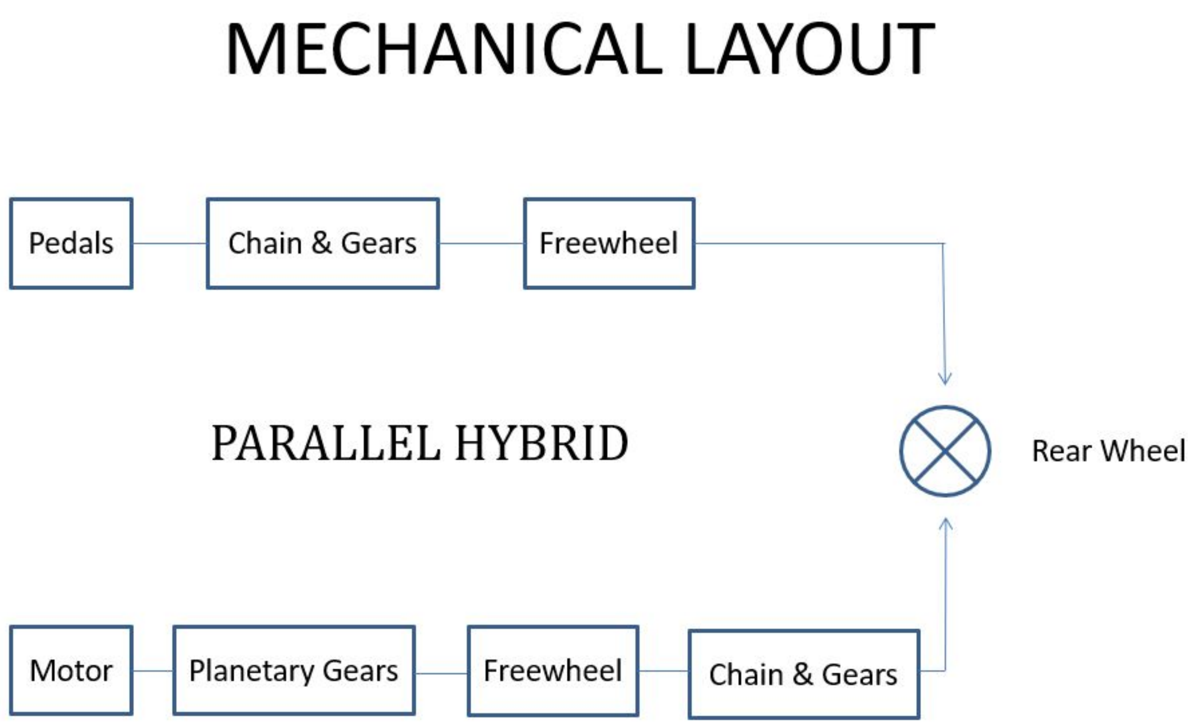
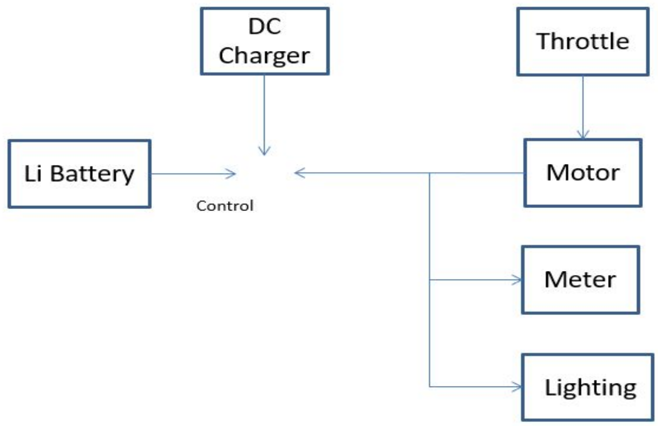
DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

For the electrical bicycle, the mechanical parts are pretty non-negotiable and look like this




Below is a basic idea of what to expect in the electrical circuit of a bike

# ELECTRICAL LAYOUT



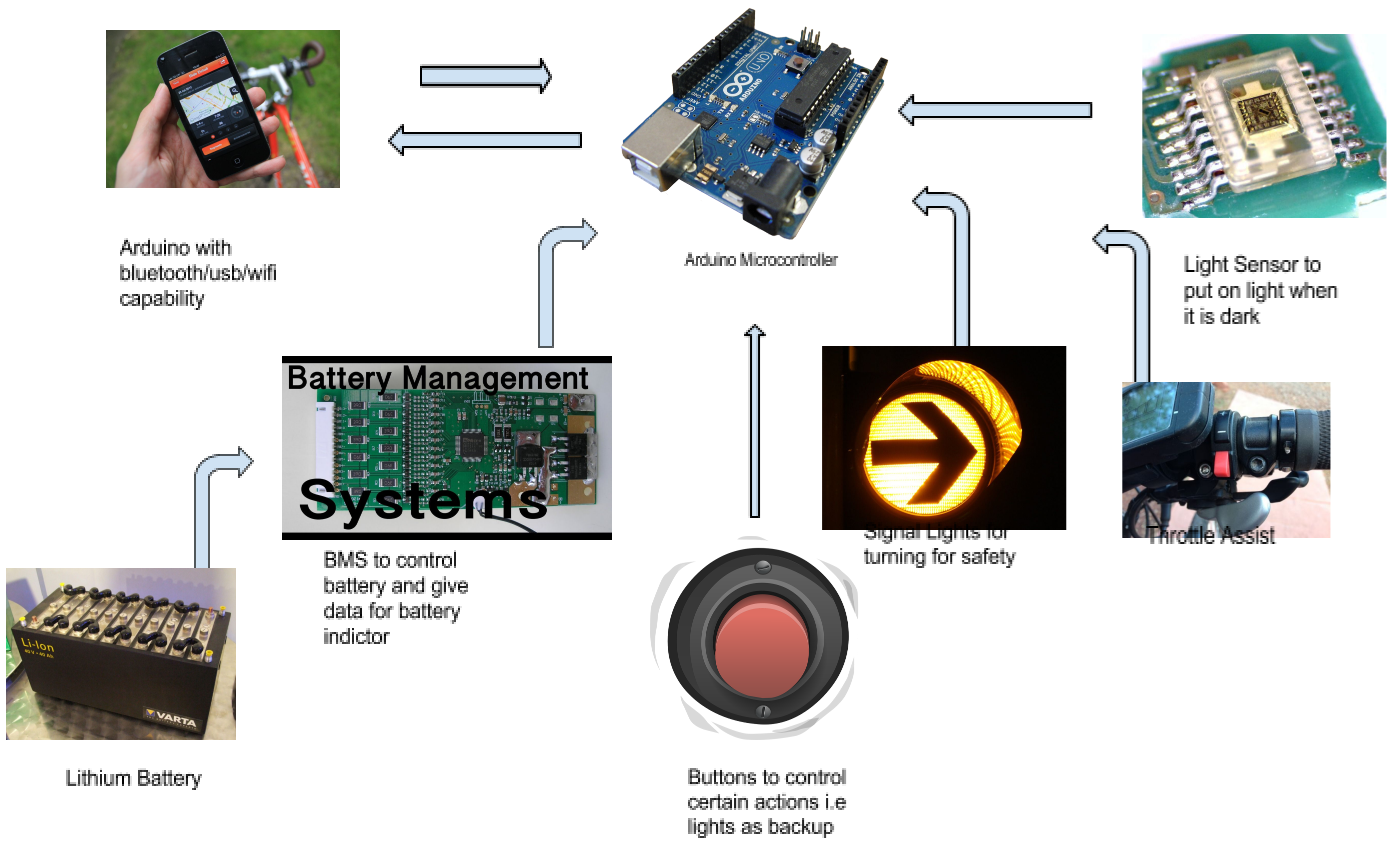

However, there are several improvements that can be made to the Electrical Component to increase the capability of melding a regular bicycle with a battery.

- Individual Ideas for the Trike:
    - Signals for safe driving to indicate that you are turning etc
    - To create a phone charger from the pedaling system power
    - To tell if the battery is dying and when it needs to be charged easily
    - Battery last longer- energy efficient wiring, and wireless charging
    - seat belt,gps included in it
    - Armrests to ensure comfort-

To streamline the decisions, we have two major designs and a decisions to make on the battery

DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

# DESIGN 1




# DESIGN 1 PROS AND CONS

| PROS | CONS |
|---|---|
| Convenient Smartphone App with more features built-in, hence reducing cost of bike<br>• GPS<br>• Speed Detector | Requires Internet connection to access GPS |
| Arduino works with BMS to provide data to battery indicator | Power required for two microcontrollers |
| Signal Lights can eventually be programmed | |

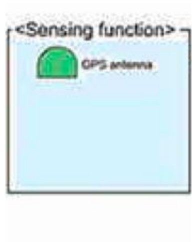
DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

| | |
|---|---|
| to come on if a turn is detected | |
| Light Sensor increases safety by coming on automatically | Switch is needed in case of errors of coming on when not needed |
| Battery is lighter, smart and more efficient | Not renewable energy |
| Arduino microcontroller is low-cost and can be updated easily | It cannot be updated remotely |
| Using an app put less pressure on the battery compared to an lcd display | |
| Throttle Assist does not need pedaling, can be beneficial for disabled people | It has the potential to have less range |

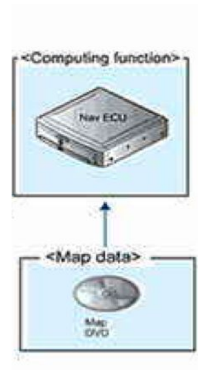
DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

# DESIGN 2

Sensing Function

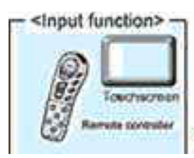



Display Function

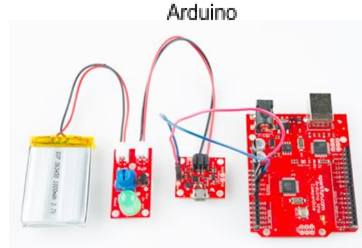




Computing Function and Map Data

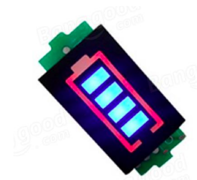
Input Function




Powercell, Uno, Indicator and Arduino



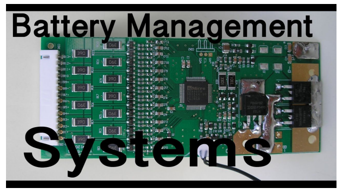
Battery level indicator



LED Battery Display

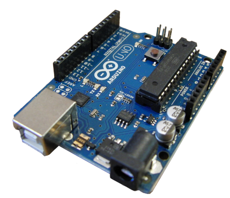
DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

BMS to control battery and give data for battery indictor




Foot rest

Arduino to control battery



Brakes

Frame of brakes

# DESIGN 2 PROS AND CONS

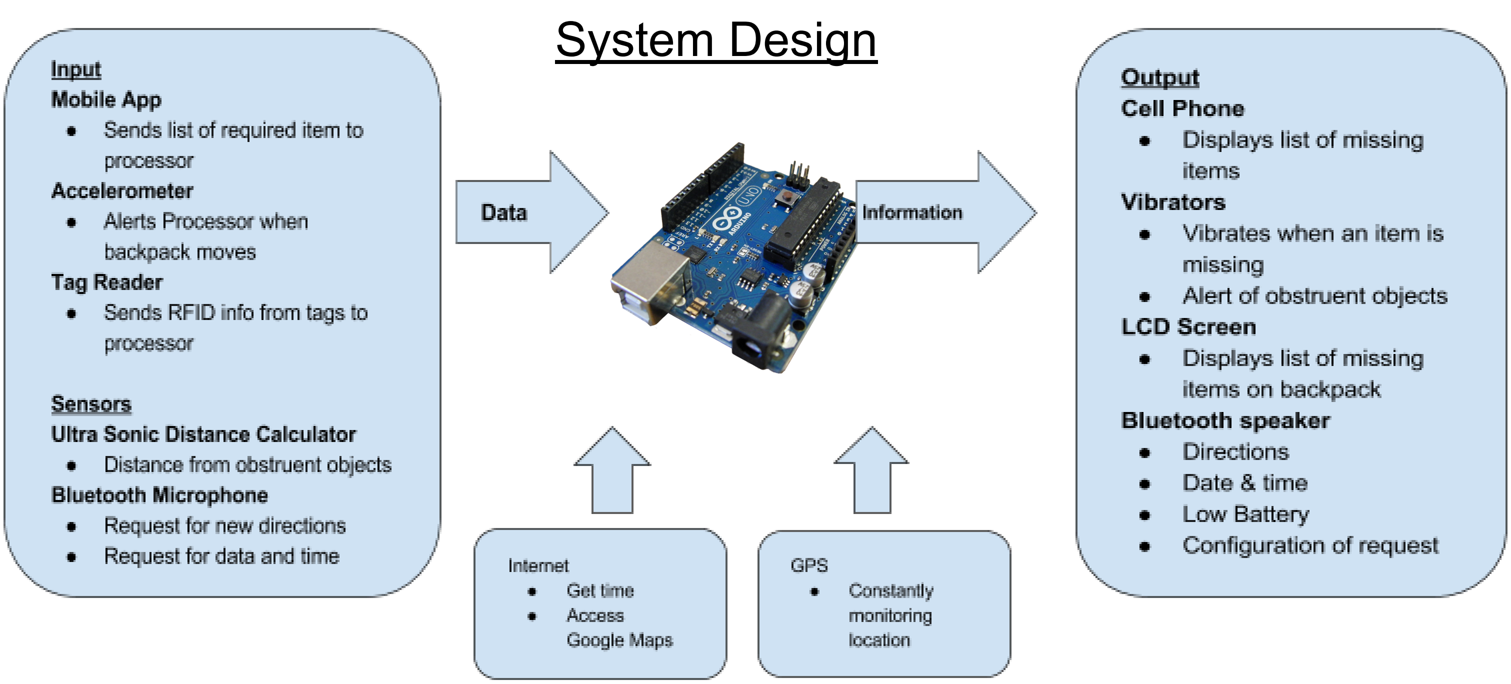
| PROS | CONS |
|---|---|
| Pedal Assist increases the range of the battery | Does not have the option for the user to stop pedalling |
| Dashboard does not rely on external features such as wifi/bluetooth to work hence increasing reliability | Dashboard drains additional power |
| Arduino works with BMS to provide data to battery indicator | Power required for two microcontrollers |
| Regenerative Brakes help to conserve energy, Dynamo included can produce energy | Twice as much energy is needed to pedal and charge at the same time. |
| The alternative energy like solar panels will allow for a cleaner and less expensive form of energy | The E-Trike won't go as fast and cloudy or alternative types of weather will affect the speed |
| The features are efficient | Adding a pedal assiter, as well as a gps and breaks can be heavy and expensive |

**Design Matrix**

| | Weight | Design1 | Score | Agg.Score | Design2 | Score | Agg.Score |
|---|---|---|---|---|---|---|---|
| Functionality | 5 | Tricycle, battery, App,lights | 5 | 25 | Solar panels, seat belt | 5 | 25 |
| Connectivity | 3 | App, Sensor | 5 | 15 | n/a | 0 | 0 |
| Weight | 2 | Heavy due to battery | 3 | 6 | Heavier-bike+solar panels | 1 | 2 |
| Power | 5 | lights=more | 3 | 15 | Solar | 4 | 20 |

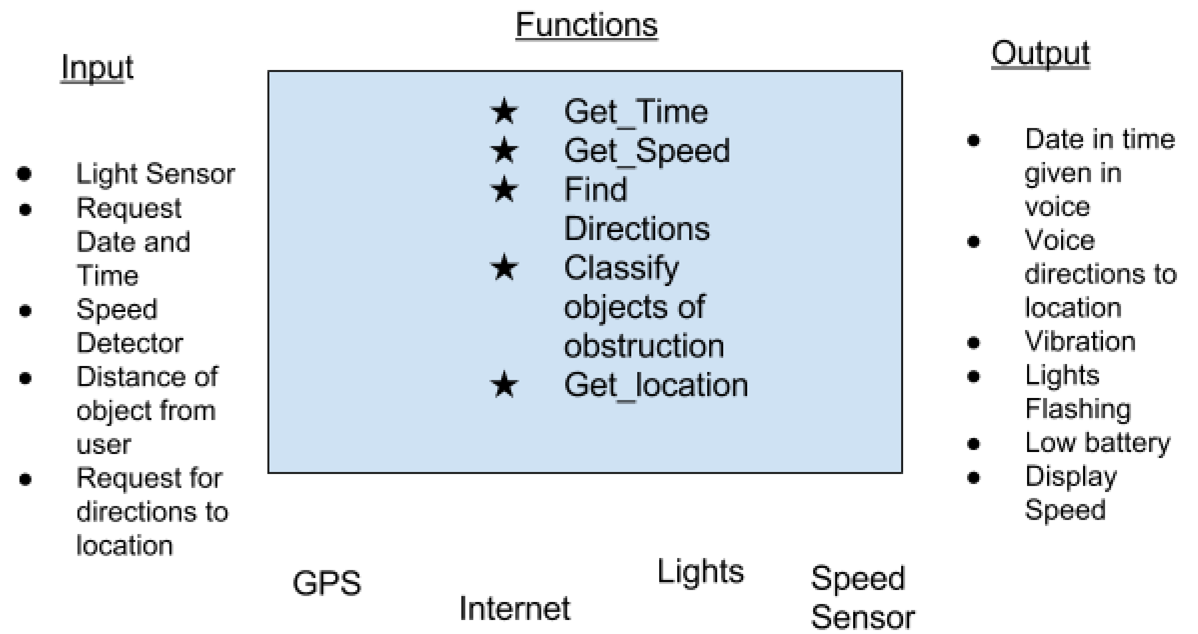
DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | power | | | Panels | | |
| Convenience | 2 | High-has an App | 4 | 8 | No gas needed | 3 | 6 |
| Assistance Mode | 4 | Throttle Assist | 3 | 12 | Pedal Assist | 2.5 | 10 |
| User Experience | 5 | SmartPhone App | 5 | 25 | Dashboard | 3 | 15 |
| Price | 5 | High: <$1,000 | 3 | 15 | Higher: >$1,000 | 1 | 5 |
| TOTAL | | | | 111 | | | 83 |



DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

CONCEPTUAL DESIGN




ALTERNATIVE MAJOR DECISIONS

The battery is major part of the bike and determines majority of the electric components of the Electric Tricycle to affect the range, the speed, and the effectiveness of the electrical components. Considering the limitation of the battery for an electric tricycle is 750W and most states require a maximum of 20mph.

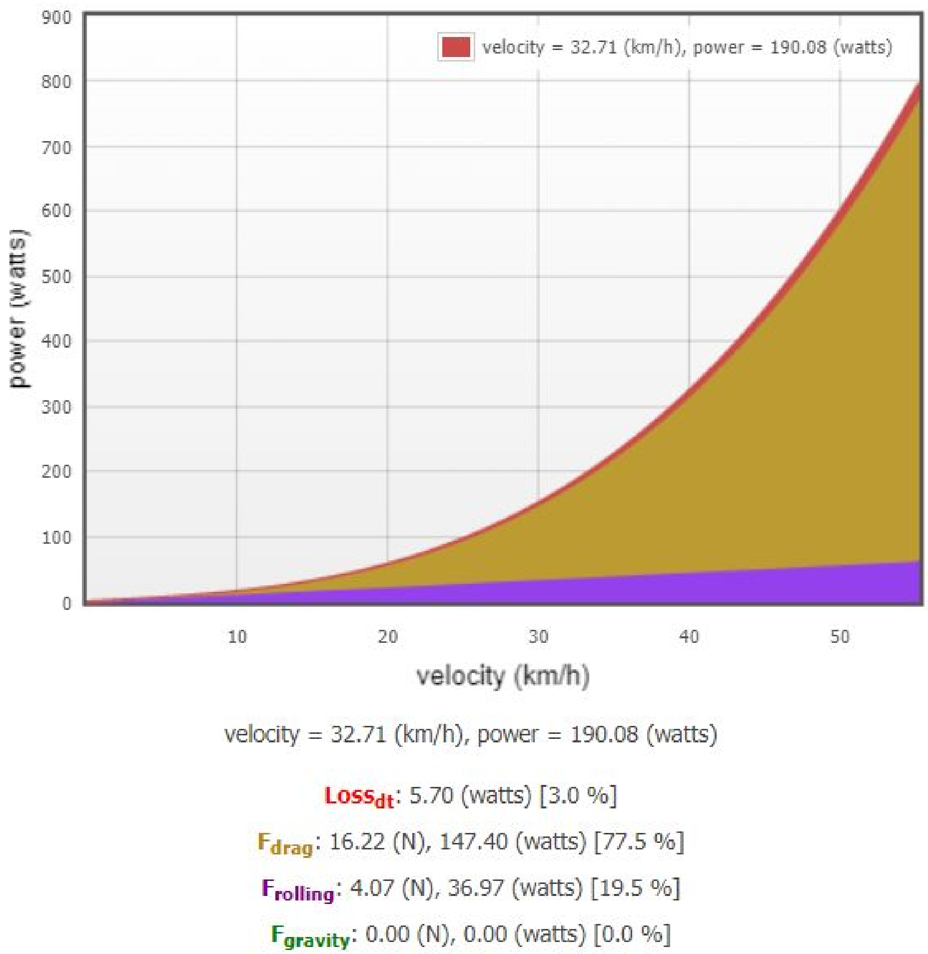
To calculate the power needed; assuming a flat ground, weight of bike to be 8kg, weight of driver to be 75kg and Drag Coefficient to be 0.63

$$P_{total} = P_{drag} + P_{R_c} + P_{hill}$$

$$\mathrm{P}_{drag} = \frac{C_d * A * \rho}{2} * v^3$$

$$\mathbf{P}_{\mathrm{R_c}} = g * m * R_c * v$$

$$\mathbf{P}_{hill} = \frac{g * m * v * slope(gradient)[\%]}{100}$$




Therefore the maximum needed is 230 -250W per hour at top speed simplified.

| | Lead Acid | NiCd | NiMH | Li-ion |
|---|---|---|---|---|
| **Capacity** | 2,000mAh | 600mAh | 1,000mAh | 1,200mAh |
| **Battery voltage** | 12V | 7.2V | 7.2V | 7.2V |
| **Energy per cycle** | 24Wh | 4.5Wh | 7.5Wh | 8.6Wh |
| **Number of cycles**[4] | 250 | 1,000 | 500 | 500 |
| **Battery cost** (estimated) | 330.22 | 330.22 | 462.3 | 660.44 |
| **Cost per kWh** (SEk) | 56.14 | 72.65 | 122.18 | 158.51 |

There are three major options of batteries we narrowed it down to;

- Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2 or NMC)
- Nanophosphate Battery
- Building our own battery with 18650 cells

DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2 or NMC)

- Used by Tesla, stores large about of energy
- $300 for 300W
- Very Light
- 

Nanophosphate® lithium iron phosphate (LiFePO4) batteries

- Does not lose charge as easily as other batteries
- More tolerant to full charge situations
- $300 for 300W
- Produced specifically by A123 systems - lighter than other batteries in the same range
- 

Building our own battery with 18650 cells

- Cheaper, about $100 for just the battery
- Light
- Easily configurable
- 

DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

BATTERY DECISION MATRIX

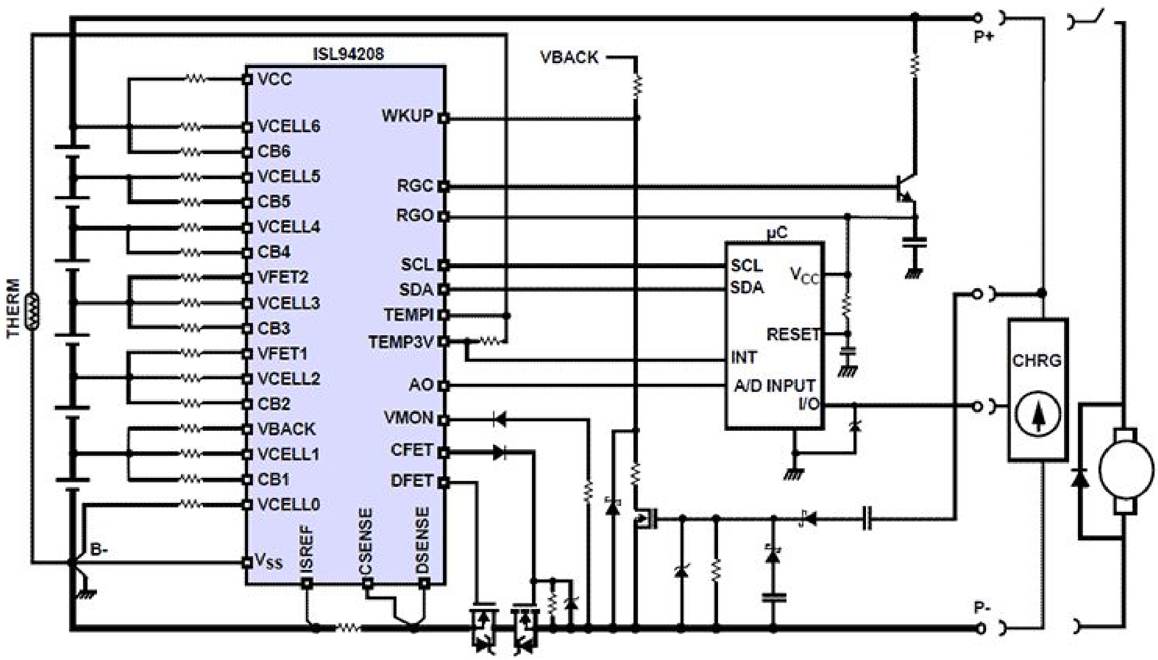
| CRITERA | WEIGHT | LiNiMnCoO2 | LiFePO4 | 18650 |
|---|---|---|---|---|
| Weight | 5 | 5 | 4 | 4 |
| Price | 5 | 2.5 | 4 | 5 |
| Range/Energy | 4 | 4 | 4 | 4 |
| Safety | 3 | 5 | 3 | 3 |
| | | | | |
| TOTAL(weighted) | 21 | 68.5 | 65 | 70 |
| | | | | |

Final Design Component: Building our own 18650 battery

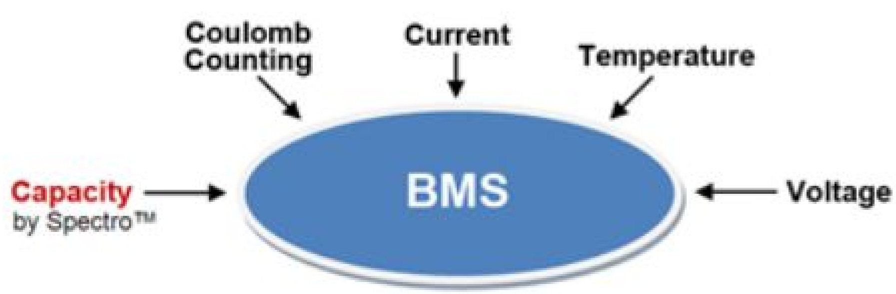
DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

<u>Specific Detail of the product</u>

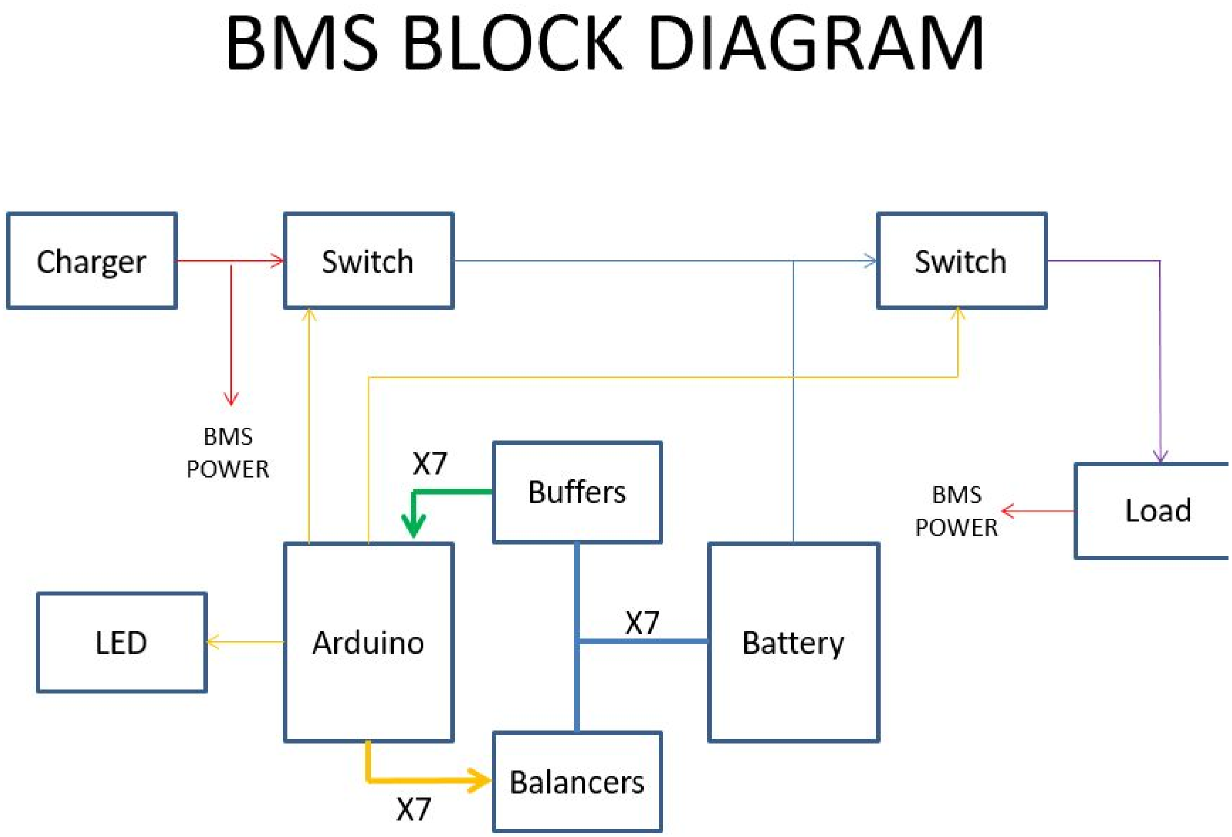
# Battery Status Indicator




It is is designed for use with a microcontroller and features an analog front-end with overcurrent protection for multi-cell Li-ion battery packs.




BMS systems monitor the energy by coulomb counting, which is currently the most efficient method.




It is going to be built on a PCB board following the diagrams outlined above.
The Design constraints and compulsory implementations for the BMS are:

- A FET driver functional block is responsible for the connection and isolation of the battery pack between the load and charger
- A current sense amplifier and an MCU with an integrated low resolution ADC is one method of measuring the current
- the use of diodes, resistors and capacitors to dampen transients
- Algorithm to make decisions
- Thermistors powered by an internal ADC voltage reference are commonly used to monitor each circuit's temperature
- Other things can be included in a BMS such as time, memory etc.

## GPS

We planned to implement GPS into our design by including it in the application downloadable to the users phone. The application will be programed to ask the system for permission to access all of the information for the location services. From there, the application will include its own code for interaction with the map and location services. Then

Speedometer

As stated previously, we plan to request permission to use GPS within our application. The speedometer works by using GPS to determine start and end position. The speed is then determined by calculating distance traveled divided by time. The Speedometer will be included within the mobile application for driver assistance on the road.

Adaugo - Smart safety lights -

We plan to implement smart safety lights which will use a ambient light sensor that switches on an LED when ambient light levels dip below a certain threshold. The sensor uses a photoelectric cell which would determine what the lighting conditions are like outside.

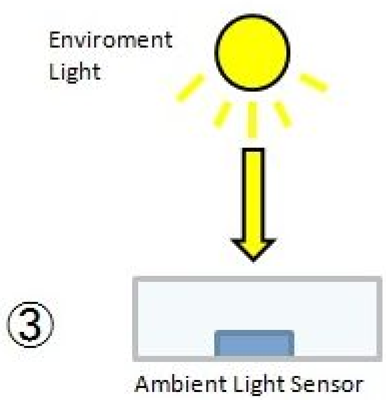
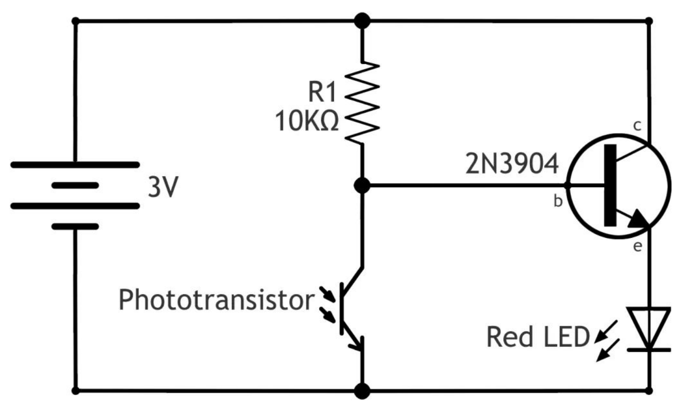


Figure 1



Example of dark detecting LED circuit

DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE

Signal Lights - Lights signalling to turn

The signal lights, is a big safety procedure for the E-Trike. As a result, of the E-Trike being able to ride on the streets the signal lights allows the vehicles in front and behind to be alert of the next of the E-Trike operators next move. The Signal lights are it's own separate function from the other systems on the E-Trike. There is a switch on the handle of the E-Trike that controls each turn signal on the front and back of the E-Trike.

Electric  Controller

The electric speed controller, is a huge dynamic to the overall structure. The speedometer, safety lights, temperature sensor, relay drivers and more are all dependent on the controller. It manages and monitors all parts the controller includes a sensor controller to know when to power on and off.

DETAILED CONCEPTUAL DESIGN FOR ELECTRIC TRICYCLE