ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 12 , December 2017

Design and Fabrication of Hybrid Half Bike

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ABSTRACT: In technological world the vehicle plays an important role but it's also has its own faults such as creating pollution and emission. In order to overcome these problems we have to use alternate vehicles. There are several available sources and one of the solutions is Hybrid half bike. The word Hybrid means two or more amount of energy sources. In this project mechanical and electrical energy is used and also it is a hybrid of segway and half bike. In this type of bikes, frames are fabricated by complicated design and it is user friendly. The important specification of the bike is that by folding the bike it can be easily carried to any place and it is affordable for common man. Less number of linkages is used to fold the bike. This paper aims at evaluating the entire existing foldable half bike and proposing a compact foldable hybrid half bike by using three bar mechanism. It is fabricated with MS Plate to reduce the total weight of the bike. The fabricated bike can be considered as the hand luggage and proposed hybrid half bike is designed in such a way that it is foldable by providing fasteners at the joints. The design structure imparts stable hybrid half bike geometry. The vehicle is controlled by body balance.

I. INTRODUCTION

A folding bicycle is a bicycle designed to fold into a compact form, facilitating transport and storage. When folded, the bikes can be more easily carried into buildings, on public transportation (facilitating mixed-mode commuting and bicycle commuting), and more easily stored in compact living quarters or aboard a car, boat or plane.
Folding mechanisms vary, with each offering a distinct combination of folding speed, folding ease, compactness, ride, weight, durability, and price. Distinguished by the complexities of their folding mechanism, more demanding structural requirements, greater number of parts, and more specialized market appeal, folding bikes may be more expensive than comparable non-folding models. The choice of model, apart from cost considerations, is a matter of resolving the various practical requirements: a quick easy fold, a compact folded size, or a faster but less compact model. There are also bicycles that provide similar advantages by separating into pieces rather than folding.

Fig.1.1 Folded view of Pedersen Bicycle.

Fig.1.1 represents the folded view Pedersen Bicycle. Military interest in bicycles arose in the 1890s, and the French army and others deployed folding bikes for bicycle infantry use. In 1900, Michael Pedersen developed for the British army a folding version of his Pedersen bicycle that weighed 15 pounds and had 24 inch wheels. It included a rifle rack and was used in the Second Boer War.

In 1941, during the Second World War, the British War Office called for a machine that weighed less than 23 lb (this was not achieved - the final weight was about 32 pounds) and would withstand being dropped by parachute. In

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 12 , December 2017

response, the Birmingham Small Arms Company (BSA) developed a folding bicycle small enough to be taken in small gliders or on parachute jumps from aircraft.

This British WWII Airborne BSA folding bicycle was rigged so that, when parachuted, the handlebars and seat were the first parts to hit the ground (as bent wheels would disable the bike). BSA abandoned the traditional diamond bicycle design as too weak for the shock and instead made an elliptical frame of twin parallel tubes, one forming the top tube and seat stays, and the other the chain stay and down tube. The hinges were in front of the bottom bracket and in the corresponding position in front of the saddle, fastened by wing nuts. The peg pedals could be pushed in to avoid snagging and further reduce the space occupied during transit. From 1942-1945, the British WWII Airborne BSA folding bicycle was used by British & Commonwealth airborne troops, Commandos, and some infantry regiments; some were also used as run-about on military bases.

Fig.1.2 Folded view of Dahon Bicycle

The 1970s saw increased interest in the folding bike, and the popular Raleigh Twenty and Bickerton Portable have become the iconic folders of their decade. It was, however, the early 1980s that can be said to have marked the birth of the modern, compact folding bicycle, with competing tiny-footprint models from Brompton and Dahon. Founded in 1982, by inventor and physicist Dr. David Hon and his brother Henry Hon, Dahon has grown to become the world's largest manufacturer of folding bikes, with a two-thirds market share in 2006.

II. HALF- OR MID-FOLD

Fig.1.3 Folded view of Helix Bicycle

Fig.1.3 represents the folded view of half fold. Many folding frames follow the classic frame pattern of the safety bicycle's diamond frame, but feature a hinge point (with single or double hinges) allowing the bicycle to fold approximately in half. Quick-release clamps enable raising or lowering steering and seat columns. A similar swing hinge may be combined with a folding steering column. Fold designs may use larger wheels, even the same size as in

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 12 , December 2017

non-folders, for users prioritizing ride over fold compactness. Bikes that use this kind of fold include Dahon, and Montague, and Tern. A magnet combined with a rear shock absorber forms the folding mechanism. The magnet connects and locks the back wheel section to the frame. To fold the bike in half, the magnet disconnects with one movement and in a second, and without having to use one's hands, the rear wheel rotates forward and the bike folds vertically. This mechanism also enables one to roll the half-folded bike on its rear wheel.Bikes may partly fold and partly disassemble for packing into a standard or custom sized suitcase for air travel (e.g., Airnimal and Bike Friday). Other variations include: Bicycle Torque Coupling, a proprietary connector system that can be retrofitted to a standard frame; the Gekko, which folds from the seat tube like an upside down umbrella; the Giatex, which folds and retracts, adjusting to the size of the rider; the iXi, which literally breaks into two halves; and the Stride, which has a triangular frame and folds to resemble a unicycle. Folding mechanisms may incur more cost and weight, allow folding smaller, and they tend to use smaller wheels. 24 inch wheels are the largest for which flip hinges are generally used, but smaller wheels, typically 16 or 20 inches, are more common. Another system found on folders, such as Montague Bikes, utilizes the seat tube as a pivot point for the frame to fold. This system uses a tube within a tube design to give the bike more torsional stiffness. It allows the user to fold the bike without "breaking" any vital tubes down, thus preserving the structural integrity of the diamond frame. This system is operated by a single quick release found along the top tube of the bike.

III. PROBLEM DESCRIPTION

In civilized world nowadays we can't see a road without any bikes but in turn, people are forgetting that it causes pollution and emissions which affects ozone layer and causes several unwanted effects on both living and non- living organisms. Increase in number of vehicles also produces traffic jam and also occupies a huge chunk of space in roads which reduces the size of road that leads to more no of accident which is fatal sometime. The vehicle nowadays has weight which is considerably increased from its predecessor it's also reduces its portability and it becomes difficult for aged people to drive and park vehicle. There is hike in fossil fuel prices often, which affects middle class people. They need alternate source of power which comes in a very low price that runs in electricity or battery. Since ordinary vehicles occupy more space they cannot be parked inside the residence or office which makes prone them to weather conditions and leads to high maintenance cost. One of the other problems faced by vehicle lovers is that they park the vehicle outside the residence which doesn't give vehicle safety

IV. PROBLEM SOLVING

Foldable half bike with reduced weight when compared to other vehicles which increase its portability that can be taken from one place to other place easily without fatigue. By using simple mechanism like three and four bar mechanism the folding methods can be simplified very easily reducing the complication in front of the others. Since these type of vehicles occupy less space it can be taken easily in to residence and office parking area and can be carried even in to the buses and trains which reduces the chance of theft. These vehicles have only minimum chance to expose to harsh weather conditions. Foldable half bike which runs on battery takes only few minutes for charging and it is capable of holding charge for prolong time.

V. DESIGN

Detailed Design of Hybrid Half Bike Parts:

- Steering Column
- Main frame
- Motorized hub wheel
- Chain Sprocket
- Rear wheels

Steering Column:

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 12 , December 2017

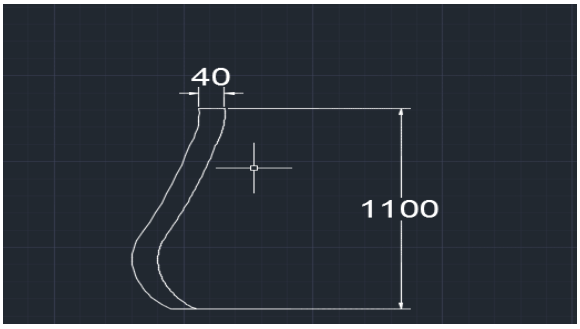

Fig 5.1 Steering Column

The above Fig 5.1.1 depicts the steering mechanism of the bicycle. The AUTOCAD software is used to design it. The 3 point Arc command is used to draw. The thickness of the plate is 40mm and height of the plate is 1100mm. It is the Side view of the vehicle. It is nearly equal to the involute shape. It is foldable one. When compared to normal bicycle, it occupy small amount of space. Handle bar is mounted on the head of the steering column. The brake, accelerator cable is mounted on the handle bar. The above figure dimensions are in mm.

Main Frame:

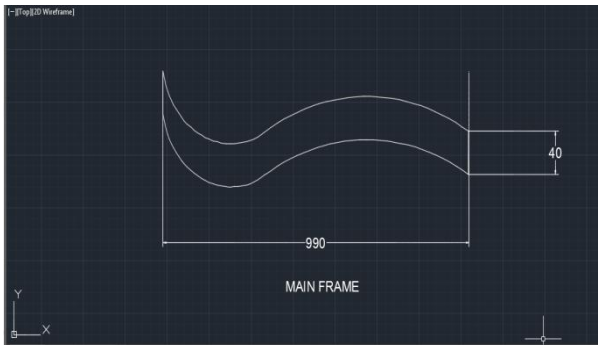

Fig 5.2 Main Frame

The above Fig 5.2 depicts the main frame of the vehicle. It is the Side view of the vehicle. The Center and Radius Arc command is used. The thickness of the plate is 40mm and Wheel base is 990mm. In fabrication process, the wheel motor is mounted on the front end and rear wheels are mounted on the rear end. It is nearly equal to the involute shape.

Motorized hub wheel:

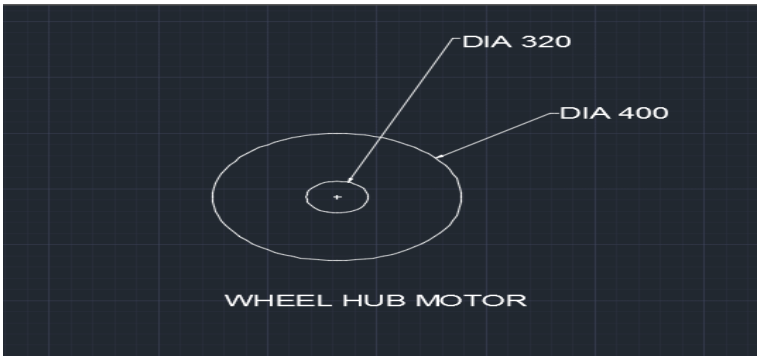

Fig 5.3 Wheel hub motor

The above Fig 5.3 represents the wheel motor. The wheel hub motor (wheel motor, wheel hub drive, hub motor or in wheel motor) the Centre Circle and radius command is used to designed with the help of AUTOCAD software. The inner wheel diameter is 320mm and the outer wheel diameter is 400mm. It is mounted in between the steering column tail end and main frame front end.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 12 , December 2017

Chain Sprocket:

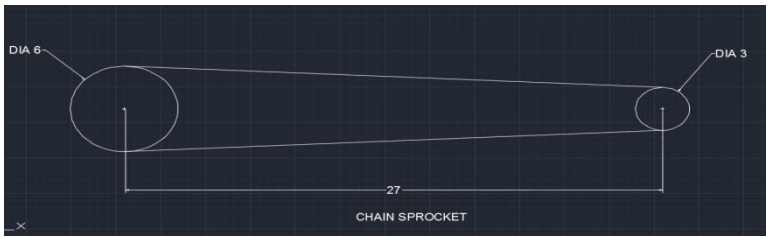

Fig 5.4 Chain sprocket

The above Fig 5.4 represents the chain sprocket. The Centre Circle and radius command is used to design with the help of AUTOCAD Software. The wheel motor is mounted on the 6mm diameter circle and the rear wheel diameter is 3mm. A Sprocket or Sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name "sprocket" applies generally to any wheel upon which radial projections engage a chain passing over it. A small pinion gear is present on the motor wheel. The gear ratio for chain sprocket is 2:1

Rear Wheels:

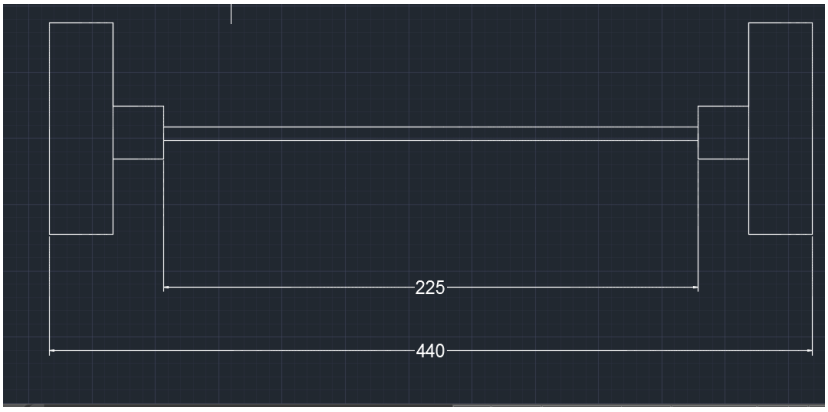

Fig 5.5 Rear Wheels

The above Fig 5.5 is the front view of the rear wheels. The hub is mounted on the rear wheels. The distance between the wheel hubs is 225mm and distance between the rear wheels is 440mm. The Line and Mirror command is used to design with the help of AUTOCAD Software.

Assembled view of Hybrid Half Bike (2D view) (AUTOCAD):

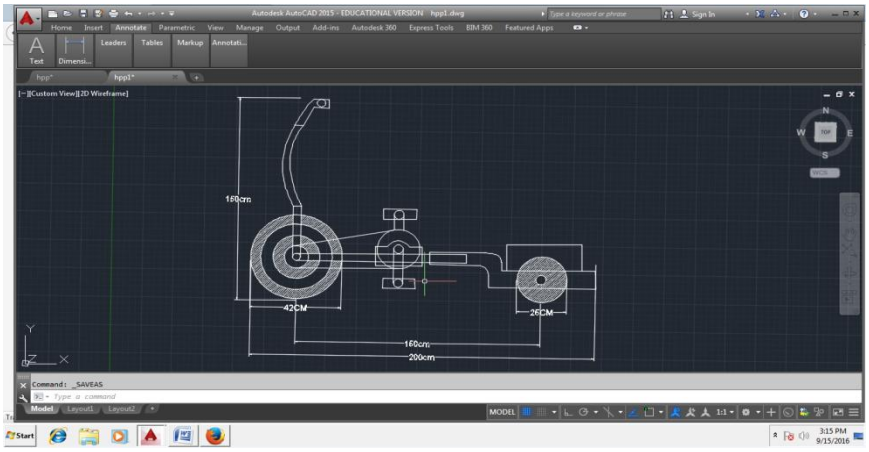

Fig 5.6 Assembled view of Hybrid Half Bike

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 12 , December 2017

Assembled view of Hybrid Half Bike (3D View) (SOLIDWORKS):

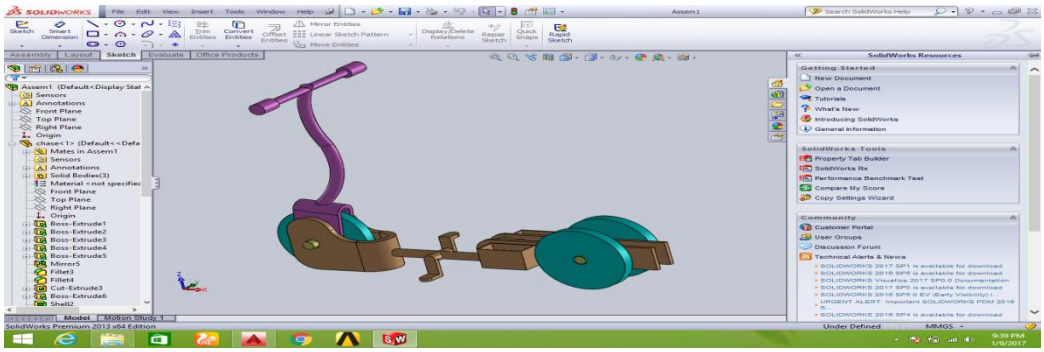

Fig 5.7 Assembled view of Hybrid Half Bike

VI Material Selection

Mild Steel Plate:

Mild steel is steel in which the main interstitial alloying constituent is carbon in the range of (0.12-2.0)%. The American Iron and Steel Institute (AISI) definition says: The term "carbon steel" may also be used in reference to steel which is not stainless steel in this use carbon steel may include alloy steels. As the carbon percentage content rises, steel has the ability to become harder and stronger through heat treating however, it becomes less ductile. Regardless of the heat treatment, higher carbon content reduces weldability. In carbon steels, the higher carbon content lowers the melting point. Mild steel also known as the plain carbon steel. It is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Low Carbon Steel contains approximately (0.05-0.25) % carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form surface hardness can be increased. The density of mild steel is approximately 7.85 g/cm3 (7850 kg/m3) and the Young's Modulus is 210 GPA (210x109N/mm2). Low carbon steel suffers from yield point run out where the material has two yield points. The first yield point (or) upper yield point is higher than the second and the yield drops dramatically after the upper yield point. Carbon steels which can successfully undergo heat-treatment have a carbon content in the range of (0.30 – 1.70)% by weight. Trace impurities of various other elements can have a significant effect on the quality of the resulting steel. Trace amounts of sulphur in particular make the steel red-short that is brittle and crumbly at working temperatures. Low alloy carbon steel, such as A36 grade, contains about 0.05% sulphur and melts around (1,426*C-1,538*C) (2599*F-2800*F). Manganese is often added to improve the harden ability of low-carbon steels. These additions turn the material in to low-alloy steel by some definitions, but AISI's definition of carbon steel allows up to 1.65% manganese by weight.

Lead Acid Battery:

The Lead-Acid Battery was invented by French Physicist Gaston Plante in 1859. It is the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power to weight ratio. These features along with their low cost, makes it attractive for use in motor vehicles to provide the high current required by automobile starter motors. As they are inexpensive compared to newer technologies, lead- acid batteries are widely used even when surge current is not important and other designs could provide higher energy densities. Large-format lead-acid designs are widely used for storage in backup power supplies in cell phone towers, high availability settings like hospitals, and stand- alone power systems. For these roles, modified versions of the standard cell may be used to improve storage times and reduce maintenance requirements. Gel –cells and absorbed glass-mat batteries are common in these roles, collectively known as VRLA (Valve Regulated Lead Acid) batteries. Lead-Acid battery sales account for (40-45) % of the value from batteries sold worldwide (1999, not including China and Russia) a manufacturing market value of about US $15 billion. The French Scientist Gautherot observed in 1801 that wires that had been used for electrolysis experiments would themselves provide a small amount of "secondary" current after the main battery had been disconnected. In 1859, Gaston Plante lead acid battery was the first battery that could be recharged bypassing a reverse current through it. Plante first model consisted of two lead sheets separated by rubber strips and rolled in to a spiral.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 12 , December 2017

His batteries were first used to power the lights in train carriages while stopped at a station. In 1881, Camille Alphonse Faure invented an improved version that consisted of a lead grid lattice, in to which a lead oxide paste was pressed, forming a plate. This design was easier to mass-produce. An early manufacturer (from 1886) of lead-acid batteries was Henri Tudor. Using a electrolyte instead of a liquid allows the battery to be used in different positions without leakage. In 1970s the valve-regulated lead-acid battery (often called "sealed") was developed, including modern absorbed glass mat types, allowing operation in any position.

Fabrication work of different parts:

Steering Column:

Fig 6.1 Normal view of Steering Column

The above Fig 6.1 depicts the normal view of the steering column. The steering column is the part of the vehicle which is located in between the handle bar and wheel motor. It is basically constructed with the help of gas arc welding. A bolt is provided between the steering column and the main frame to fold the whole vehicle which helps to reduce the vertical space covering.

Fig 6.2 Folded view of steering column

The steering column is easily converted in to portable option. It helps to reduce the large amount of space. The bicycle is easily converted in to tricycle.

Motorized Hub wheel:

Fig 6.3 The motorized hub wheel

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 12 , December 2017

VII. Analysis

ANSYS is the pioneering the development and application of simulation methods to solve challenging design and product engineering problems. In ANSYS the following test were conducted.

- Load test
- Deformation test

Load test:

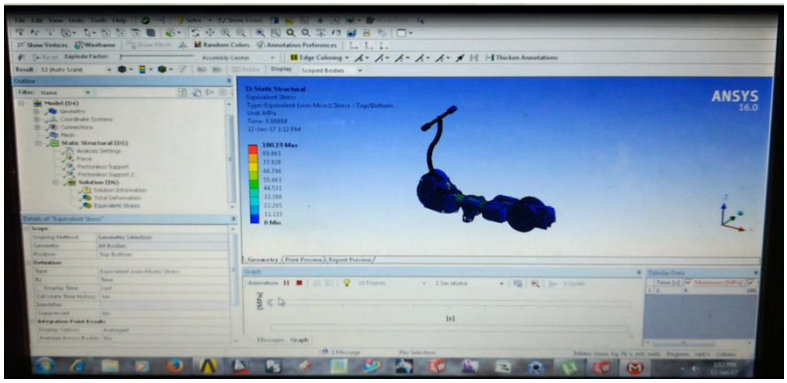

Fig 7.1 Load testing on Hybrid half bike

The above Fig 7.1 depicts the load test conducted for this work by applying Uniform Distributed Load (UDL). The Maximum Load withstand was found to be 100.19 kg (982.86 N). The front wheel motor and rear wheel is fixed on it for the load distribution. The material selected is Mild Steel.

Deformation Test:

The below Fig 7.2 depicts the deformation test conducted for this work based on the result of load test. With the application of maximum Load 100.19 kg (982.86 N) the deformation found was 0.21916max.

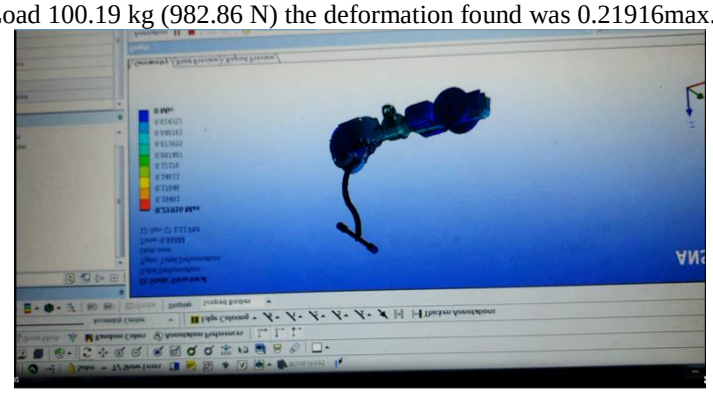

Fig 7.2 Deformation test on Hybrid half bike

VIII. Cost Estimation

Table 8.1 Real time vehicle price in market

Sl. No	Model and Company of the Vehicle	Market Price in Rs
1	AVON E Mate	39,259
2	Hero Electric	42,317
3	Indus Yo Xplor	40,904

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 12 , December 2017

Table 8.2 Approximate Estimation of this project

Sl.No	Parts Details	Quantity	Price (Rs)
1	Motorized hub wheel	1	7,000/-
2	Battery	3	4,500/-
3	Frame	1	10,000/-
4	Brake and accelerator cable	-	3,000/-
5	DC controller	1	4,500/-
6	Accessories	-	4,000/-
7	Paint Work	-	2,000/-
		Total	35,000/-

IX. RESULT AND CONCLUSION

When compared to other foldable half bikes, the hybrid half bike gives good results. The vehicle was designed using four bar mechanism. In case when the battery power discharged completely it can be used like bicycle with the provision of pedal. The vehicle was designed using mild steel plate if any part is damaged means, it could be replaced easily. The hybrid half bike didn't produce any emission and it reduces the pollution in earth atmosphere. With the use of electrical and mechanical drive we can reduce the use of fossil fuel that is depleting rapidly. The vehicle requires less maintenance. In future by adding solar panel the battery can be charged with the help of solar energy. The design of the foldable bicycle was based on the standard data available. The fabrication was done using locally available materials. Compared to the foldable bicycles existing in the market, our bicycle is economical and occupies less space. The weight of our bicycle is with par with light weight bicycles available in the market. Though the bicycle is foldable, sleek and having small wheels, complete justice is done to the ergonomics of the rider hence making it comfortable.

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