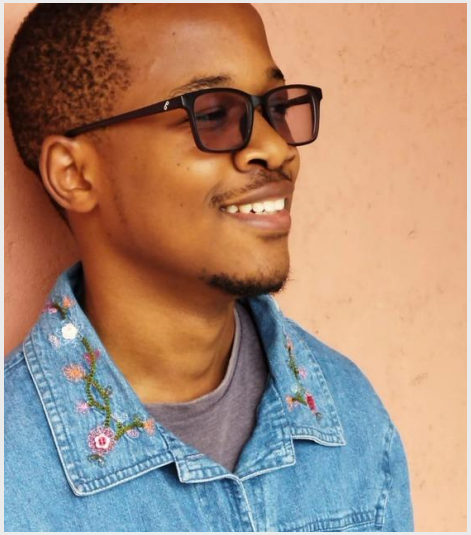
Electric Subsystem

Electric Team



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Objectives

The major objective of the electric team was to facilitate the use of an electric motor to drive the tricycle and the tractor.
The following objectives were thus formed in order to achieve the above.

1. Component sizing (motor and battery) for both tricycle and tractor.
2. Implementation of Battery Management System and Charging system for Tricycle
3. Implement mechanisms for user interaction with the system e.g start/stop, Reverse, Speed, battery percentage etc.
4. Designing Speed and throttle control mechanisms.
5. PCB design to meet required objectives

TIMELINE

PHASE I

Major Component sizing and scope of work

PHASE II

Function design and PCB design

PHASE III

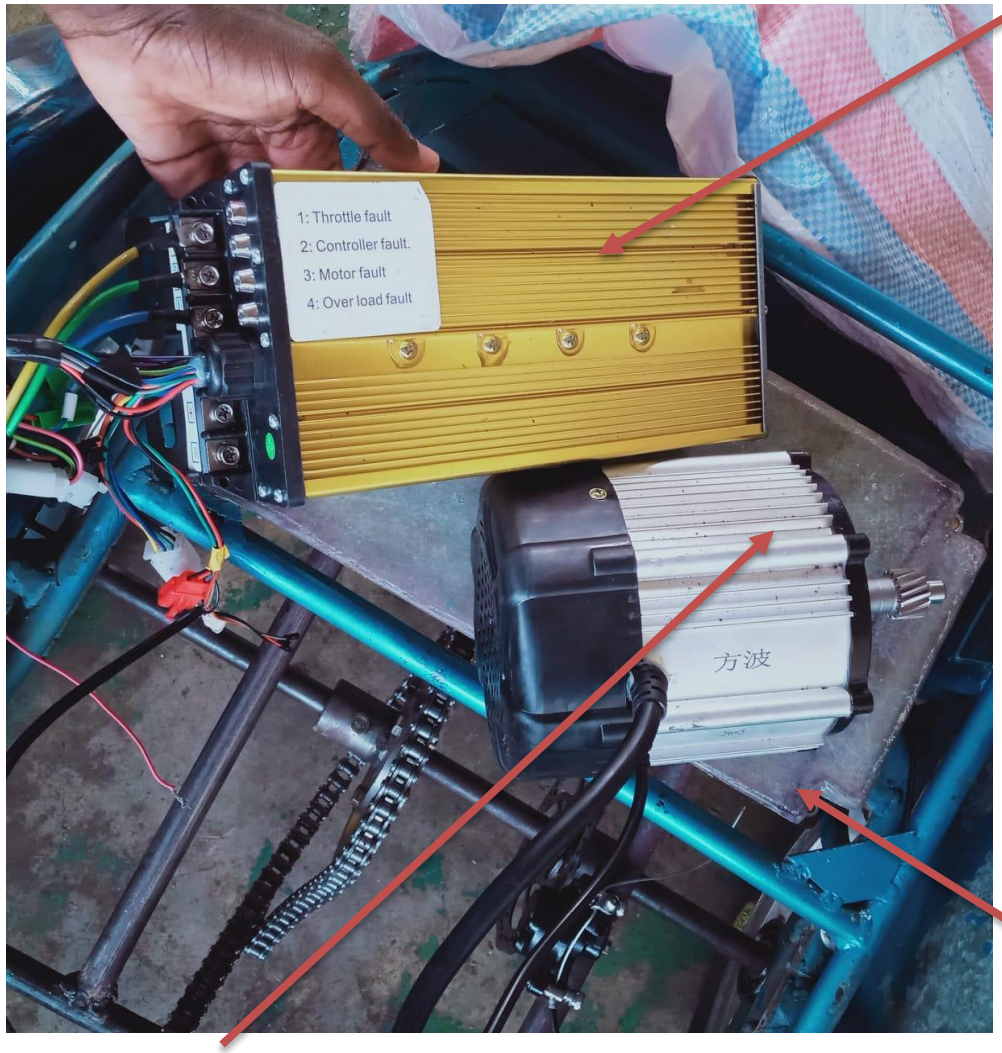
Alpha testing

PHASE IV

Subsystem Integration and Product launch

TRICYCLE

Battery and Motor Sizing



ESC(Electronic Speed Controller)

Battery

BLDC Motor

Considering torque requirements, battery sized at 48V 24AH, Motor 1.2KW

Key learning from battery sizing

Lightweight Multi-Cell Battery (7KG)
Cheap and locally sourced

Heavy Single block battery (26KG)
Expensive and imported. Undesirable weight distribution

Battery comes with inbuilt Battery Management Systems and also includes a charge controller for charging.

KEY METRICS

BLDC Motor Power

1.2KW

Battery Capacity

48V 24AH

Top Speed

16KM/H

Operating time

6 HRS

Max Carrying weight(Rider inclusive)

150 KG

Charging time

5 HRS

KEY METRICS

BLDC Motor Price

20,000

Battery Price

30,000

Throtlle Price

6,000

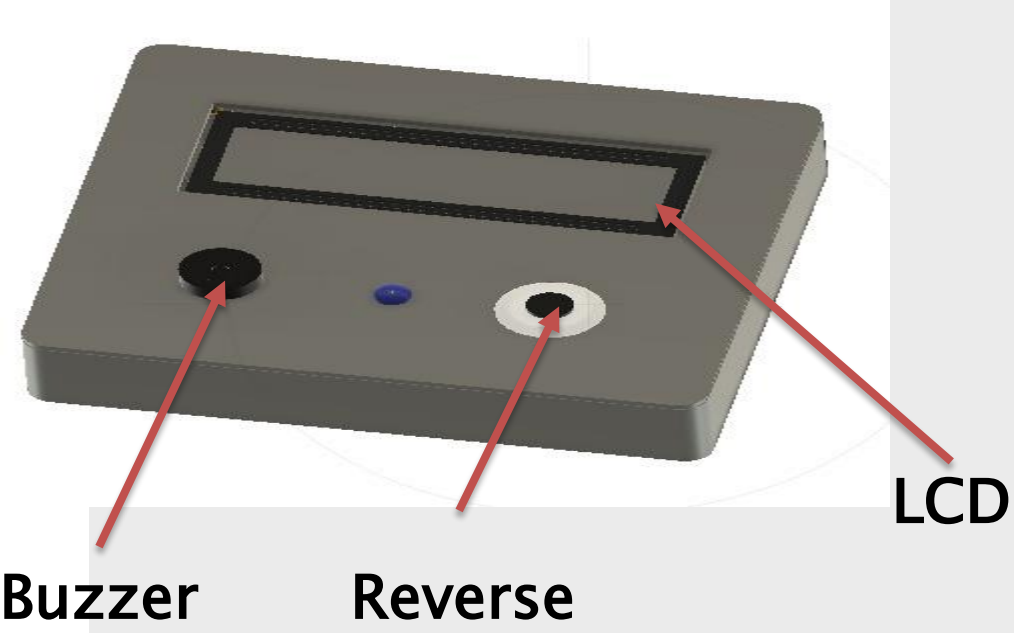
PCB & other components price

10,000

USER INTERACTION

The user is provided with a key for turning the system on or off.

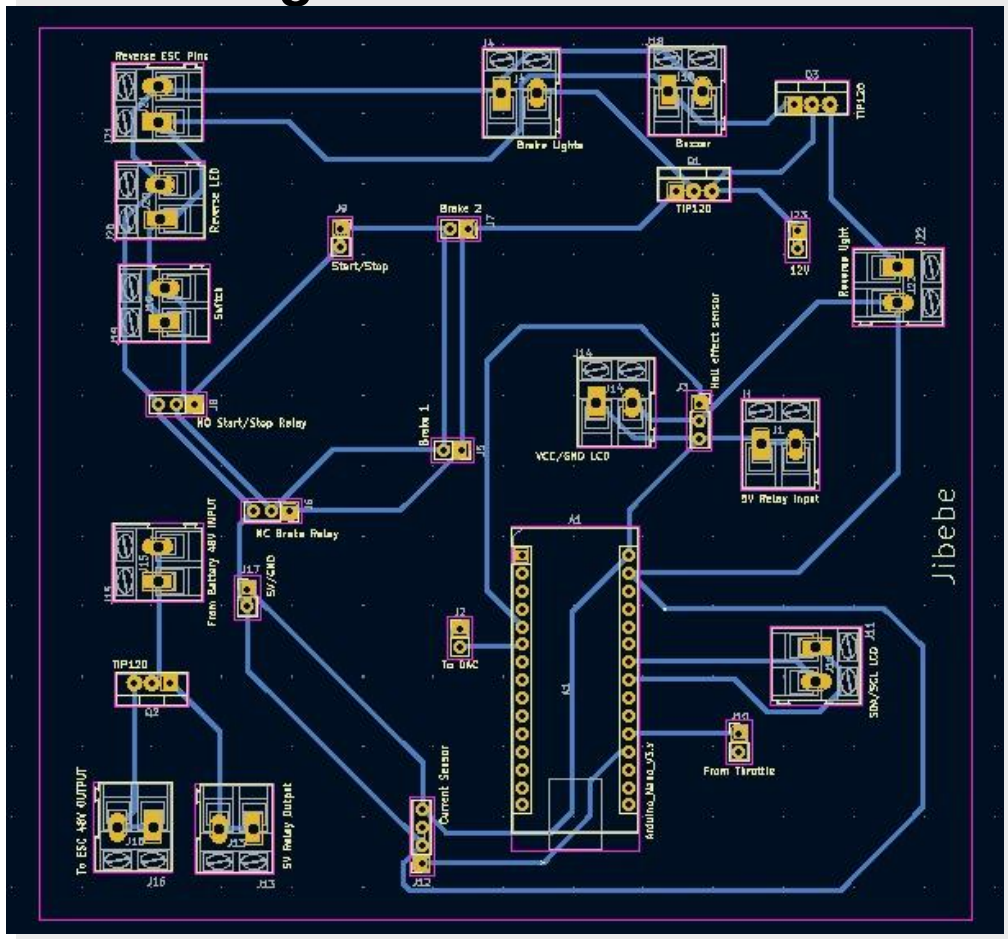
- They have a mounted LCD hub for monitoring Speed, and Battery Percentage.
- The hub also has provisions for engaging reverse mode.
- During reverse mode, a buzzer and LED are turned on to indicate reverse mode.
- Brake lights engage during braking and reverse mode.



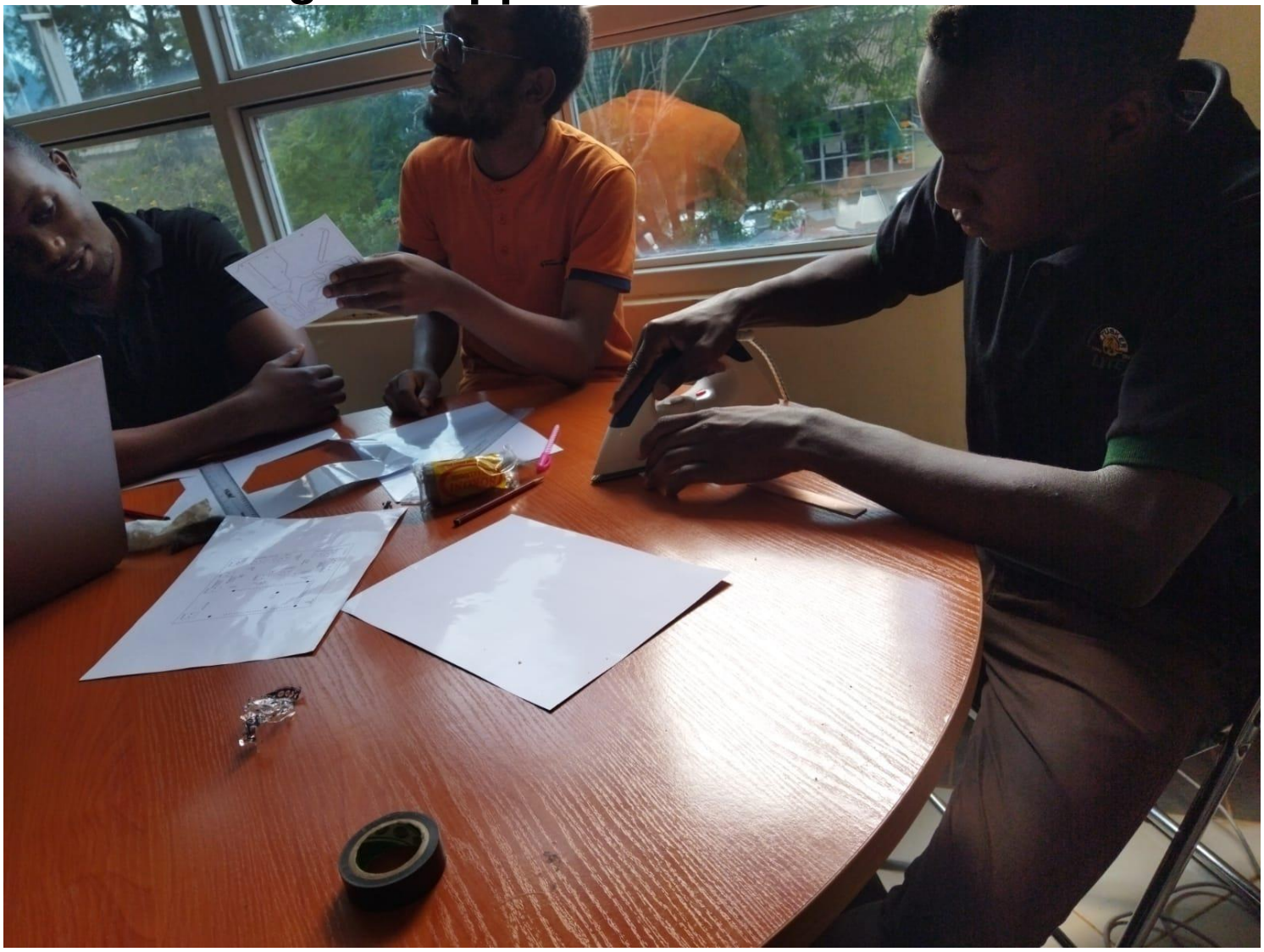
PCB Design

Printed Circuit Board that covers all the objectives and user interaction requirements was designed. The team did everything in house from design to the final fabrication.

1. Design



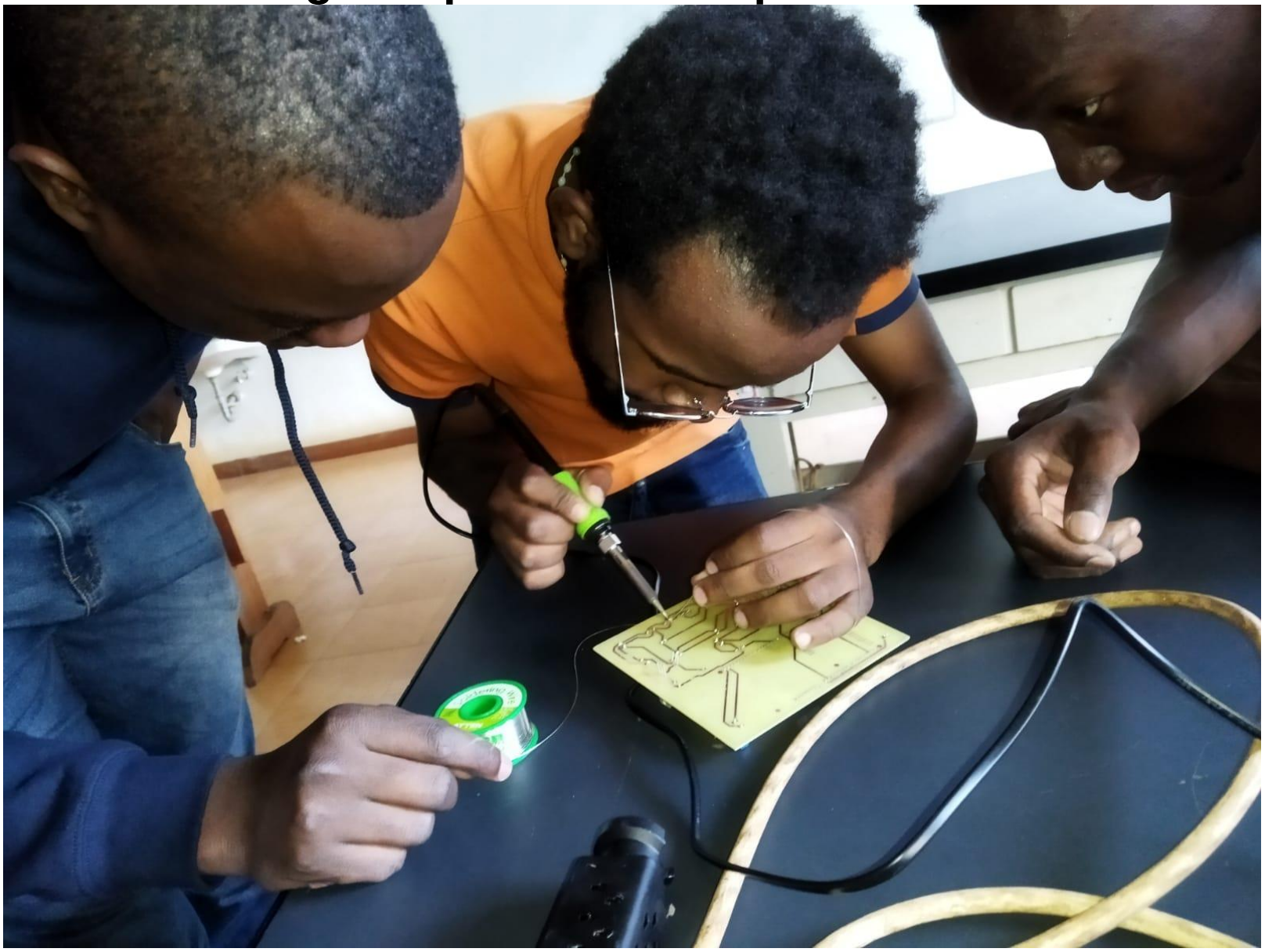
2. Printing on copper board



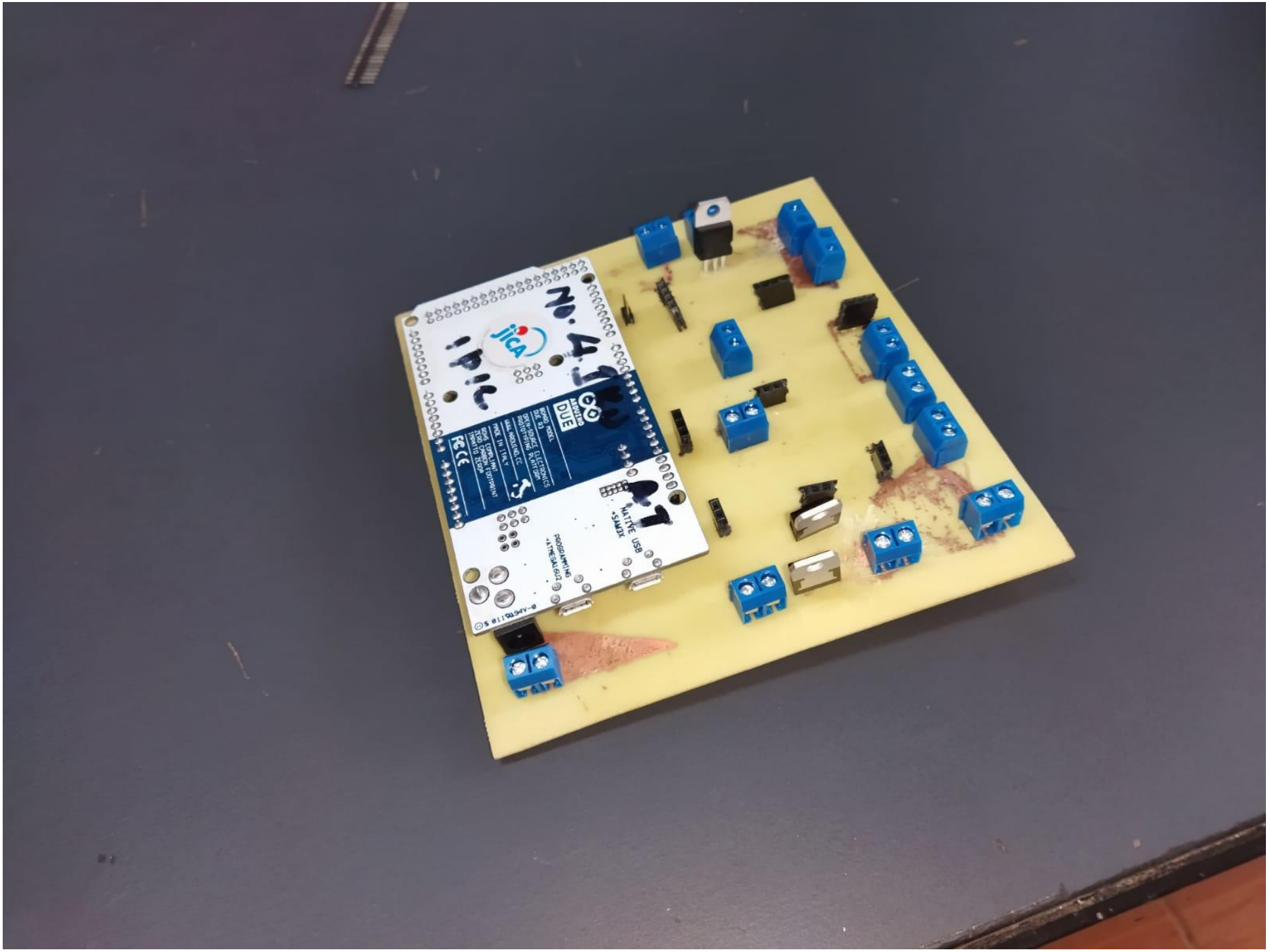
3. Etching

4. Drilling holes

5. Soldering components after placement



6. Final result



Speed and Throttle Control

PROBLEM

Initial tricycle runs revealed an uncomfortable and hazardous inconvenience. The tricycle tended to jerk owing to the ability to go from rest to the top speed within short periods of time.

The speed control of the motor used was not desirable.

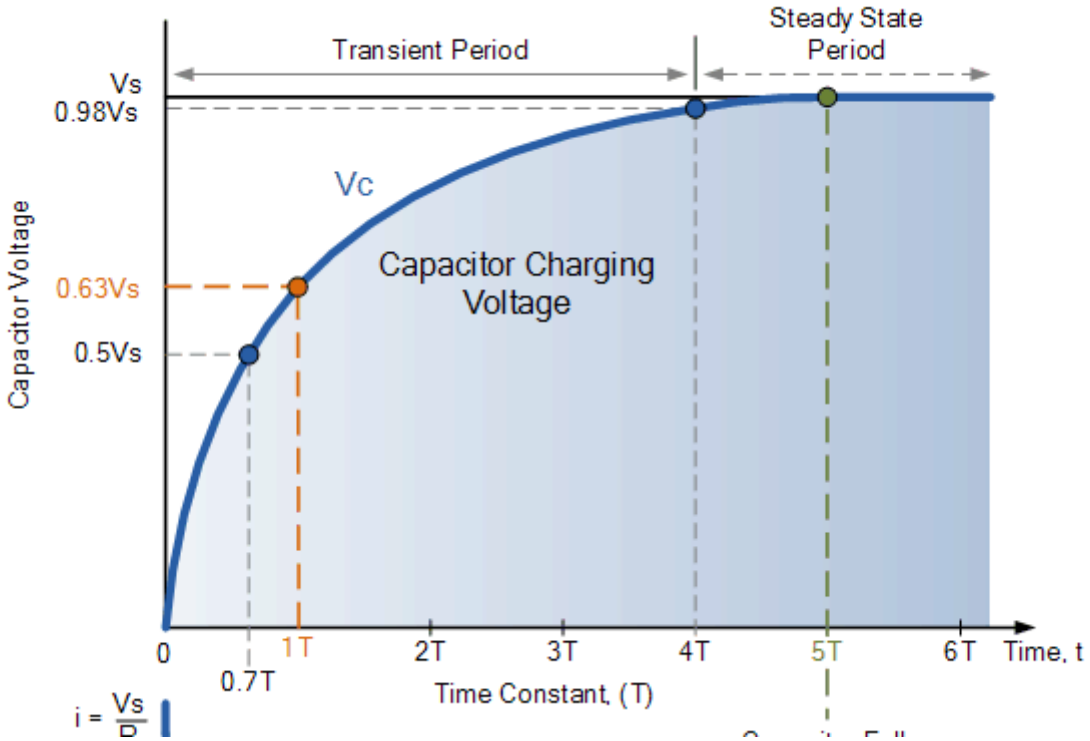
SOLUTION

The team came up with several solutions in order to achieve a constant acceleration, linear speed behavior in the tricycle. This was to increase user experience and comfort.

SOLUTION 1:

Delay circuit(RC circuit) between the throttle and the speed controller to increase delay when accelerating to the top speed.

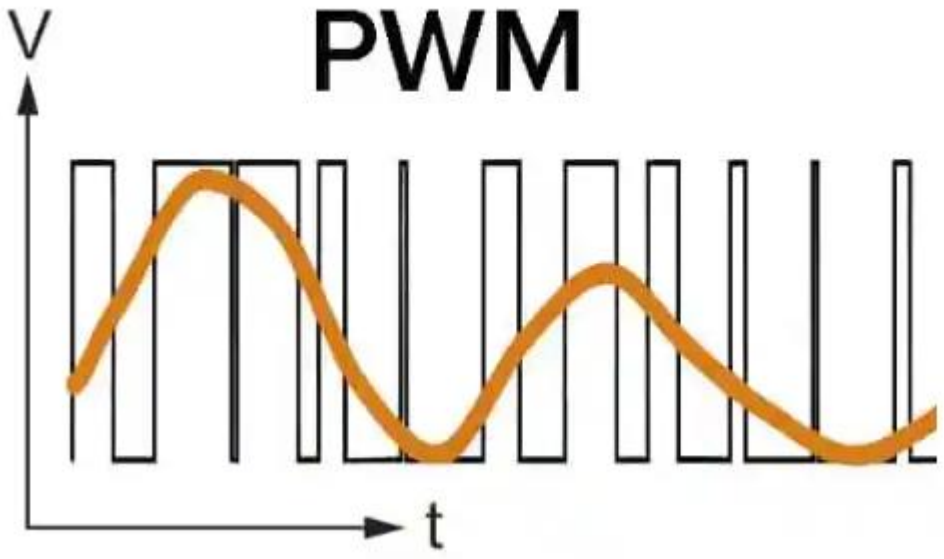
This however caused an exponential output which was not applicable to our usage.



SOLUTION 2:

The team implemented a microcontroller solution to solve the problem. This was done by using a PWM pin to sequentially output a given throttle input. This however produced erratic output owing to PWMs nature.


Throttle
Analog Pin
Arduino
Microcontroller
PWM
Speed Control


V
PWM
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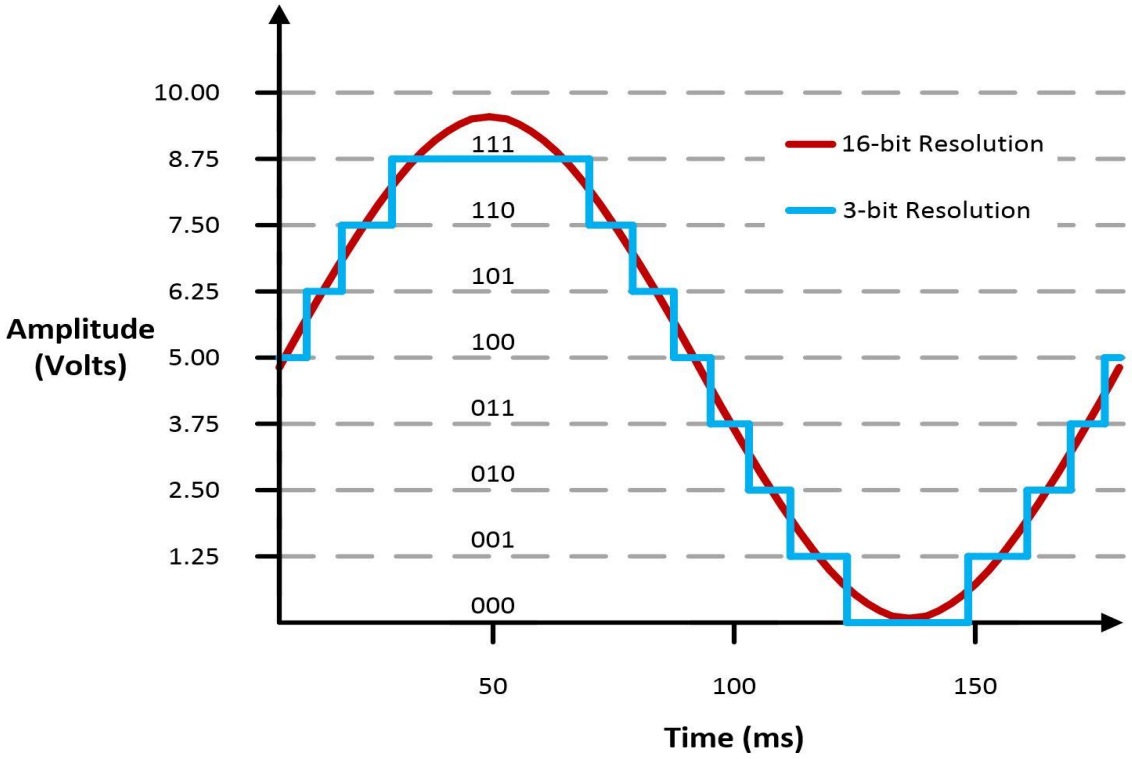
SOLUTION 3

An innovative new solution involving the use of Digital to Analog Converter Output was trialed. This proved to be a SUCCESS. Where PWM had failed, DAC triumphed. A special microcontroller board (Arduino DUE) was chosen for its DAC capabilities.



As a result of the work on the Jibebe Project. The Electric Team is working on two papers:

1. Speed and Throttle Control of BLDC Motors
2. Battery Capacity and Motor Sizing of electric vehicles.

Recommendations

1. Using a hub motor instead of the current arrangement.
2. Using a lower rated motor. 500W is sufficient.

BE ON THE MOVE

TRACTOR

ELECTRICAL SYSTEM

Component Sizing

Sizing of both the motor to be used(BLDC/AC) and sizing of the battery required to supply that motor.

This took into consideration both torque requirements and operation time requirements.

User experience

Design the systems which which the user interacts with the tractor. Starting and Stopping, security locks, speed display, battery display. Reverse mode engagement and brake lights

PCB Design

Design of PCB to support all electrical functions e.g brake lights, buzzer, speed display

TRACTOR TIMELINE

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Major Component sizing and scope of work
(WE ARE HERE)

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