E-Trike Cycle

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***Abstract*—The E-Trike Cycle is a high-performance improvement in sustainable transportation, able to combine electric power with stability and accessibility through a three-wheel design. The following project emphasizes design, functionality, and environmental impact in an attempt to outline the potential role of the E-Trike Cycle in driving change in urban commutation. This project's objective is to design and develop a battery-powered trike. In this study, common issues faced by current trikes were identified and addressed. By the end of the project, a prototype of the battery-powered trike will be fabricated, demonstrating the feasibility and practicality of the design. The fabrication process involves several key techniques, such as drilling, turning, bending, and welding. The resulting prototype is intended to pave the way for future commercialization efforts.**

***Index Terms*—E-Trike Cycle, sustainable transportation, electric power, stability, accessibility, three-wheel design, power-assist motor, battery-powered trike.**

1. INTRODUCTION

At present many exciting developments in electric vehicle technology are taking place. Some of these have advanced sufficiently to be commercially available, whilst others remain for the future. The first demonstration electric vehicles were made in 1830's and commercial vehicles were available by the end of the 19th century. Today's concerns about the environment particularly noise and exhaust emissions, coupled to new developments in batteries, fuel cells, motors and controllers may swing the balance of electric vehicles.

There are many types of electric vehicles such as railway trains, ships, aircrafts, cars, bikes, bicycles, wheel chair and many more. But in this project is focused on electrical powered Trike which is categorized under Low-Speed Vehicles (LVSs) are an environmentally friendly mode of transport for short trips.

An electric Trike, commonly referred to as an E-Trike Cycle, is a three-wheeled vehicle powered by an electric motor. It represents a blend of traditional pedal-powered Trikes and modern electric propulsion technologies, offering a versatile and eco-friendly mode of transportation. E-Trike Cycles have gained popularity due to their enhanced stability compared to two-wheeled bicycles, making them a safer and more accessible option for a wider range of users, including the elderly and those with mobility challenges.

1.1 Problem Identification

Problem 1: Economic constraints often prohibit the use of battery-powered Trikes, as they require large amounts of capital.

Problem 2: Every electric vehicle's weight greatly affects its efficiency, distance it can travel and how much it costs in total for an electric Trike.

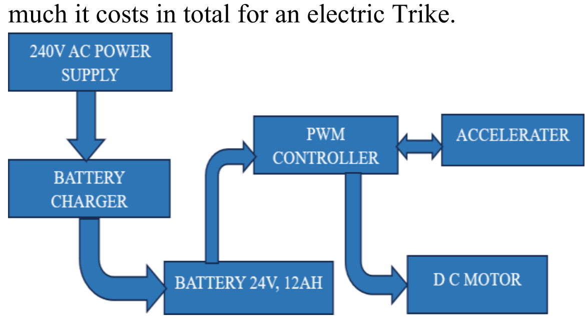

Figure 1: Block Diagram of E-Trike Cycle Motor Circuit

2. OBJECTIVES

The objectives of the study are:

- To design and develop a battery powered electric motor Trike speed of 10- 15km/h.

• To design a Trike which is far more stable in braking turns.
• To design a battery powered Trike particularly suitable for short distance use (10km).

3. HARDWARE DEVELOPMENT

3.1 Calculations of Trike Component Selection

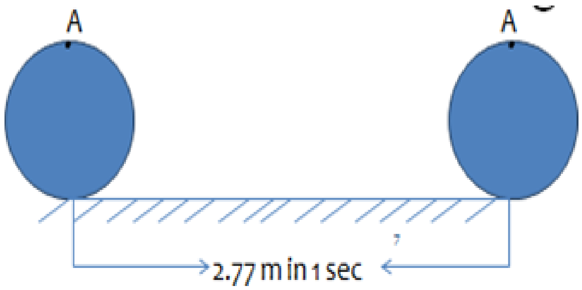

Figure 2: Distance travelled by the front wheel in 1 sec

Table 1: Trike Component Details

1	M	6 kg
2	F	58.86 N
3	T	13.45 Nm
4	Power	237.76 W
5	Speed of Cycle Wheel	115.38 rpm
6	I	14.58 A

Table 2: Electrical components used in our E-Trike Cycle

SL. No.	Components	Purpose
1	PMDC motor	The main component used to move the front Wheel of the Trike.
2	Motor drive circuit	Used to control the speed of the motor.
3	Sealed lead acid Batteries	To supply energy to the motor.
4	Electrical accelerator	To increase or decrease the Speed of the motor.
5	Battery charger	To charge the battery when low.
6	RF based wireless remote control	To turn on and off the Trike from a distance.

Table 3: Mechanical Components Used in The Trike

SL. No.	Parts	Dimensions
1	18-inch front wheel	Wheel diameter- 45 cm Width- 4 cm Rim- 38 cm, thickness- 1cm.
2	Plywood sheet	
3	Back wheel	Diameter = 3.5 cm Thickness = 2.5 cm Length = 12 cm
4	Free wheel	24 teeth
5	Mechanical brakes	

3.2 Electrical Components


Figure 3: PMDC Brush Motor

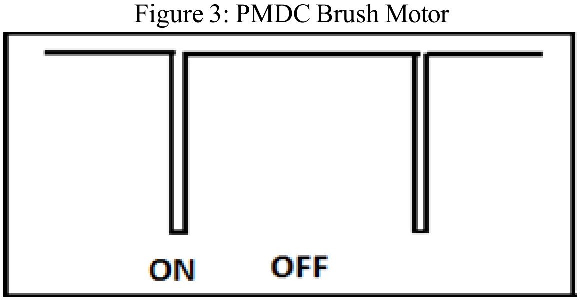

Figure 4: Motor on for a short period.

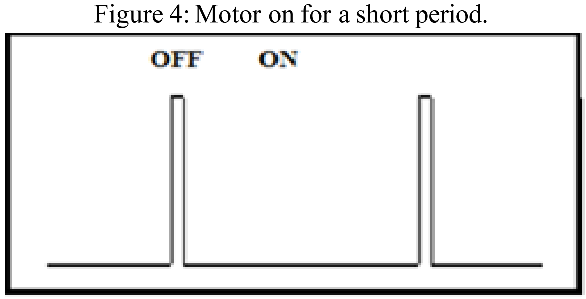

Figure 5: Motor on for 50% and off for 50%.

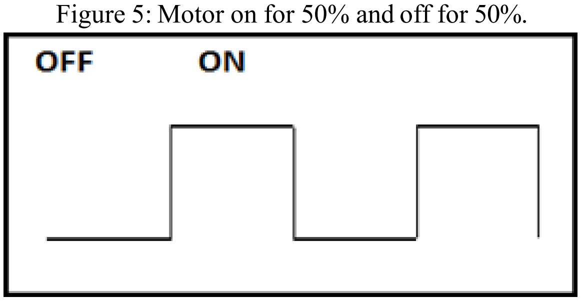

Figure 6: Motor on for a long period.

Table 4: Specifications of PWM motor controller

Sl. No.	Description	Range
1	Supply voltage	24V
2	Supply current	0 A (at zero speed)
3	Output voltage	0 to 100% full speed
4	Switching frequency	0-20 kHz
5	Size: (board only)	122mm x 55mm x 30mm
6	Size: (with heat sink)	180mm x 55mm x 35mm
7	Weight	100g
8	Input	1k to 10k pot.
9	Input voltage	0v to full speed
10	Full speed input	adjustable 3v to 20v

Table 5: Components required for motor drive circuit.

SL No.	Component	Technical specifications	Purpose
1	SG3526	Supply voltage=40V Output current= ±200A	Pulse width modulation control circuit
2	LM7812C	Output voltage =12V	To obtain fixed output voltage
3	MOSFET	IRFP4710	Motor control
4	Resistors	20KΩ, 10KΩ, 10Ω, 0.001Ω, 1KΩ	Biasing purpose regulates the current flow.
5	Capacitors	220µF/35V, 47µF/15V, 4700µF/35V	Stores charges and removes harmonics
6	Potentiometer	20KΩ	To increase or decrease the speed of the motor

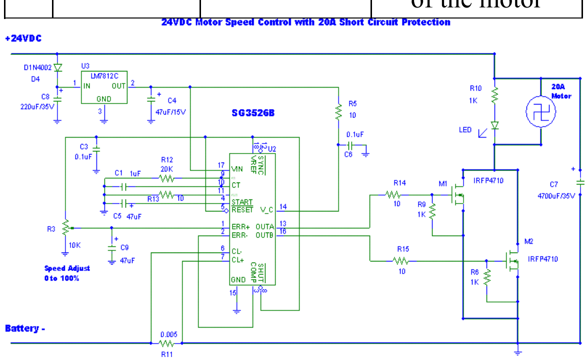

Figure 7: Motor Drive Control Circuit.

3.3 Mechanical Components

Figure 8: 18 Inch Front Wheel.

Figure 9: Plywood Sheet.

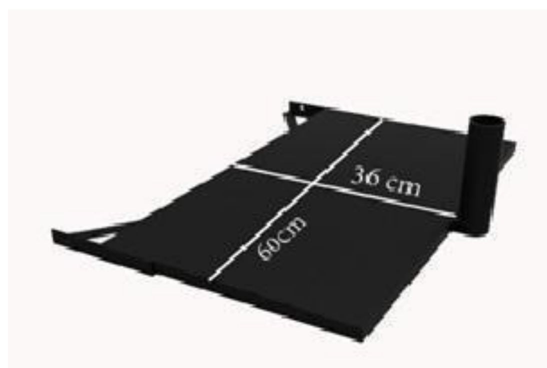

Figure 10: Dimensions of plywood angular frame.

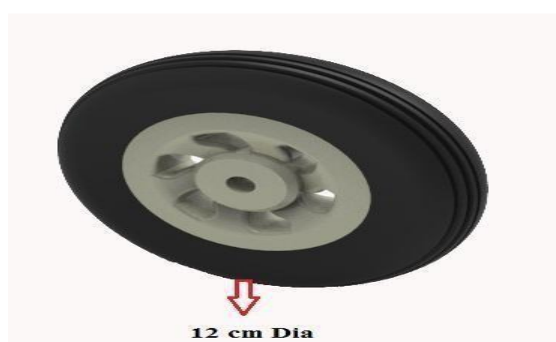

Figure 11: 6-inch Back Wheel

Figure 12: Freewheel

Figure 13: Caliper brakes

4. CIRCUIT DIAGRAM AND OPERATION

The simple electrical connections are as shown in the Fig 14 All the connections are taken from the PWM speed controller circuit. Connect the motor terminal to the motor. Reversing this connection will reverse the direction of motor. Connect the brake terminal to the Trike handle where the brakes are placed. The two terminals of the power lock must be shorted in order to start the motor. The battery terminals must be connected to the battery terminals of the motor drive circuit. Care must be taken that the positive terminal of the battery is connected to the positive terminal of the motor drive circuit and vice versa or else this would permanently damage the drive circuit. The throttle terminal of the drive circuit is connected to the throttle (electrical accelerator). When the battery needs to be charged, the charging port terminal of the drive circuit will be connected to the battery charger.

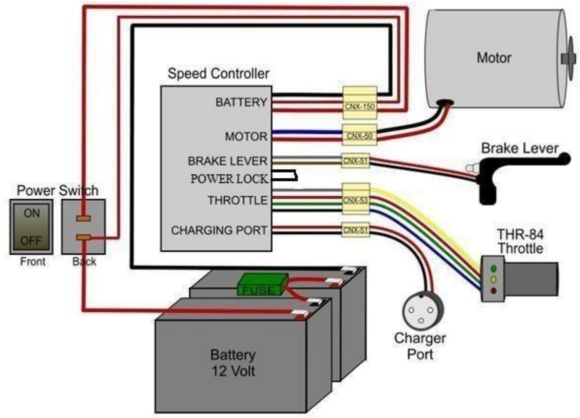

Fig 14: Electrical connections.

5. RESULTS AND DISCUSSION

5.1 Project Design Development:
As the project proceeded, the project went through various changes and improvement. This section discusses many of the obstacles and advancements the group faced as the project developed. The key points that will be outlined in this section are the evolution of the project design, the obstacles faced and the prototype building phase.

5.2 Design of the Trike:
We encountered a few difficulties while constructing our prototype. In designing the mechanical part, welding was one of those processes that we had to keep in mind since those in the area where our design will be implemented. Designs requiring milling or turning operations for construction were not options.
Design 1: Constructing the front part of the Trike:
Initially, we started off our mechanical design by constructing the front part of the Trike as shown in the Fig 15. Welding was again the main process used for this. The entire mechanical structure was designed using iron.

Figure 15: Front part of Trike.

The front wheel was then attached to the end together with the 24 teeth freewheel with the help of nuts and bolts as shown in Fig 16.

Figure 16: Front Wheel and Freewheel Assembly.

Constructing the handle:
Secondly, we went on to design our Trike handle which goes on to the top of the Trike handle. We installed the electrical accelerator as well as the brakes on this and the connections were taken out to be connected to the drive circuit which is as shown in the Fig 17.

Figure 17: Connection of electrical accelerator and brakes.

Constructing the motor base platform:
Then a motor base platform was constructed by welding on the front part of the Trike where the motor could be placed as shown in Fig 18.

Figure 18: Motor base platform.

Assembly of the Stem Pipe:
The stem pipe was then welded on to the front part of the Trike as shown in the Fig 19. to which an angular frame made of plywood was attached and the two 5-inch back wheels were then connected to this plywood sheet with the help of nuts and bolts as shown in the Fig 20.

Figure 19: Stem Pipe.

Figure 20: Angular Frame.

Design 2:
Installation of motor, drive circuit and batteries and remote control:
The motor was mounted on to the motor base platform which was then connected to the front wheel through a chain drive system to transmit the motor power to the front wheel as shown in the Fig 21.

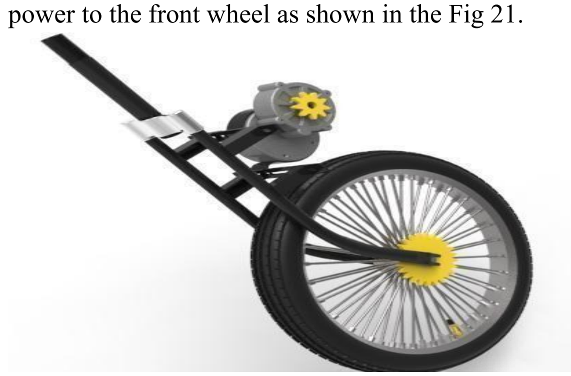

Figure 21: Mounting of motor

Finally, the motor, electrical accelerator, brakes and the batteries were connected to the appropriate terminals as shown in the Fig 22. and the Fig 23. shows the final design of our E-Trike Cycle.

Figure 22: Front view of final design

Figure 23: Back view of final design

6. RESULTS

After analysis of all designs, we successfully completed all the designs which is shown in Table 6.

Table 6: Design process

Design 1	Front part of the Trike, constructing the handle, constructing the motor base platform, assembly of the stem pipe and angular frame was successfully Completed.
Design 2	The connection of the motor to the front wheel and batteries, brakes to the drive circuit was completed.

Observation

Table 7: Observed Values

Factor	Flat Surface	Inclined Surface
Power Drawn (W)	203.8	237.76
Current Drawn (A)	8.49	9.90
Speed (m/s or km/h)	10	6
Battery Efficiency (%)	70	60

This analysis examines the performance differences of a system operating on flat versus inclined surfaces by comparing key metrics under varying conditions. The data reveals that on an inclined surface, the power drawn increases to 237.76 W from 203.8W on a flat surface, with the current drawn rising from 8.49 A to 9.90 A. Correspondingly, the speed on the inclined surface decreases to 6 km/h compared to 10 km/h on the flat surface. Additionally, battery efficiency is observed to decline from 70% on a flat surface to 60% on an inclined surface. These findings indicate that while the system requires more power and current on inclined surfaces, it also experiences reduced speed and lower battery efficiency.

7. APPLICATIONS, ADVANTAGES AND DISADVANTAGES

7.1 Applications:

- It useful in aero drum.
- It is useful in Railway station to carry luggage.
- It is useful for Students.
- It is very useful in visiting places like zoo, palace, Lake Visitors, etc.

7.2 Advantages:

Electric vehicles do, however, offer other strong benefits that are ignored by the marketplace.

- Speed: E-Trike Cycles generally have a higher top speed than a normal Trike with the same rider.
- Great for Commuting: An electric bicycle can require little to no effort to ride. Just twist the accelerator and steer the cycle where you want to go. Another huge advantage is the ability to skip the traffic. An E-Trike Cycle can be ridden on a sidewalk, through a park or down an alley allowing it to beat the traffic and, in many cases, to get to a destination faster than a conventional Trike. Since it has 3 wheels, this type of cycle also has greater

stability.

- Environment friendly: One is the dramatic reduction in oil consumption and gasoline imports that their widespread use would bring about. The use of electric hence does not create any pollution and is eco-friendly and they have the potential to dramatically reduce global warming, smog forming and toxic pollution from cars and trucks.
- Easy to assemble: These types of Trikes can be disassembled any time when not being operated and can be reassembled very easily again for use.
- The greenhouse gas emissions are relatively lower.
- System efficiency: The overall system efficiency considering the production of electric power, transmission and distribution, local storage in batteries and conversion of electric power to mechanical motion is estimated to be approximately 50%, while combustion engine vehicles are only 15% to 25% efficient.
- Moving parts: These types of electric vehicles have many components that will last longer than a typical gasoline car, they have fewer moving parts and because they do not operate at a high temperature of an IC engine.
- About 10% of the energy used in combustion engine vehicles is during idling; E- Trike Cycles consume no energy during idling.
- High torque: In these vehicles, the electric motor can deliver very high torque over short periods of time, providing good acceleration on the highway.

7.3 Disadvantages:

- Maintenance cost: When any components fail to operate, it becomes very costly to replace them and the maintenance cost is very high.
- If the batteries fail to operate, it is very necessary to dispose these batteries safely else it will cause environment degradation.

7.4 Suggestions for Improvement

As a whole, the group felt that they achieved the objectives that they set forth for themselves at the beginning of this design process. After completing the designed prototype, the group suggests the following improvements. The Table 8 shows the description and its suggested solution.

Table 8: Description with suggested solution.

SL. No.	Description	Improvement
1	Motor selection	In our project we have assumed a speed of 10 km/hr, so we used a350W motor. Motor of higher rating should be used for higher speeds.
2	Elevation of road	We have assumed an elevation of 10°.However, if we require the Trike to travel at a greater angle of elevation, we should again choose a higher rating of motor.
3	Security alarm	In order to avoid theft, a security alarm can be provided which alerts the user.

8. CONCLUSIONS

The E-Trike Cycle has been successfully designed and developed. This type of E- Trike Cycle can be very helpful in reducing pollution.

Our current oil dependence leads to myriad problems – environmental, security and economic. Reliance on oil leaves us vulnerable to fluctuations in oil prices and gas price shock and creates significant challenges for our foreign policy. Oil and other petroleum products are also the great source of global warming pollution – just edging out coal.

Transportation is almost exclusively dependent on oil and represents over two- thirds of U.S. petroleum demand. It is also a single source of many air pollutants. It causes more than half of the carbon monoxide, more than a third of the nitrogen oxides, and almost a quarter of the hydrocarbons in our atmosphere.

Motor vehicles also emit pollutants, such as carbon dioxide, that contribute to global climate change. The transportation sector is responsible for about 30% of all U.S. greenhouse gas emissions.

So, by using electric vehicles, we reduce this pollution to a large extent and thus they allow an ecofriendly mode of transportation.

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