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E-Trike

FINAL REPORT

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SUMMARY

The ETRIKE aims to be a comprehensive friendly form of transportation. Given a surge in Demand for clean, cheap, and convenient means of transportation. The ETRIKE fills that void while being convenient. The most important thing to note about the project is for students it gave us the ability to apply what we learnt through our four years on a somewhat complex yet deliverable scale. The ETRIKE consists of a mechanical and electrical system that reflected real world designs as we navigated the solutions processes and ideas. For this semester against all delays and constraints we were able to implement a fully electric bike, though not manual and implement a Software Map and a wirelessly control tail lights via bluetooth.

PROBLEM STATEMENT

Starting from Fall 2017, we initially defined our 2017-2018 problem statement on the bike being used for disabled customers, people with problem balancing their bikes. However we evolved our problem statement to encompass a bike for everyone as we believe there is a market for it. Our current problem statement is

"ETRIKE aims to create a mainstream, reliable, friendly Comprehensive Solution that combines the efficiency of a bike with the comfort of a motorized car, also including an Internet of Things Framework to improve comfortability, reduce prices and be more energy conscious not just for disabled people who might have problems balancing a bike but young people who are seeking cheaper means of getting around"

Our 2017-2018 Goal was to successfully obtain get the E TRIKE parts needed to renovate the bike and get it moving. There were a couple of changes in our implementation plan due to delayed parts arrival therefore changing our 2017 - 2018 goal:

- Replace Battery and Missing Parts
- Initial Development of IOS App
- Implementation schedule of IoT Technology with Bike

The Long term goal also evolved from successfully creating an energy-clean tricycle to:

- Complete Exterior Renovation for better reception
- Optimization of parts for cheaper price
- Further Integration of IoT Technology
- Compatibility with Public Charging Facilities

The most recent long term goal reflects the new problem statement to take advantage of technology to appeal to younger audiences as well as the recent industry state of art of automated technology. We also understood that making something a standard makes it more accessible and leads to further technology growth and better lives for the customer. Therefore public charging compatibility with SAE J1772 (IEC Type 1), also known as a "J plug", a North American standard for electrical connectors for electric vehicles will allow the ETRIKE an opportunity to benefit from the advantage of using a standard connector to make it more ubiquitous.

DESIGN REQUIREMENT
From last semester our design requirements focus mainly on the user. In trying to make the bike for attractive to our user, we determined what considered the Financial, Socio Cultural, Environmental Constraint for the user. Below is our final design requirement:

Socio Cultural Constraints - Helps with the goal of making our bike mainstream as well as aligning ETRIKE to what the customer is used to:

1. The entire trike should weigh between 80-100 pounds
2. The battery should weigh less than 10 pounds
3. The app should be built on the IOS Platform

Standard Constraints - Federal standards to be adhered to

4. Go less than 20mph

Economic Constraints - Typical amount our target audience will be willing to spend

5. Cost less than $1000

Environment Constraints - Ease of use in current environment

6 Compatibility with Public Chargers

DETERMINING BATTERY CONSTRAINTS

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.

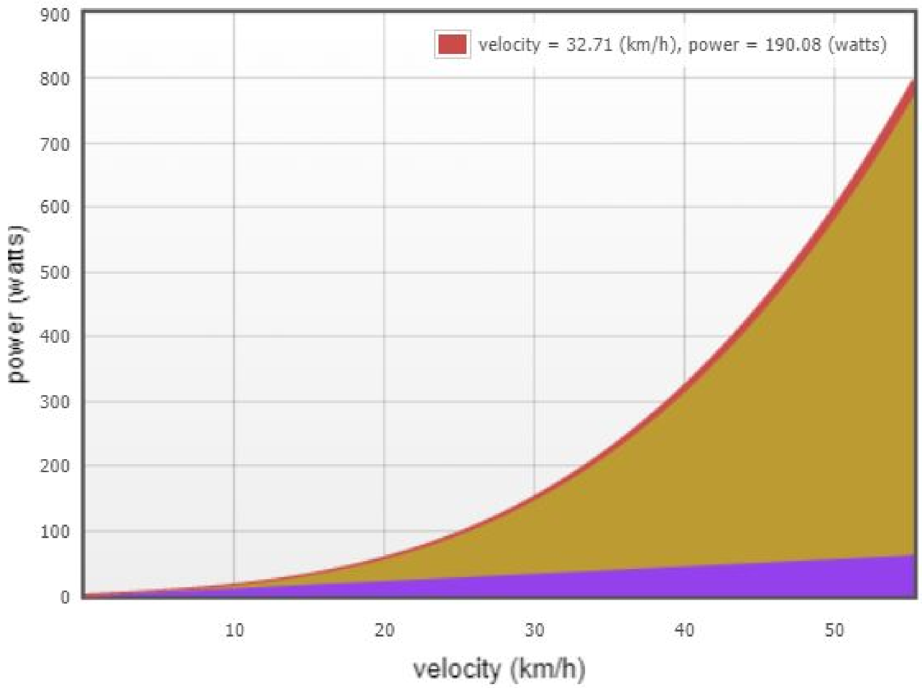
To calculate the power needed; assuming a flat ground, weight of bike to be 8kg, weight of driver to be 75kg and Drag Coefficient to be 0.63

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

$$P_{drag} = \frac{C_d * A * \rho}{2} * v^3$$

$$P_{R_c} = g * m * R_c * v$$

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



velocity = 32.71 (km/h), power = 190.08 (watts)

$Loss_{dt}$: 5.70 (watts) [3.0 %]

F_{drag}: 16.22 (N), 147.40 (watts) [77.5 %]

$F_{rolling}$: 4.07 (N), 36.97 (watts) [19.5 %]

$F_{gravity}$: 0.00 (N), 0.00 (watts) [0.0 %]

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

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

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.
However due to the fact that we couldn't get our parts on time we decided to go with 4, 12V Lead Acid Batteries that cost $60.

CURRENT STATE OF ART

There are three major markets the ETRIKE can be compared to

- Regular Recumbent Tricycle
- Moped
- Regular Bicycle
- Electric Scooters

	Price	**Est. Max Range**	**Form of Power**	**PRO's**
	$2,200	15 miles	Pedal assist	X Not Cheap ✓ Comfortable
	$12, 985	65 miles	Gas Powered	X Not Cheap X Not comfortable
	$80	20 miles	Manual Powered	✓ Cheap X Not comfortable
	$200	20 miles	Electric Assist	✓ Cheap X Not comfortable

The ETRIKE aims to be comfortable and cheaper than the leading choice now to cater to the market that currently buys a moped, a recumbent bike and eventually the younger generation when it becomes a cool and attractive method of transportation.

SPECIFIC COMPARISON OF E-TRIKE TO BIKE ON MARKET

The E-Trike Project is focused around an electric battery-powered tricycle, The Sinclair C5 and IRIS e trike are both relevant electric technologies that are currently patent. The sinclair C5 is discontinued, however, the IRIS e-trike is on the market for consumers. Due to its advantages and disadvantages. They are environmentally efficient, battery powered not ran on gasoline, easy to use and the world's fastest human powered long ranged cycle. However, the E-trikes are extremely expensive, not safe or comfortable for the roads and the highest speed is averaging around 50 MPH. Our E-Trike team will be aiming to create a safer body for consumers, less expensive, using a more accessible and convenient battery power.
Sinclair C5 is a electric battery powered vehicle created in 1985, by its manufacturer Sinclair Vehicles. Although it was one of the very first battery electric vehicles its british market was not at all satisfied by its launching. There were an extreme amount of safety concerns, the bikes speed was at about 15 mph, it was not comfortable for people to sit in and once tested the battery motor could not sustain the control system. Within 3 months of being launched the Sinclair C5 had a horrible reputation and to make matters worst Sinclair vehicles inflated its prices to about 5000 from 400 just to meet sales reports. The Sinclair C5 was demise and the assembly line shut down for products.

The IRIS e-trike is a new and improved version of the Sinclair CS electric powered bike, much more advanced than the Sinclair version after years of improvements but like minded concepts The IRIS e trike is costing about 5000, more comfortable, eco friendly traveling at about 30 mph. Currently, the products that we need to build the e-trike are on the market, and there have been advancements made in these products. A typical E-trike kit such as from makers like ISIS and Sinclair will include a lithium battery. The lithium-ion battery is a step of innovation from the lead battery. There are many explanations as to why the lithium-ion battery is at the forefront of new e-trike technology. For one, it has more capacity, i.e. 15 AH versus 11 AH. It is lighter; 5 lbs instead of 8 lbs. It also has a better voltage match; 24.5-28.7 volts and a low resistance of 33 Milliohms. Overall, the current status of the e-trike components is available but costly.

The E-Trike has a target market and demographic of people in their mid 40's and above.
As a result of the E-Trike having a target market where individuals are prone to having more health ailments the E-Trike wants to cater to those elements while allowing our target market to

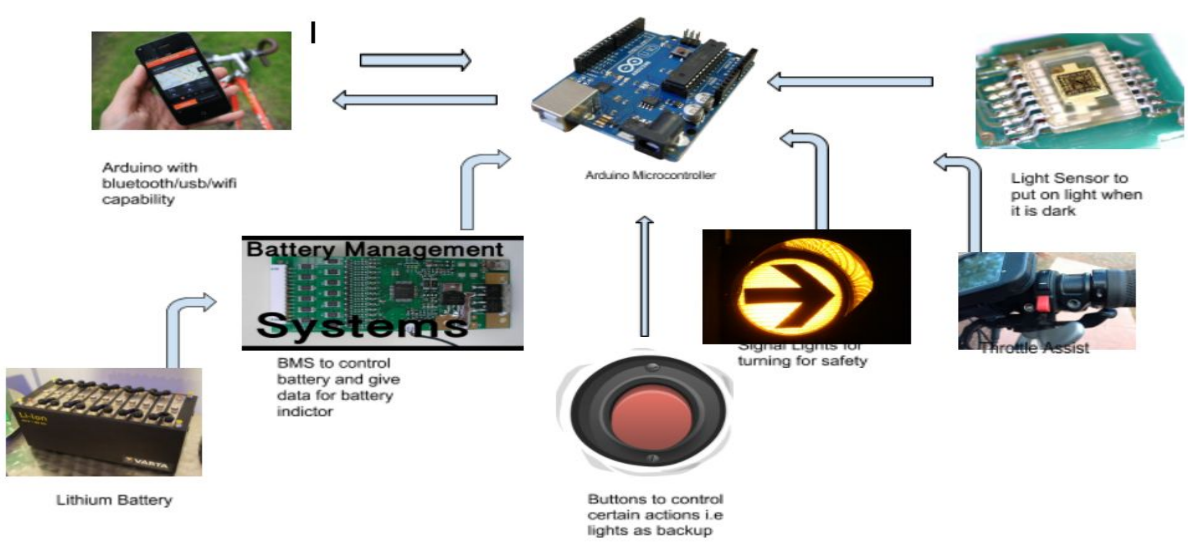
also be physically active to an extent. Now, although we want our target market to be physically active we don't want them to push themselves too hard. We desire to take some of the strain off of their exercise. We plan to do this by allowing the bike to do more of the pushing instead of the user's legs. The E-Trike caters to the needs of those with physical limitations. The seat has an obtuse angle formation that allows the user to sit at an angle that provides back support. The controllers on the side of it allows for the user to push themselves up and establish a balance. Due to different health ailments that may occur in users such as knee problems and back problems etc. our E- Trike team is striving to make improvements by providing more cushion in the seat. The seat is important because trike sits low and it's easy to feel the pain when you bike over big rocks or rough terrain. The users comfort is a big factor because our demographic would have increased sensitivity. The laws of the D.C. Bike Association state that the E-Trike is allowed to be mobile on the streets, therefore an improvement is providing the bike with tools to provide efficiency throughout traffic. Adding a turn signal on the front and back of the bike that includes a 1500 lumens LED bulb to provide notice to other vehicles when the eTrike will switch lanes or turn corners. Adding an electronic notification system that brings notice of how many miles left until the battery dies.

Our device can be improved by adding to various aspects of the device. One area would involve the affordability of the product. By saving money on parts we would be able to decrease the cost of the bike which would allow for more customers willing to purchase the Trike. Another area would involve safety, which is extremely important. Currently the Trike lacks seatbelt, seat belt requirements, turn signals, sensor signals, mile trackers, as well as battery low warnings. We wish to put in all of these technologies in order to keep the customer informed about what's happening. This will result in more cautious drivers and less avoidable accidents and issues. For travel convenience, we would work to decrease the weight of the battery as well as the weight of the entire Trike. This will come in handy when carrying the Trike up stairs or when storing. In addition, we propose to decrease the amount of pedaling needed to run the bike and increase the distance the Trike can reach in one trip. Which will aid in customers with limited mobility and those who live in areas with spaced out facilities and/or homes. We propose to decrease the issue with e-bikes climbing up hills as well. Users who live in Mountainous regions have had a difficult time getting up hills, however if we increase the amount of gears involved and increase motor use during uphill riding the rider should have better mobility on hills. Finally, we look at aesthetics and user convenience for improvement. We can make the Trike's design more appealing to users with color or shape. And we can add to the user convenience by installing a phone charger.

SOLUTION DESIGN

The E-Trike mainframe consists of a steel chassis elongated to reach the two front wheels and the back wheel consisting of the motor. Attached to the chassis is a metal plate that allows for storage of the motor controller and the 3 12V Lead batteries. The tricycle is electrically powered only. Attached to the steel chassis are metal “L” brackets secured in with two ½ inch screws on both sides of the chassis. that add more width to the steel chassis allowing the wheel to fits securely in the brackets. In the future, the goal is for it to be manually powered as well. The wheels allow the trike to sit roughly 2-3 inches off other ground. Equipped with the trike is an in hub motor requiring a minimum of 40V to power and taking in about 2.5 amperes of current.

The trike also consists of a battery management indicator that uses multiple color LED’s to notify the user of the current power the batteries consume. The battery management indicator is attached to a throttle allowing the user to adjust the speed of the tricycle. The trike also has a manual break (brake 1) that ceases motion of the front wheels and an manual brake(brake 2) that cuts the power to the motor in the the back wheel. Brake 2, as well as the battery management indicator are attached to the hall sensors connected to the motor controller. The motor-controller is also attached to the power source as well as the in hub motor. The motor controller was used to govern the performance of our in-hub motor. Alligator clips were soldered onto the wires in order to provide a connection from the motor controller to the power source. The tricycle cohesively worked with the IoT technology associated with the bike as well as the IOS application. Within the application the user was able to turn on the left turn, right turn and brakes lights at their convenience. The user was also able to control the GPS feature as well as pinpoint their location with the IOS application.



Picture: Solution Design Implementation

PROJECT IMPLEMENTATION PLAN

Month	Week No	Tasks	Member in Charge	Monthly Deliverables
Jan	1	N/A		Getting our parts and software outline
	2	N/A		
	3	Getting the funding for hardware	Mercy	
	4	Getting the hardware ordered and having a plan for the software	Mercy and Tiauna	
Feb	1	Designing the PCB Board - learning about it	Breyonna	Designing the PCB Board and having drafts of the whole system
	2	Designing the PCB Board - having a draft prototype	Breyonna	
	3	Coding the App - Building the draft interface	Tiauna	
	4	Putting together the parts - verifying each part works	Kasandra Adaugo	
Mar	1	Putting together the parts	Kasandra	Having a moving bike and something to present
	2	Designing the PCB Board -	Felicia	
	3	Designing the PCB Board -	Felicia	
	4	Coding the App - writing the code behind the interface	Adaugo	
Apr	1	Coding the App - writing the code behind the interface	Adaugo	Having a good presentation
	2	Project Demo + Presentation Event	Mercy	
	3			
	4			

Our Project Implementation Parts was revised several times due to not being able to get the parts.

PATENT-LIKE DESCRIPTION

FIRSTLY WHAT IS THE ETRIKE MADE OF?

The electric bike is made up of 4 main components. This includes the frame, the battery, the motors and the controllers. The frame of a bike mainly composes of the gears/motors, wheels, handles, brakes and the actual frame. The battery is one of the most important components because the type of battery an electric bike has can determine how heavy the bike will be overall.. The capacity of the battery used in each bike varies depending on the specifications of the bike but generally the energy that is stored is up to at least 400W per hour. The quality of the battery determines how many cycles it takes to charge, it also determines how long after the fixed running time the battery is still functional. Though there are many different types of batteries that have been tested the most popular ones used for electric bikes are NiMH, Ni, or Lithium-ion batteries. NiMH batteries take around 400-800 cycles to recharge while Lithium-ion batteries can take up to 1000 cycles. Battery type determines how long charging time can take and this time can range from two to nine hours. Of the three most commonly used batteries for electric bike lithium-ion is the most popular due to its lightweight, durability, and ability to deliver power to a system for a longer period of time.

Electric bikes today use a hub motor that is either “brushed” or “brushless”. In a brushed motor there are small metal brushes the move electric energy to the commuter which is the rotating part of the motor. Over time this transfer of energy creates about 3000 miles of use but also wears down the brushes and they have to be replaced around the same time. Though not expensive the maintenance work is not easy. Brush motors also have the advantage of needing less complex controllers which can cut down on the cost of the bike overall. Brushless hub motors part of the frame, still obey the basic principle: turning stored energy into electric power. The convention as stated for bushed hub motors is to pass an electric current through a tightly coiled current which creates motion that can turn a wheel because of the force . So usually, you have the battery passing current to the motors to create the force to turn the wheel. However in brushless hub motors, instead of having one motor creating the force and relying on gears and chains to pass the force to nearby wheels, each wheel has it’s own motor and instead of the usual brushes turning in the motor to create the turning force, the motor consists of several small coils and circuits just large enough to create the same turning force but with more efficiency.

Electric Tricycles use electronic controllers to provide real time data to control when the additional power to augment the rider's pedalling comes into play. There are various factors considered and various school of thought for the controllers, some controllers measure the cycling of the pedal and augment it with enough power to keep it consistent. Other controllers sense the pressure, when the foot is placed on the pedal and automatically augments the rider's effort. Regardless of how the sensors work to augment the rider’s pedalling the controllers operate in a closed feedback loop, adjusting its output by the input. Real time data is extremely important, so the controllers make use of the simplest data representation and send pulses containing the information(PWM). There is another option of using a cheap hall sensor which does not require closed loop feedback, however they work with brushed motors which are not

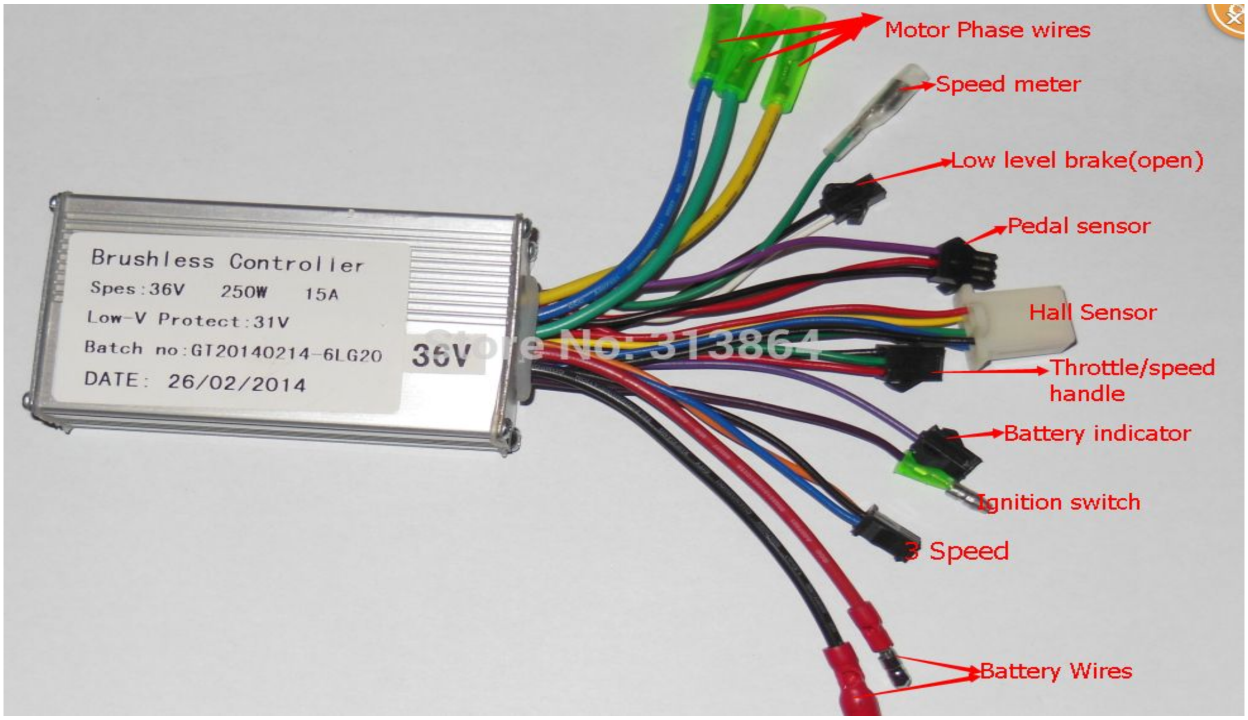
Efficient.

Patent Like Description :
KMX Kolt Recumbent Trike

1. KMX Hardshell Bucket Seat with an easy angle and frame position adjustment.
2. Double Wall White Rim wheel 20 inches 32 spokes , all wheels of equal size Front and rear.
3. Brakes Bengal MB600 Disc brakes on front wheels only
4. Gears 8 speed microshift 332-11 Rear Cassette
5. TIG welded steel box frame with aluminum front. There is 11cm of leg adjustments. The chain length will not have to be adjusted with the KMX Chains
6. Derailleur microshift mezzo rail rear derailleur
7. Motor is 12.8lbs located on the rear wheel. 20 inches reliability of the 500w direct-drive hub motor and the option of supplying their own 36 volt or 48 volt battery pack.
8. Battery 4 Acid Lead batteries producing 12-14 volts individually. Expert Power standard 12v 7Ah rechargeable SLA Battery. Sealed Lead Acid Battery. If possible replace with lithium battery. **Don't exceed 50volts** or will over power and blow the fuses.
9. Microcontroller regulates power and communicate to the other devices. Brushless DC motor controller

Microcontroller Design:

The final design incorporates a motored wheel, which requires a microcontroller to regulate power and information from other devices on the E-Trike such as the throttle and the brakes. The microcontroller regulates the voltage that enters from the battery or power supply to the wheel by delivering the appropriate range of voltage, a minimum of 40 volts and a maximum of 50 volts. With the microcontroller's hall sensors the throttle and brakes, located on the handle bars, can send information to obtain control of the wheel. Additionally, it allows the user to be aware of battery levels which is displayed below the throttle. Below is a diagram that maps out the inputs and outputs of the microcontroller along with the description of the functionality of the wires we use.



1. Motor Phase Wires

   When even two of the three motor phase wires (normally thick yellow, blue, and green wires) are crossed the motor is short circuited and locks the wheel from all motion. Although the wires crossing does not damage the circuit it does begin to produce heat. Insulate the wires with electrical tape and connect with wires of appropriate diameter.
2. Low Level Brake(open)

   Installing the low level brakes to the E-trike, allows the users to cut the power flowing to the wheel, spereraly from the manual brakes. When testing the bike, be sure to check to see if the brakes were not left open, otherwise the bike will not run.
3. Hall Sensors

   Hall sensors are utilized in the order to replace a mechanical commutator and brushes. Its role is to keep track of the rotor's position. These sensors can pick up speed detection, current sensing, and more.
4. Throttle/Speed Handle

   Adding a throttle to the system allows the user to control the speed of the motored wheel. The throttle takes in multiple sensors and when properly installed should give off about 4.2 volts.
5. Battery Indicator

   Currently the battery indicator installed is located below the throttle on the handle bars. The microcontroller monitors the power level and displays it as a red, yellow or green light, denoting empty, half full and full. The battery indicator has two wires to receive information.

6. Battery Wires

   The battery wires are appropriately colored red for positive and black for negative. As the power source is installed to the e-trike make sure the throttle is turned off and all other sensors and circuitry are complete. Never cross the red and the black wires, and be sure to insulate the wires for safety. It is important to use wires that are sufficiently large in diameter because of the high voltage that will be sent through them.

In the future, it is wise to test all components of the circuit to make sure power and information is successfully transferring. There is a manual included with the microcontroller that explains steps for component testing. Another strive would be to incorporate more features the microcontroller can facilitate. For example, it has the ability to monitor light control, incorporate an LCD display and allow for a cruise control setting.

PROJECT IMPLEMENTATION PROCESS

The first process we encountered was trying to make the ETRIKE work manually, although we failed. It was an experience worth learning from, as we went to three different bike shops around D.C. with the whole bike: Gear Up Bikes and City bikes at Adams Morgan. However we needed a 1.5inch screw-on freewheel we could not get no matter what, although we did get free parts. The next part of the implementation process focused on building a PCB board, but even with that we were not assured of getting the parts.

Therefore we decided to do what was feasible and went with building an IoT device around the ETRIKE which will be expantiated on below.

We then refocused our energy on the next part of the implementation

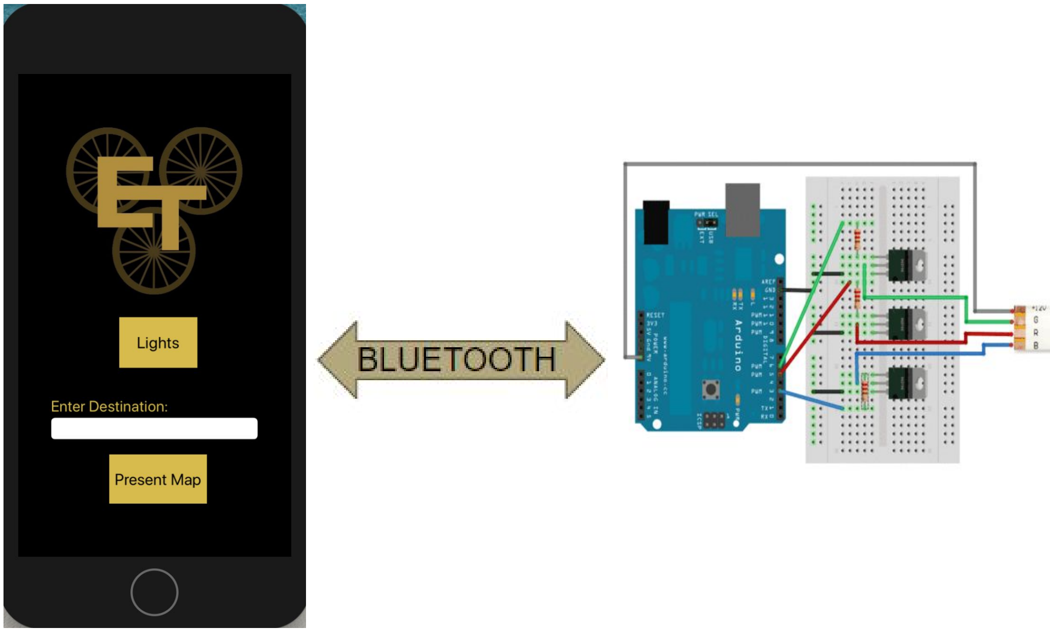
There were several parts of the ETRIKE as it evolved from just a functional ETRIKE to an ecosystem to allow for friendly Transportation.

I.e. Software and Hardware peripherals - Tail Lights, GPS, Light Sensor for Lights

A. Software

   a. User Interface

   Our eTrike iOS mobile application was created using Swift. The mobile application takes in data from the Bluetooth module which is connected to the Arduino Uno. The swift mobile app was designed in Xcode. The home screen interface is shown below.

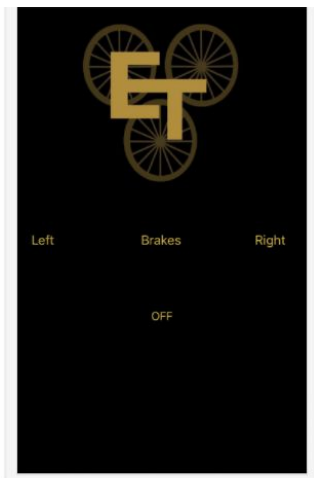


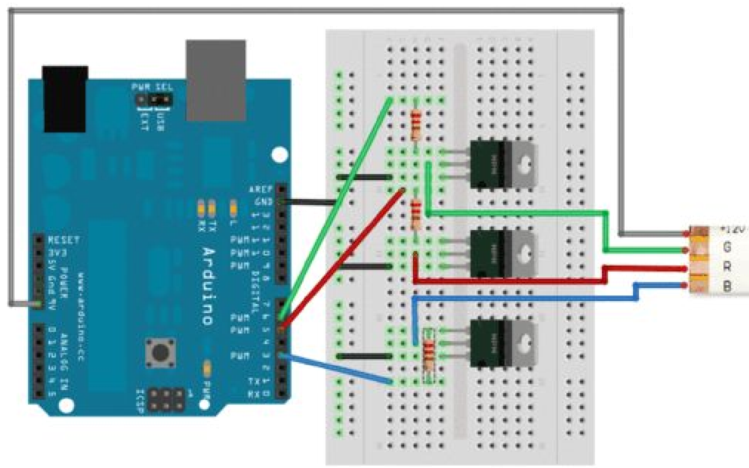
Each “buttonTapped” function above correlated to a different light which was signified by a different hexadecimal input. Orange was 0x31, red was 0x32, white was 0x33, and off ws 0x30 in the swift code. In the Bluetooth code for arduino, these inputs equated to 1, 2, 3 and 0 respectively as shown below.

```
@IBAction func onButtonTapped(_ sender: Any) {
    print("Orange ON")

    assert(characteristic != nil || writeType != nil, "The EditValueController didn't initilize correct!")
    self.title = "Edit Value"
    bluetoothManager.delegate = self
    let inputView = MRHexKeyboard(textField: valueInputTf)



    var textContent = "0x00"
    if textContent == "" {
        return
    }
    textContent = "0x31"
    print(textContent)

    var hexString = textContent.substring(from: textContent.characters.index(textContent.startIndex, offsetBy: 2))


    if hexString.characters.count % 2 != 0 {                'characters' is deprecated: Please use String or Substring
        hexString = "0" + hexString

    }
    let data = hexString.dataFromHexadecimalString()
    // print(self.characteristic)

    self.bluetoothManager.writeValue(data: data!, forCharacteristic: self.characteristic!, type: self.writeType!)

    inputView?.setDoneAction { () -> Void in

    }
    valueInputTf.inputView = inputView
}
```

B. **Bluetooth with Tail-lights**

The headlights consists of three bulbs which need at least 8V. The three different colors indicate three different actions. Red represents the middle light, or the brakes. White represents the leftmost light and signifies left turn, and the yellow light signals right turn. The headlights were able to be controlled wirelessly using bluetooth. The ETRIKE app had three buttons, each one indicating the individual light bulb. Since the bulb were 8V while arduino pins only support up to 5V, Transistors(SUNKEE IRFZ44N Power Mosfet) had to be used to act as a switch to control the incoming current.





Schematic to Control Lights

There was a slight change to the schematic above. The light bulbs need to be connected in series to the power supply directly instead of the arduino. The positive leg of the power supply goes into the negative leg of the bulb.

BLUETOOTH CODE FOR ARDUINO

```
int state = 0;
int flag = 0;
#define REDPIN 5
#define GREENPIN 6
#define BLUEPIN 3

#define FADESPEED 5     // make this higher to slow down

void setup() {
 pinMode(REDPIN, OUTPUT);
 pinMode(BLUEPIN, OUTPUT);
 pinMode(GREENPIN, OUTPUT);
digitalWrite(REDPIN, LOW);
```

```
digitalWrite(GREENPIN, LOW);
digitalWrite(BLUEPIN, LOW);

 Serial.begin(9600); // Default connection rate for my BT module
}

void loop() {

 if(Serial.available() > 0){
 state = Serial.read();
 Serial.println(state);
 flag=0;
 }

 if (state == '0') {
digitalWrite(REDPIN, LOW);
digitalWrite(GREENPIN, LOW);
digitalWrite(BLUEPIN, LOW);
 if(flag == 0){
 Serial.println("LED: off");
 flag = 1;
 }
 }
 else if (state == '1') {
 digitalWrite(GREENPIN, LOW);
digitalWrite(BLUEPIN, LOW);
 digitalWrite(REDPIN, HIGH);
 if(flag == 0){
 Serial.println("LED: on");
 flag = 1;
 }
 }

else if (state == '2') {
  digitalWrite(GREENPIN, LOW);
digitalWrite(REDPIN, LOW);
 digitalWrite(BLUEPIN, HIGH);
 if(flag == 0){
 Serial.println("LED: off");
 flag = 1;
 }
 }

 else if (state == '3') {
  digitalWrite(REDPIN, LOW);
digitalWrite(BLUEPIN, LOW);
 digitalWrite(GREENPIN, HIGH);
 if(flag == 0){
 Serial.println("LED: off");
 flag = 1;
 }
 }
```

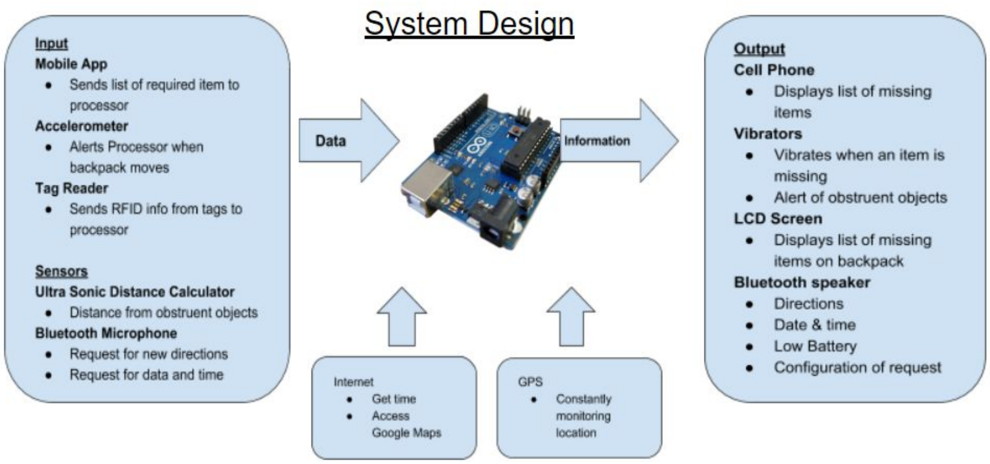
On how the App worked the CoreBlueTooth Library for IOS was used. For more explanation on that, please visit the Software implementation Section.

Future Implementation

In view of automated systems, there are countless opportunities for this:

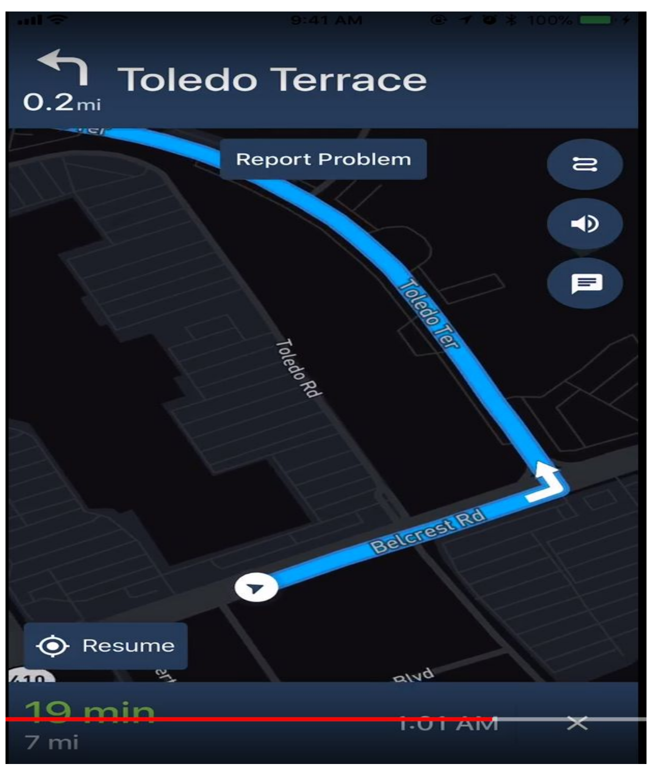
1. The light signals come on automatically sensing the direction from the mobile GPS

2. This core technology can als0 be used to implement other things i.e. Diagnosis Systems, Accelerometer,Tag Reader, BlueTooth Microphone, Distance Sensors combined with Alert Systems to prevent collisions. The Diagram below shows how some of these might work.



C. GPS

The software GPS aspect of the mobile application utilizes the google maps API and was integrated with the original code for the eTrike app.



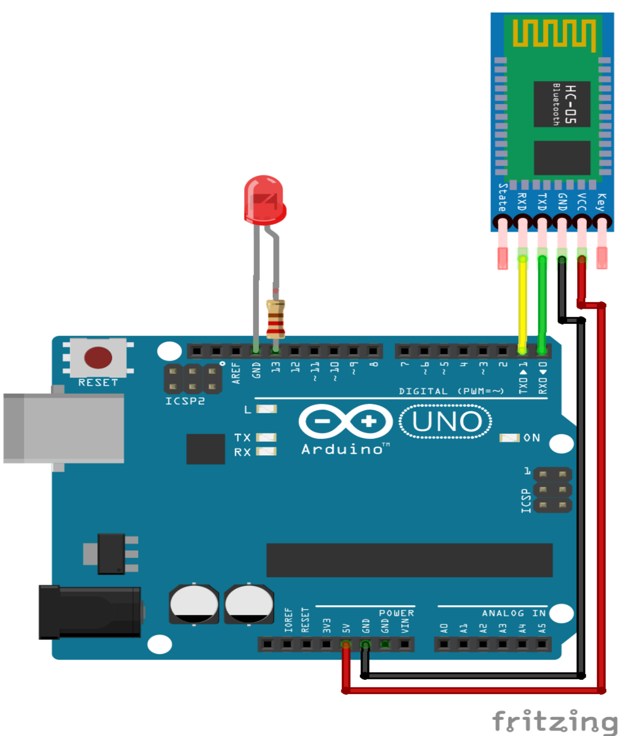
Future Suggestions

The gps and light sensor are a starting point for the full mobile application capabilities.

1. The goal is to enable the eTrike to be fully controlled by the mobile application.
2. Make the eTrike marketable and profitable by enabling ride sharing through the mobile app. The user would be able to check the eTrike in and out using the app and pay a small fee to ride the eTrike.
3. The light signals come on automatically sensing the direction from the mobile GPS
4. The light signals come on automatically sensing the direction from the mobile GPS
5. This core technology can als be used to implement other things i.e. Diagnosis Systems, Accelerometer,Tag Reader, BlueTooth Microphone, Distance Sensors combined with Alert Systems to prevent collisions.

GPS HARDWARE

To fully realize the idea of a bike that is IoT integrated, we worked on a mobile GPS system as well as a light sensor. At $1000, a low price but still not cheap, the GPS system allows the development of a "Find My Trike" Feature although we did not have enough time to implement it fully. The "Find My Trike" Feature allows the user to receive longitude and latitude locations of the bike because it is always on the bike and powered by the battery while running on an arduino. The schematic is below:



To connect the gps module for locational services such as

- Navigation
- Speed
- Tracking

The problem that arose with the "Find my Trike" Feature was that on Arduino there is only one port of serial communication and the arduino used one to communicate to the bluetooth while the gps module used another one. For future, using a raspberry pi will be advisable

Conclusion

In Conclusion the E-Trike is a fully functional electric tricycle. Rechargeable Acid lead battery powered. The etrike is convenient, reliable, energy efficient and environmental friendly. The electric trike has its very on mobile app that connects the Gps and light sensors. The Microcontroller connects the software to the actual bike. The E-Trike is geared toward the youth, the three wheels are helpful for those who have trouble balancing and the design is cool and modern for leisure activities. In the future we would like to make the E-trike profitable by adding a lithium battery and portable chargers all over college campuses.

References

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