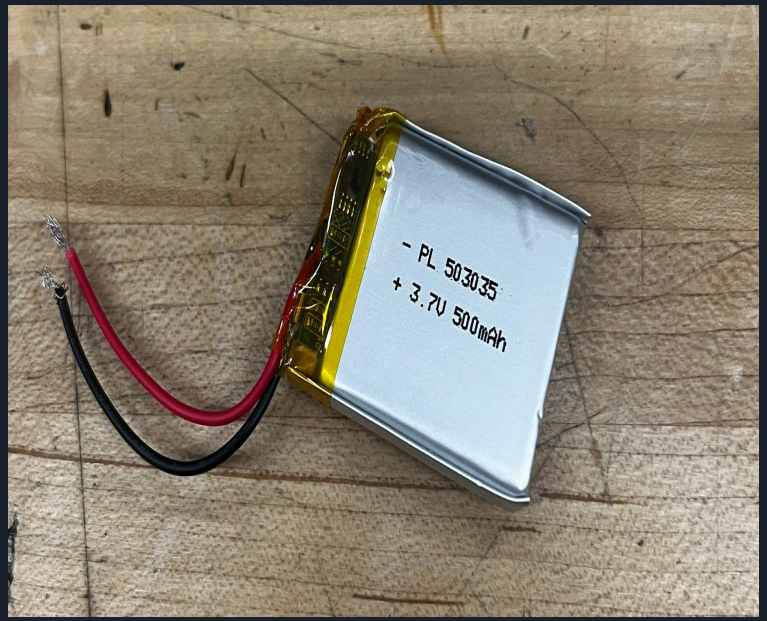
Second Battery



PL 503035 Specifications:

- 3.7 Volts
- 500mAH
- Weight: 13 grams
- Dimensions: 0.11" x 1.18" x 1.46"
- Used to power Arduino

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What if it rains?

- Rain can lead to irreparable damage to the board
- Can also create dangerous conditions for the rider themself
- What can we do to mitigate these problems?

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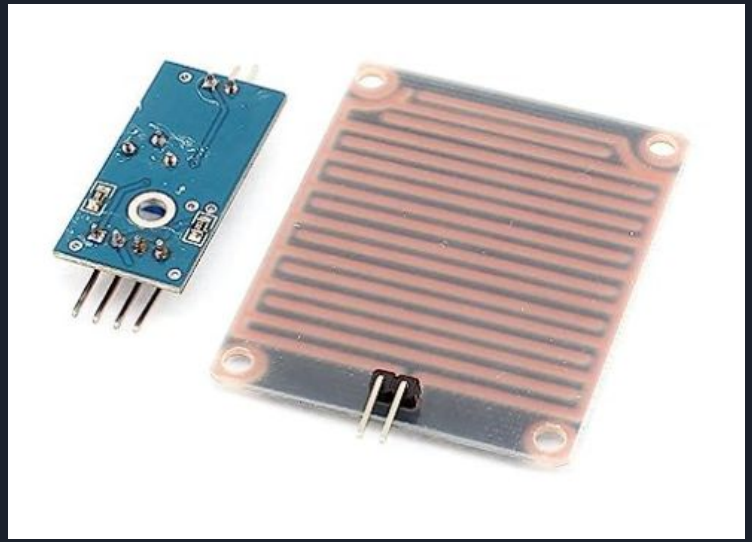
Rain Sensor



LM393 Rain Sensor Module Specifications:

- Compatible with Arduino
- Input Voltage Range: 3.3V - 5V
- Control Board (Left) Dimensions: 3mm * 1.6mm
- Raindrop Test Board (Right) Dimensions: 5.4mm * 4.0mm
- Works in unison with Buzzer
- Alerts for both rain & moisture

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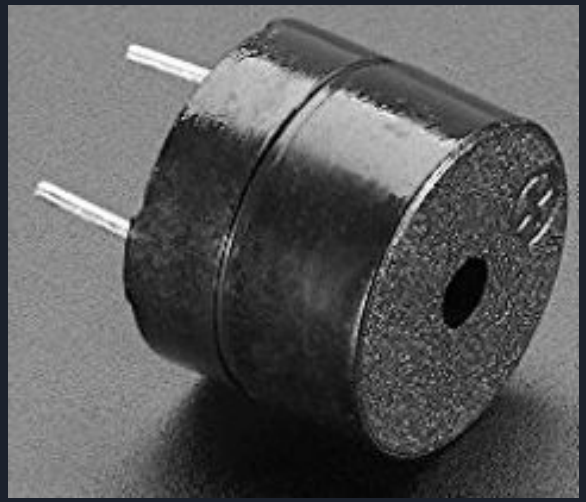
Buzzer



Passive Buzzer Specifications:

- Used as output for rain sensor
- Alerts user to upcoming rain through loud noise
- Voltage Input: 5V
- Compatible with Arduino

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LED Comparison

LED	Price	Number of LEDs	Max Current
100 Pieces Clear LED Light Emitting Diodes Bulb LED Lamp	$7.59	100	20mA
DiCUNO 450pcs (5 Colors x 90pcs) 5mm LED Light Emitting Diode Round Assorted Color	$11.99	450	20mA
200 Pieces LED Diode Lights, 3mm and 5mm LED Lights Emitting Diodes Assortment Set Kit	$8.98	200	20mA
LOAMLIN WS2812B Individually Addressable RGB LED Strip 16.4FT 5050SMD Smart Flexible Dream Full Color 60Pixels/m Balck PCB Light IP30 Non Waterproof DC5V (Black PCB, 16.4FT 300LEDs IP30)	$20.99	300, 16.4 ft	12A

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LED Lights

LOAMLIN WS2812B Specifications:

- 5 Voltage DC
- Cuttable
- Connects to Ultrasonic Sensor

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Ultrasonic Sensor

HC-SR04 Specifications:

- 5 voltage DC
- 15 milliAmp current
- 4 Meter range
- Connects to Arduino
- Connects to LEDs

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Deck

Deck Specifications:

- Made out of bamboo (lightweight)
- Length: 38.75in
- Width: 9.65in
- We have used a router to cut an indent into the deck for the solar cells, drilled a hole to connect Solar panels with MPPT Solar Charger

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Challenges: Hardware

- Not enough solar cells, didn’t come with wires
  - We bought more solar cells to actually be able to fit the deck
  - Soldered wires onto the solar cells so they are actually able to be charged
- Deck didn’t come with an open space for the solar cells
  - Added the space on our own by cutting
- Deck didn’t come with a hole on almost the middle part, so we had to do it to connect the MPPTs with the Solar cells

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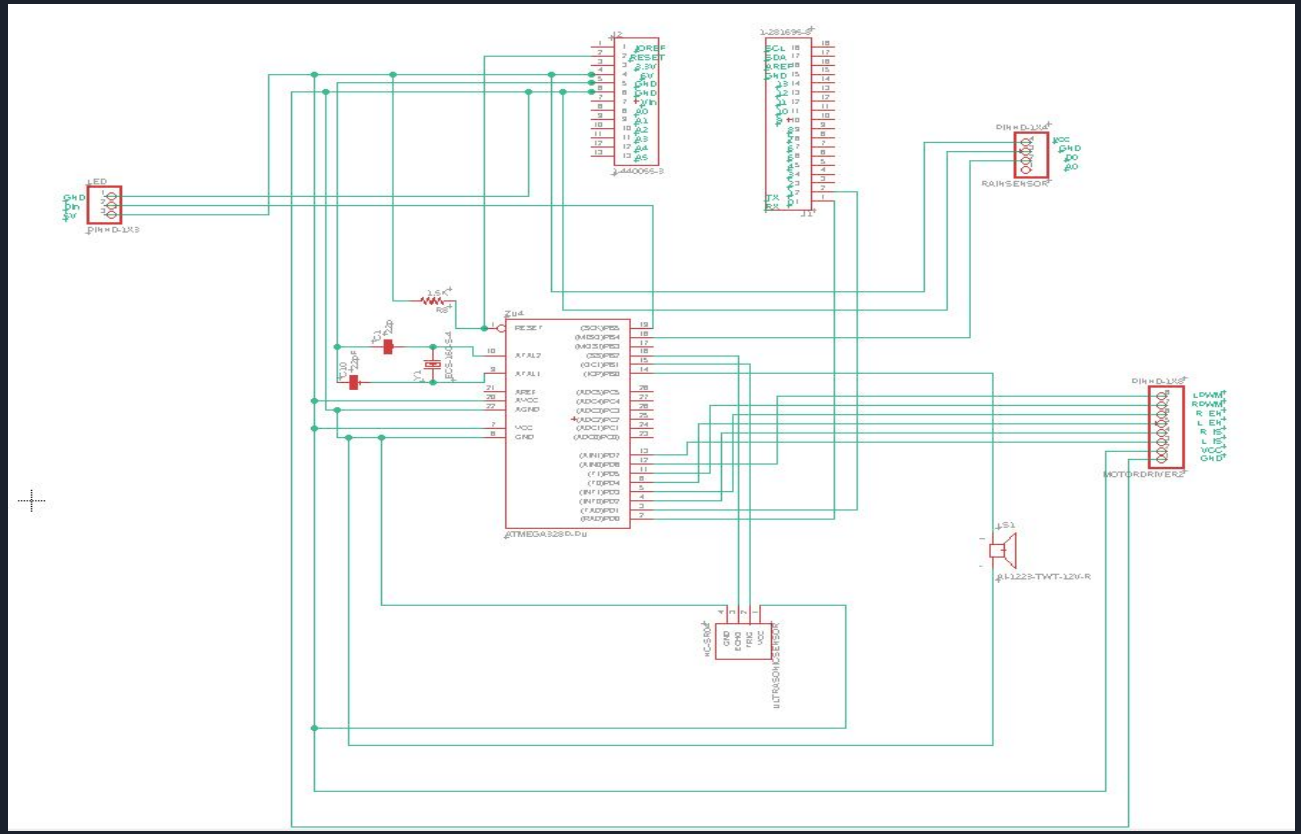
Schematic



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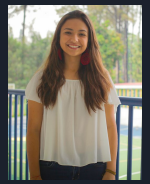
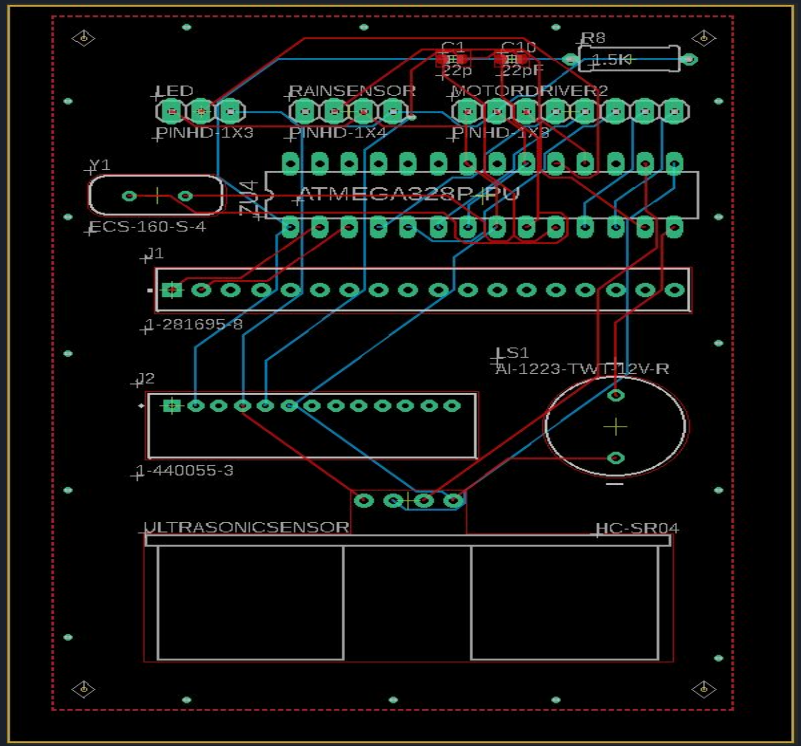


PCB Board Design



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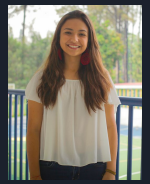
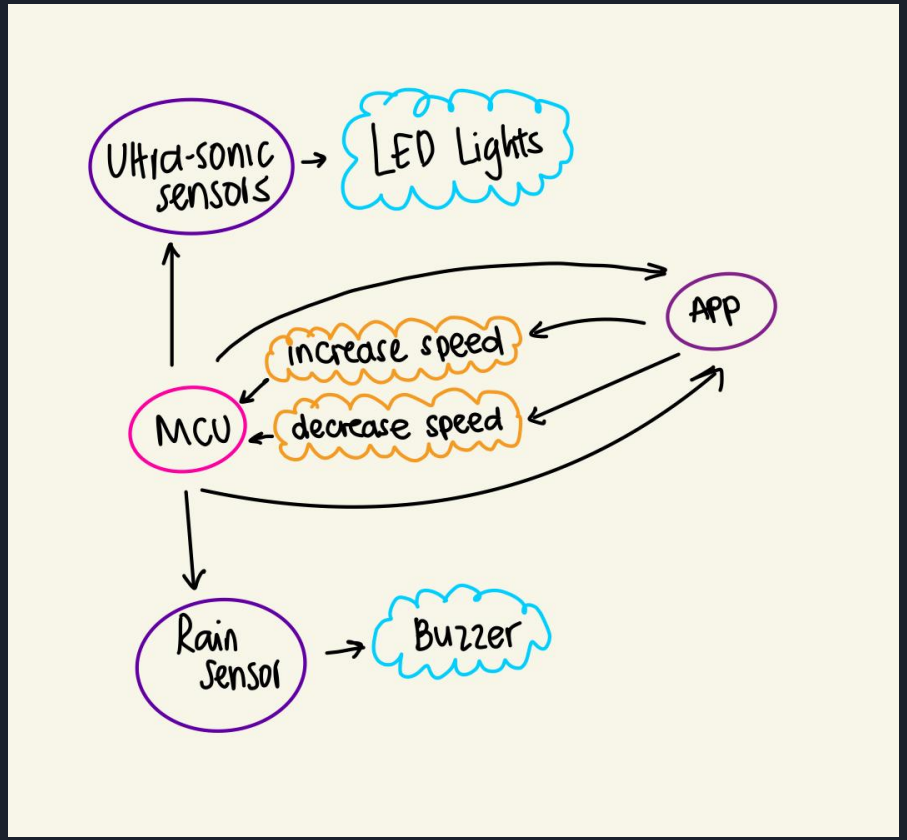


Communication Loop



This shows how the app and the board will communicate with each other, as well how the MCU will communicate with the features that make our board different.

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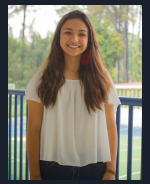
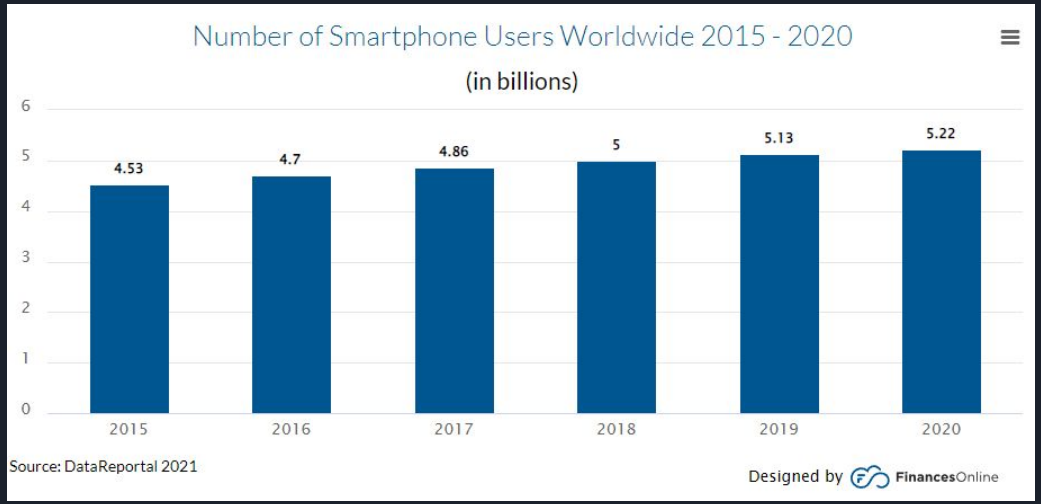


User Interface



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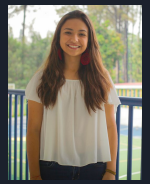

Since the main purpose of this project is sustainability and a eco-friendly solution and the use of smartphones increase more and more everyday. We thought that the app is what better aligns with our purpose and differentiator of this project.

App Testing Comparisons

Apps	Features
MIT App Inventor	• Free • Easy to set up with bluetooth module • Block coding • Android Development
Kodular	• Free • Block coding • Android Development

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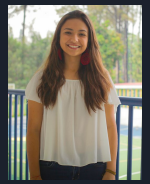

App Testing

Why MIT App Inventor?

- Easy to test the wirelessly communication at an early stage
- Perfect to test if the motor is working accordingly with the app (Increasing and reducing the speed)
- Easy to brainstorm and arrange the logic in which we want the app to work

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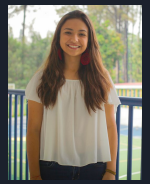

App Development Comparisons

We chose these two frameworks since we will be able to eject our Expo project to React Native without a problem, making our development easier and time-saving.

Apps	Features
Expo	• Easier to deploy to Apple/Google Store • Over the air updates • Mobile UI • Better development experience • No need to link a lot of libraries • Pre-configured tools
React Native	• Connect with Bluetooth • iOS and Android development • Steeper learning curve

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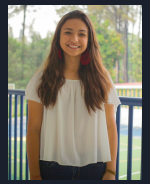
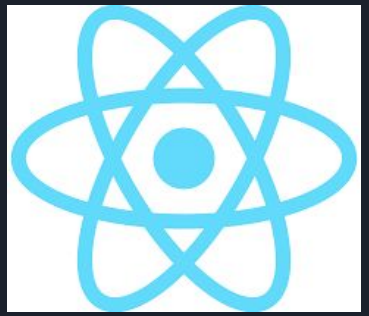


App Development



It will be easier and less time-consuming to start developing the app in Expo since it has pre-configured tools and services that will make the process easier. Since our whole purpose is to use wireless communication between the board and the phone, React Native has that feature. We will then eject the code from Expo and use React Native to add that Bluetooth feature.

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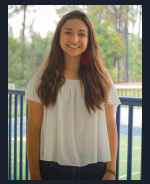

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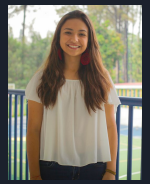
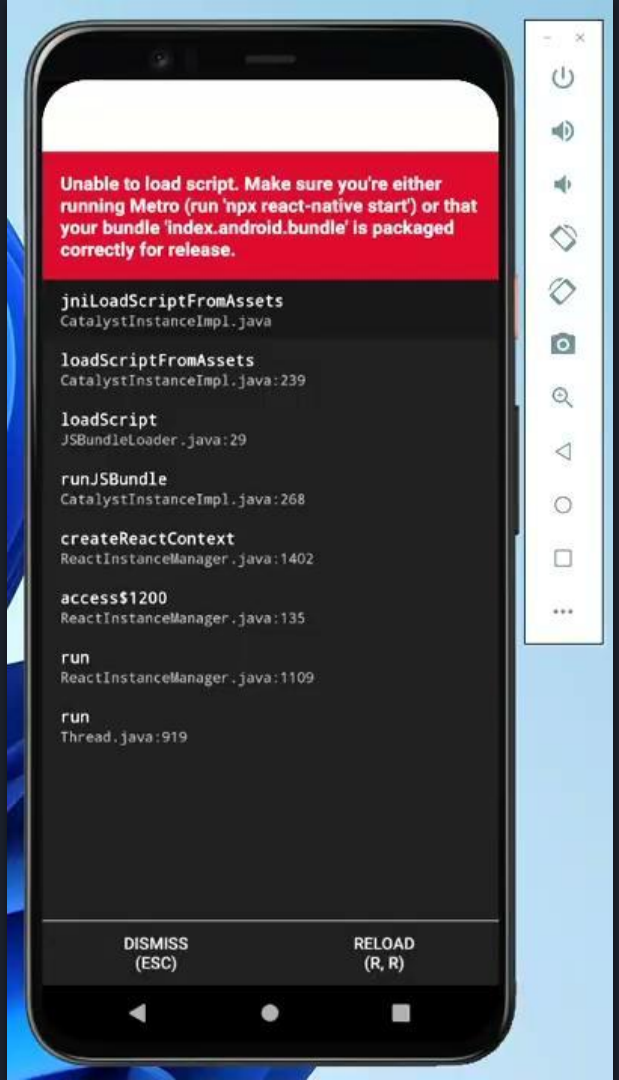
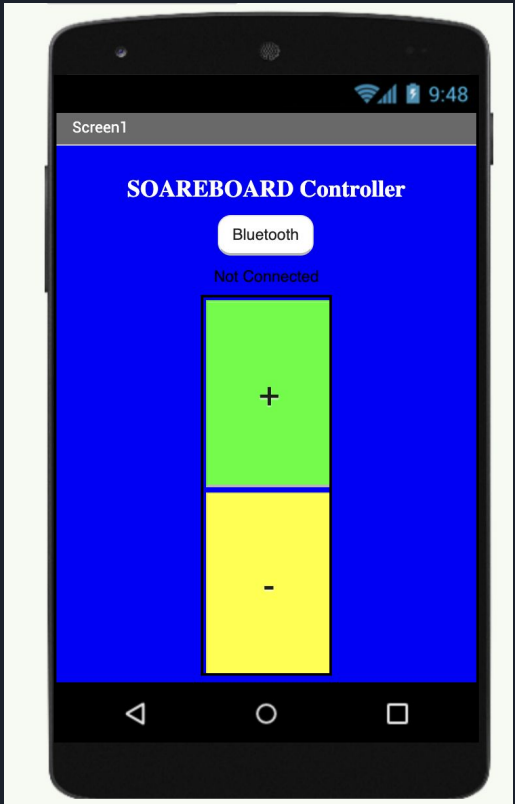




App Final Version & Features



- Bluetooth connection Set-up
  - Connect to Soareboard
- Adjust speed (Decrease, increase)

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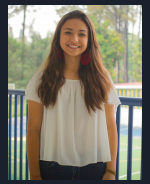
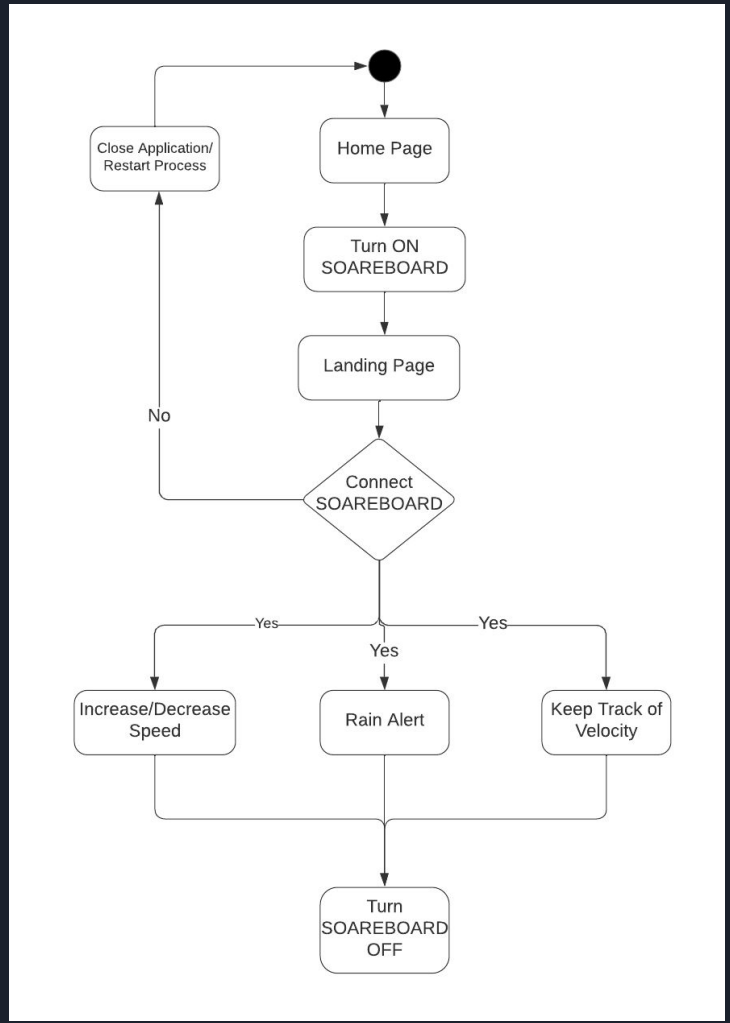


Software Flowchart



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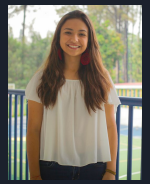
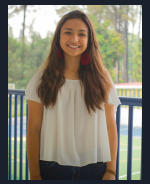


Challenges: Software

- Expo doesn’t have the bluetooth module connection, so we will need to eject the project to React Native when we finish coding the whole app
- Issues with Android Bluetooth Permissions
- Issues with libraries coming from Expo but not needed anymore on React-native
- Big learning curve with Expo and React Native

Computer Engineering



Work Distribution

Components	Antonia Jimenez	Devon Jacobs	Franco Curcio	Julia Lampert
Solar Charging & MPPTs	X			X
Battery		X		X
App Connection	X		X	
Motor & Motor Driver	X		X	X
PCB	X	X		
Arduino	X		X	X
Sensors	X	X	X	X

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Finance and Budget

Component	Quantity	Vendor	Total Cost	Senior Design 2 total cost
LEDs	300 lights	Amazon	$11.90	$20.99
PCB Print	3	JLCPCB	$20.00	$60
Jizmo Skateboard Parts	1	Amazon	$30.00	$30
Bamboo Skateboard deck	1	Amazon	$47.95	$47.95
DC Motor	2	Amazon	$30.88	$30.88
Motor Driver	8	Amazon	$10.99	$87.92
Lithium-Iron Phosphate Battery	2	Amazon	$36.00	$72.00
HC-05 Arduino	1	Amazon	$10.57	$10.57
Arduino UNO board	1	Amazon	$19.50	$19.50
Solar Cells	Pack of 10 layers	Amazon	$40.00	$40.00
DFROBOT DF900	1	Amazon	$13.90	$13.90
AKZYTUE 3.7V	1	Amazon	$8.99	$8.99
Total Cost				$442.70

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Future Plans

If there were no time constraints, there are a few things we would have included:

- Casings around the battery and under the board to cover the components
- Resin over the solar cells to protect them from the environment
- Speedometer for the app
- Continue the development of the app in React Native

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Thank You!

Any questions?

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