DESIGN OF ELECTRIC BICYCLE

[1] S. Raja Sekhar, [2]K. Shanki, [2]N. Sameer Chandra, [2]M. Pruthvi, [2]V.V. Krishna Kumar

[1]Associate Professor, [2]UG Student,
Department of Automobile Engineering
Godavari Institute of Engineering & Technology (Autonomous), Rajahmundry, A.P., INDIA.

Abstract : To highlights E-bike's features and importance, we have done a thorough investigation, taking comparative analysis with ordinary bicycles and normal vehicles, by using common elements like cost effectiveness, power efficiency, leisure service, easy accessibility, environment effects and so on. The findings have proven e-bikes to be the most effective solution on various grounds than any other transport alternatives especially in short distance and inner city traveling. In theoretical details on E-bikes, we have introduced details about the components applicable in e-bike, how they operate, their importance in terms of effectiveness with respect to power consumption and energy dispatching (motor capacity), quality of performance (types of components and features) and other comparative technical aspects. To understand the ground reality better, a short survey have been conducted to give some understanding about the awareness people are having regarding e-bike, their remarks towards this product, and based on their conclusions, our predictions report on its development and popularity chances in Sweden. While analyzing facts in general, we discovered that pedal for U S may not be pedals for Sweden, because of standard varies from country to country. According to European classification standard, a pedal must have the motor capacity up to 250 W, and must stop the motor when the speed is above 25 km/h. Speaking about the popularity of e-bike, In China the number of E-bikes sold reached up to 200 million, Germany is leading the way in Europe, therefore by the favorable situations available in Sweden, we can predict high potential in Sweden. The statistics data proved that Sweden is a bicycle country, where the amount of bicycles sold in 2016 was around 525,000, among which 6,500 were E-bikes imported the same year, suggesting its potential of growth being real.

***Index Terms* - E-bikes, power consumption, energy.**

I. INTRODUCTION

An electric bicycle, also known as an E-bike, is a bicycle with an integrated electric motor which can be used for propulsion. Many kinds of E-bikes are available worldwide, from E-bikes that only have a small motor to assist the rider's pedal-power (i.e., peddles) to somewhat more powerful E-bikes which tend closer to moped-style functionality: all, however, retain the ability to be pedaled by the rider and are therefore not electric motorcycles.

E-bikes use rechargeable batteries and the lighter ones can travel up to 25 to 32 km/h (16 to 20 mph), depending on local laws, while the more high-powered varieties can often do in excess of 45 km/h (28 mph). In some markets, such as Germany as of 2013, they are gaining in popularity and taking some market share away from conventional bicycles, while in others, such as China as of 2010, they are replacing fossil fuel-powered mopeds and small motorcycles.

Depending on local laws, many e-bikes (e.g., peddles) are legally classified as bicycles rather than mopeds or motorcycles. This exempts them from the more stringent laws regarding the certification and operation of more powerful two-wheelers which are often classed as electric motorcycles.

II. DESIGN OF ELECTRIC BICYCLE

2.1. MOTOR

If you've read our main article on electric motors, you'll know the basic idea of turning stored electricity into motive power: feed an electric current through tightly coiled wire that sits between the poles of a magnet and the coil spins around making a force that can turn a wheel and drive a machine.

Most electric-powered vehicles (electric cars, electric bicycles, and wheelchairs) use onboard batteries and a single, fairly ordinary electric motor to power either two or four wheels.

Fig 1Electric Motor

TABLE 1 Electric motor characteristics

1	Model	MY 1016
2	Standard	250W 24V/36V
3	No-load currency/A	≤1.6/1.2
4	No-load rate speed /rpm	3350
5	Rating Torque/N	0.90
6	Rating Torque/N	2750
7	Rating Torque/N	≤13.4/8.9
8	Rating Torque/N·	≥78

2.2 CONTROLLER

Designed this controller for my Crystallite Sparrow 24V electric bicycle motor. The core function of a DC motor controller is to periodically read the throttle setting and adjust the current being supplied to the motor. It does this with a technique called pulse-width modulation or PWM (more on this later).

Other functions of the controller include:

Low-voltage cut off .. Monitor the battery voltage and shut down the motor if the battery voltage is too low.. this protects the battery from over-discharge.

Over-temperature cutoff.. Monitor the temperature of the FET power transistors and shut down the motor if they become too hot .. this protects the FET power transistors.

Over-current cut off .. Reduce the current to the motor if too much current is being supplied .. this protects both the motor and the FET power transistors.

Brake cutoff.. shut down the motor when the brake is applied. This is a safety feature if the user applies brake and throttle, the brakes win.

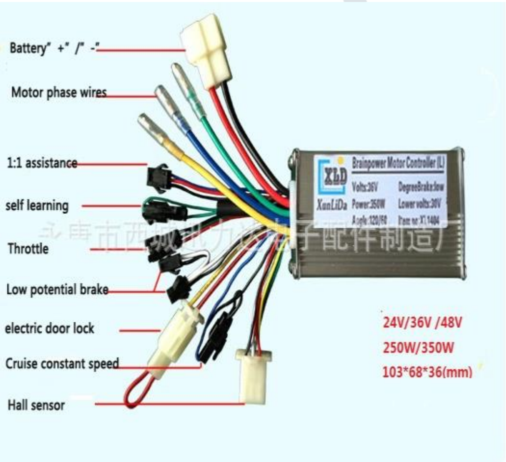

Fig: 2 Connection routing of controller

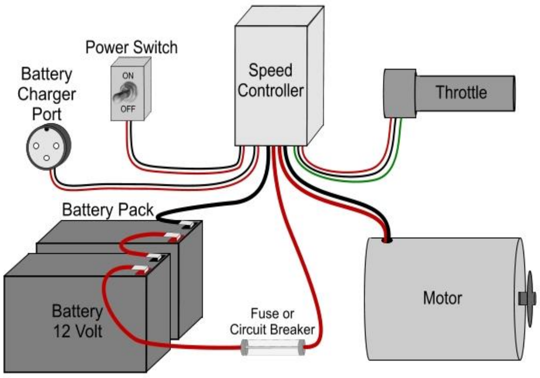

Fig: 3 Block diagram of control connections

2.3 BATTERY

Lead acid batteries for E-bicycle

Lead acid batteries for E-bicycle generally use “sealed lead acid” or SLA battery. SLAs come sealed in a hard plastic case and can be turned in any orientation safely without leaking acid. This makes them appropriate for E-bike use. Wet cell lead acid batteries, like many car batteries, would leak dangerous acid if turned on their side or upside down, making them a bad idea for use on an electric bicycle, which is a lot more likely to get knocked over than a car. Remember to stick with SLAs – not wet cell lead acid batteries – for electric bicycle use.

Fig: 4 Battery

Lead acid batteries are much larger and heavier than lithium batteries, limiting their placement on E-bicycle. They almost never come packaged with E-bicycle specific mounting hardware which means that they generally have to go in a bag on the rear rack or in panniers on either side if the rear wheel. Mounting them up high on the rack isn’t a good idea either because it will negatively affect handling. Generally speaking, you want to mount your batteries as low as possible to keep the center of gravity of the e-bike lower towards the ground. This will significantly improve your e-bike’s handling.

2.4 ADVANTAGES OF LEAD ACID BATTERIES FOR E-BIKES

The biggest advantage of lead acid batteries is their price: dirt cheap. Lead acid batteries can be purchased from many different online retailers and local stores. Purchasing SLAs locally helps save on shipping and makes them even cheaper. Many hardware and electronic stores carry them. Even Radios hack has them, though you'll pay more there.

Another advantage of lead acid batteries is their high power output potential. Lithium batteries generally don't like to handle too much current. SLAs, on the other hand, can provide huge amounts of current. If you are planning a very high power electric bicycles, SLAs might be a good option for you.

2.4.1 ACCELERATOR

There are many different types of electric bicycle with different ways of activating the electric assist.

In this we will learn about the different throttle types (twist grip, thumb, push button), pedal assist types (torque sensor and cadence sensor) and which mode may be best for you.

2.4.2 THROTTLE MODE

The throttle mode is similar to how a motorcycle or scooter operates. When the throttle is engaged the motor provides power and propels you and the bike forward.

A throttle allows you to pedal or just kick back and enjoy a "free" ride! Most throttles can be fine tuned like a volume dial between low and full power.

A lot of e-bicycle in the US have the throttle feature. In some countries the throttle electric bicycle is not allowed; only pedal assist.

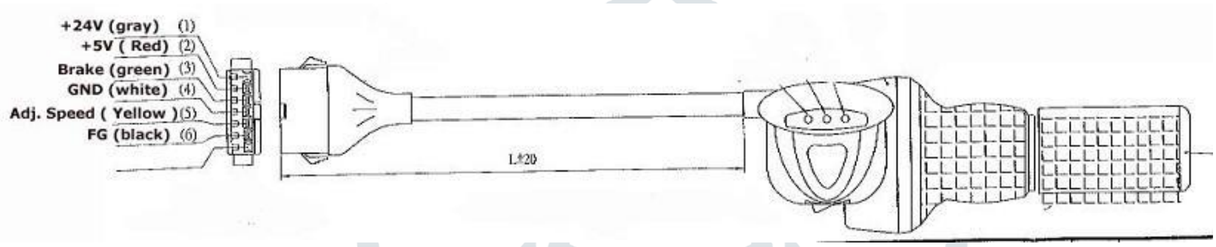

Fig. 5 Throttle construction

Details:-
- Can be used in 12v, 24v, 36v, 48v, 60v Electric Bicycle
- Three pin male connector
- RED positive (5v) Black ground (0v) Green output signal wire (0 - 5 v)
- Linear type of hall sensor
- Variable flux density permanent magnet

III. MECHANICAL COMPONENT'S DESCRIPTION

3.1 CHAIN DRIVE MOTORS

Chain drives, gear drives and belt drive systems are all effective power transmission choices. Each offers advantages and disadvantages with respect to the other. The advantages of chain drive systems are as follow

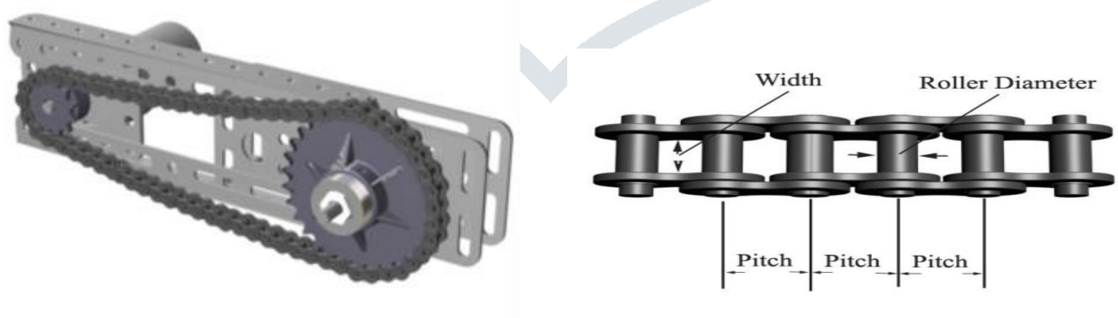

Fig. 6 Chain drive

Shaft center distances are relatively unrestricted. Whereas gear drive center-to-center distances are restricted to specific dimensions for a given set of gears, the center distances between two chained sprockets can vary anywhere from 50% to 300% or more of their pitch diameters.

Chain Drive are relatively easy to install. Assembly tolerances are not as restrictive as those for gear drives. Chain drives are a better choice for less experienced builders working with a minimum of machine tools.

Chain drives can be readily redesigned and reconfigured in comparison to gear drive systems.

Chains perform better than gears under shock loading conditions.

Chain drives spread operating loads over many teeth whereas the operating loads acting on gear drives are concentrated on one or two teeth.

Chain drives do not require tension on the slack side (Belt drives do) thus bearing loading is reduced.

Chain drives require less space for a given loading and speed condition than pulleys and belts.

3.2 ROLLER CHAIN CONSTRUCTION.

Roller chains are assembled using link plates, pins and rollers and connecting them in an endless chain using a connecting link.

Chain Size (Pitch) Chains are sized according to their pitch. The center-to-center distances of the link pins determine pitch. The plastic chain used in the GEARS-IDS kit is an industry standard pitch size. The center-to-center distance of the pins is 0.250 inches. The pitch of chain drive components is specified by a 2 digit number.

The first digit specifies the center –to center distance of the chain link pins in 1/8ths of an inch, the second number specifies the chain style. #25 chain means: Chain pitch = 2 x 1/8 or ¼" pitch Chain style = 5 = rollerless chain.

Chain style specifications are as follows: 0 = Standard proportion roller chain 1 = Light weight roller chain 5 = Rollerless chain

3.3 FREE WHEEL

A freewheel mechanism on a bicycle allows the rear wheel to turn faster than the pedals. If there is no freewheel on a bicycle, a simple ride could be exhausting, because one could never stop pumping the pedals. And going downhill would be downright dangerous, because the pedals would turn on their own, faster than one could keep up with them.

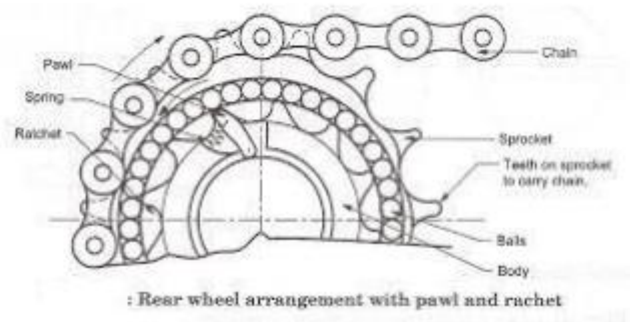

Fig. 7 Sprocket wheel

Power Train of a bicycle: The power train of a simple bicycle consists of a pair of pedals, two sprockets and a chain. The pedals are affixed to one sprocket — the front sprocket, which is mounted to the bike below the seat. The second sprocket is connected to the hub of the rear wheel. The chain connects the two sprockets. When you turn the pedals, the front sprocket turns. The chain transfers that rotation to the rear sprocket, which turns the rear wheel, and the bicycle moves forward. The faster you turn the pedals, the faster the rear wheel goes, and the faster the bike goes.

Coasting: At some point — when going downhill, for instance — speed is high enough so that the rear wheel is turning faster than the pedals. That's when coasting: we stop working the pedals and let the bike's momentum keep moving forward. It's the freewheel that makes this possible. On a bicycle, instead of being affixed to the wheel, the rear sprocket is mounted on a freewheel mechanism, which is either built into the hub of the wheel — a "free hub" — or attached to the hub, making it a true freewheel.

Now when you have to move forward, the pawl acts like a hook and gets locked with the teeth - called ratchet and transmits the torque. The complete mechanism is called ratchet and pawl mechanism.

But when you reverse pedal, it falls back and becomes "free". A spring prevents it from falling permanently. This is the reason why you hear the distinct "click-click" sound when you reverse pedal. Also, there are multiple "pawls" placed along the circumference too.

3.4 MOTOR MOUTING BRACKET

The mounting bracket which is to be holding the motor to the bi-cycle frame that hold with nut and bolts with clamps


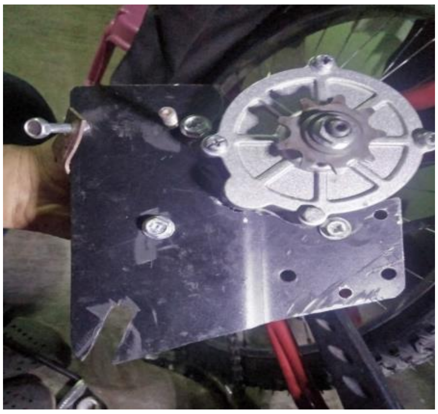

Fig. 8 Mounting Bracket

3.5 FORK CUPS ARRANGEMENT

A bicycle fork is the part of a bicycle that holds the front wheel. A fork typically consists of two blades which are joined at the top by a fork crown. Above the crown, a steered tube attaches the fork to the bicycle and the handlebars allowing the user to steer the bicycle. The steered tube of the fork interfaces with the frame via bearings called a headset mounted in the head tube. At the bottom of the fork, dropouts hold the wheel. Usually, either the axle is bolted to the fork, or a skewer passes through a hollow axle, clamping the axle to the fork.

The term fork is sometimes also used to describe the part of a bicycle that holds the rear wheel, which on 19th Century ordinary or penny-farthing bicycles was also a bladed fork. On most modern bicycle designs the rear wheel is now attached to a rear triangle made up of multiple triangulated tubes, rather than an actual fork, but the rear fork usage persists.

3.6 HANDEL BAR

Fig: 9 Riser handle bar on a mountain bike.

3.7 COMPARTMENT BOX

Fig. 10 Compartment box

A riser is a variation of the flat bar in which the outer sections of the bars rise from the center clamp area by about 15 to 50 mm. Both flat and riser bars may be appended with bar ends, providing more hand positions.

IV. BI-CYCLE ACCESSORIES AND PAINTING

TABLE 2

S.No.	COMPONENT	MATERIAL
1	MTB CYCLE	STEEL
2	MOTOR BRACKET	IRON
3	MOTOR SUPORT ROD	IRON
4	COMPARTMENT BOX	MILD STEEL
5	FREEWHEEL	IRON
6	LONG SHAFT	IRON
7	WHEEL HUB	STAINLESS STEEL
8	SPOKES	STAINLESS STEEL
9	RIM	STAINLESS STEEL
10	TYRES	TUBE TYRES
11	MUD GUARD	PLASTIC
12	BREAK ASSEMENT	REGULAR BREAKS
13	HANDLEBAR	IRON
14	PEDALS	PLASTIC

PAINTING

To protect the metal sheet from corrosion due to atmospheric influences like moisture, air etc the vehicle has been painted.

STEP 1: The surface was provided a rough finish using hand surface grinding machine

STEP 2: Then it was coated with zinc oxide as to protect it from corrosion and to provide proper surface for the painting to be done.

STEP 3: It was left for drying in the sunlight for at least 12 hours.

STEP 4: A layer of putty was applied to the body to avoid uneven surface finish.

It also provides good corners and fills the gaps created during welding.. It was again exposed to sunlight for 12 hours for the process of drying.

Before

Fig 11

After

Fig 12

V. RESULTS

Finally the fabrication of E-Bicycle has done, the outlook of the vehicle is similar to the bicycle. It has taken approximately 45 days for the fabrication and this electrical bicycle can carry single person up to 18 km for one complete charge.

Fig 13

FINAL ASSEMBLY OF THE PRODUCT

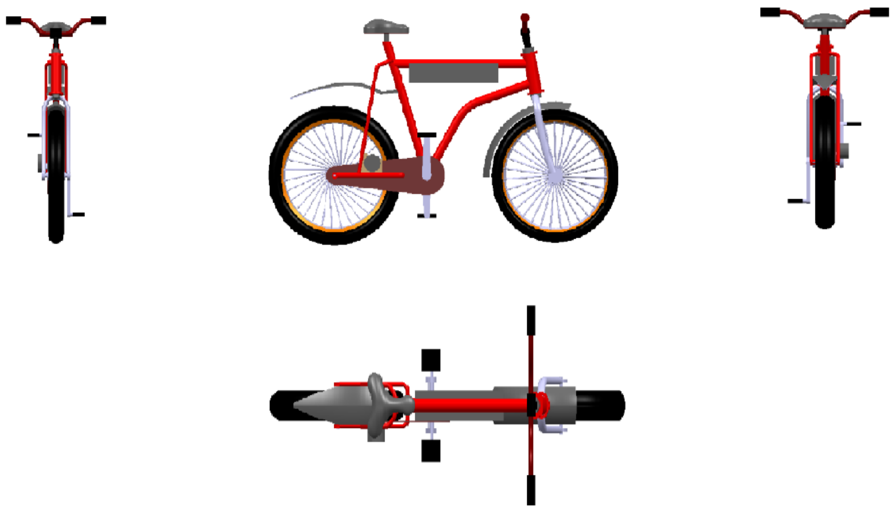

Fig. 14

VI. CONCLUSIONS

In this paper an electronic converter using two power sources connected through two DC-DC converters is described having potential application in electric bicycles or in other vehicles for individual use without internal combustion engines.

The proposed system uses in its basic topology a set of batteries and a bank of supercapacitors to supply the traction system but is also designed to replace the batteries by fuel cells. The conception of the proposed system is also the first step to investigate the solutions and systems that allow to charge electrical vehicles in remote places or when the infinite power nets are not available. In this case, fuel cells can be used to store energy and to restore the energy of these types of autonomous vehicles.

With the proposed solution, it is expected to increase the autonomy of electrical vehicles as electric bicycles or scooters and to avoid high current peak and fast discharges of the batteries. Therefore, a control algorithm managing the energy stored on board and the running of the proposed system is described.

From the experimental and simulation results obtained it is important to point out that the proposed system has an appropriate performance in hard situations like high loads avoiding deep discharges of the batteries. Furthermore, it is also possible to adequate the algorithm of to the profile of the course and maximize the energy recovering. It is also important to refer that the running of the DC-DC converter either as buck or boost converters does not introduce perturbations in the system dynamics, in particular the vehicle speed remains constant.

This work reflects also the real perspective of integration of multi energy storage systems in a unique traction system. The proposed solution reveals advantages from the point of the viewpoint of the traction system concerning overload situations and avoiding an unnecessary over dimensioning of all system.

In the further work, the implemented power circuit (figure 3) will be analysed taking into account the amount of energy stored for unit of weight in the storage systems available and useful to these type of small vehicles With the increasing consumption of natural resources of petrol, diesel it is necessary to shift our way towards alternate resources like the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving crores of foreign currencies. The second most important feature is it is pollution free, eco – friendly and noiseless in operation. For offsetting environmental pollution using of on – board Electric Bike is the most viable solution. It can be charged with the help of AC adapter if there is an emergency. The Operating cost per/km is very less and with the help of solar panel it can lessen up more. Since it has fewer components it can be easily dismantled to small components, thus requiring less maintenance.

VII ACKNOWLEDGMENT

The work is carried with the cooperation of Head of the Department, Mr. V Subrahmanyam, Department of AME and Special thanks to the Principal, Dr, T V Prasad as well as Management of Godavari Institute of Engineering and Technology (Autonomous) for their tremendous support from Initial stage to till the output of the project.

REFERENCES

Books:
1. Electric Motors and Drives, Author: Austin Hughes and bell Drury
2. Practical Electric Motor Hand Book Author: Irving M Gottlieb
3. Manufacturing Technology Author: R.K. RAJPUT

Articles:
4. India's Electric Vehicle, THE HINDU
5. Car and Bike, AN NDTV venture
6. Electric Vehicles in India, AN NDTV Venture
7. Two-wheelers, not cars, a better bet to meet India's Electric Vehicle goal, businessstandard.com
8. In the two-wheeler sharing market, Electric Scooters are getting hot, m.timesofindia.com

Websites:
9. Electric vehicle https://en.m.wikipedia.org/wiki/Electric_vehicle
10. Hub motor https://en.m.wikipedia.org/wiki/Wheel_hub_motor
11. Battery https://en.m.wikipedia.org/wiki/Electric_battery
12. Suspension https://en.m.wikipedia.org/wiki/Suspension_(motorcycle)
13. Bajaj sunny https://en.m.wikipedia.org/wiki/Bajaj_Sunny
14. Tyres https://www.amazon.com/SET-TWO-Electric-Scooters-Bikes/dp/B01D5AR2O8