DEMON: AN ELECTRIC BIKE

Yashwant Sharma[1], Alok Yadav[2], Divya Upadhyay[3], Harsh Patidar[4]

[1,2,3] Final Year student, Department of Automobile Engineering, OIST Bhopal (M.P)
[4]Assistant Professor, Department of Automobile Engineering, OIST Bhopal (M.P)

Abstract - *To save our environment is a prime concern of the government in all over the worlds due to the increment in the usage of automobiles in few decades. This paper presents the development of "RETRO STYLE ELECTRIC BI-CYCLE with FUTURE TEGHNOLOGY". The aim of this paper is to show that the normal bi-cycle can be upgraded to an electric one by some means that including the development of a new front suspension i.e REDEMPTION SPRINGER FORK and innovative BLDC motor control for providing comfort to the rider. Electric bikes have simultaneously gained popularity in many regions of the world and some have suggested that it could provide an even higher level of service compared to existing systems. There are several challenges that are related electric bike design: electric-assisted range, recharging protocol, and bike and battery checkout procedures. This paper outlines system requirements to successfully develop and deploy an electric bike, focusing on front suspension, operational concepts, and battery management. Although there is little empirical evidence, electric bike could be feasible, depending on demand and battery management, and can potentially improve the utility of existing bike systems.*

***Key Words*: BLDC Motor, Controller, lithium-ion battery.**

1. INTRODUCTION

In the present scenario, with increasing population, the need of automobiles for transportation reaching to a peak point and due to that pollution level is also increasing rapidly. Therefore, Governments of every country are trying to save environment without affecting transportation. Therefore, latest technology, which will act as an alternative for such a problem, is Electric Bike. The idea of a motorized bicycle is not a recent conception and has been around for over a century. Until 1895, the electrical bicycle created its place in history. That year, Ogden Bolten was granted U.S. Patent 552,271 for a powered bicycle with a six-pole brush-and-commutator DC hub motor mounted within the rear wheel. The bike itself had no gears and therefore the motor may draw up to 100A with a 10V battery. Since then, the conception of the electrical bike became possible and sensible. Because the years progress, additional and additional electrical bikes were made with varied driving mechanisms. The electrical bicycle offers a cleaner various to travel short-to-moderate distances instead of driving a petrol/diesel-powered automotive. The value of crude has multiplied consider over the past few years and it looks to be no turning back. The electrical bicycle could be a project, which will save environment and provide a better transportation. It will run on clean power with the flexibility to recharge the battery by the help of charger and provide a comfortable ride with the help of suspension. Fashionable electrical bicycles integrate many inventions from technology and style, significantly within the past few year.

1.1 PROBLEM DEFINITION

In the modern days, the primary concern of government in every country is to save nature without affecting its transportation. There are huge demands for 2-wheeler

However, it also increases the pollution. On the other hand, by using an ordinary cycle it takes more effort form rider. Therefore, we are trying to develop an alternative.

2.1 Instrument with Specification

These are the following instrument with specification, which is used in designing an ELECTRIC BIKE, and they are

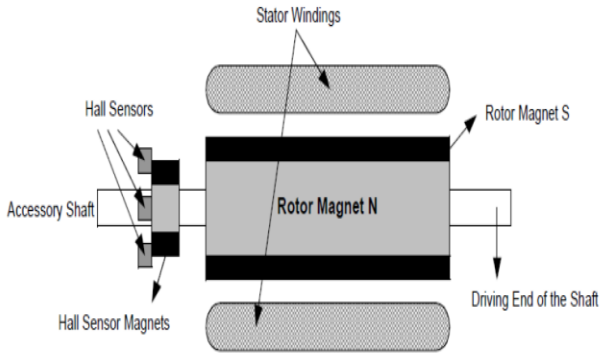
a) Motor

b) Battery

c) PIC Controller

a) Motor

Brushless DC (BLDC) motors are synchronous motors consisting of armature windings on the stator permanent and magnets on the rotor. The stator of a BLDC motor consists of stacked steel laminations with windings placed in the slots and these stator winding can be arranged in two patterns i.e. a star pattern or delta pattern. The major difference between the two patterns is that the star pattern gives high torque at low RPM and the delta pattern gives low torque at low RPM. There are many advantages of BLDC motor such as better speed versus torque characteristics, high dynamic response, high efficiency, long operating life, noiseless operation, higher speed ranges.



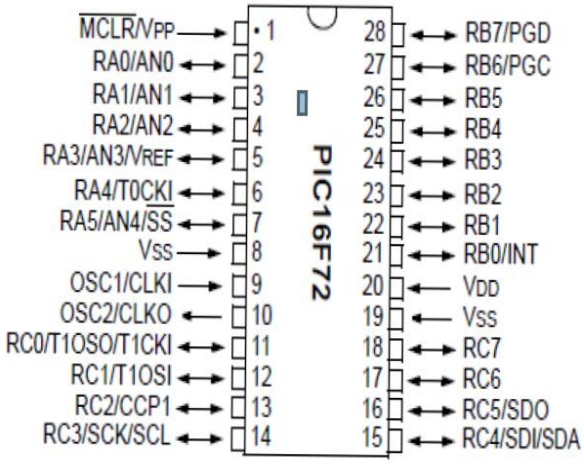
In this Fig.1 shows a transverse section of a BLDC motor. The rotor has alternate N and S permanent magnet s. The Hall sensors are embedded into the stationary part of the motor. Here hall sensors are connected with hall sensor magnet to detect the position of the rotor. In BLDC motors, the phase windings are distributed in trapezoidal fashion in order to generate the trapezoidal waveform. The commutation technique generally used is trapezoidal commutation where only two phases will be conducting at any given point of time. Typically, BLDC motors have three phase windings that are wound in star or delta fashion and need a three-phase inverter bridge for the electronic commutation. The brushless motors are generally controlled using a three-phase power semiconductor bridge. The motor requires a rotor position sensor for starting and for providing proper commutation sequence to turn on the power devices in the inverter bridge.

b) Battery

E-bikes use rechargeable batteries, electric motors and some form of control. Battery systems in use include sealed lead-acid (SLA), nickel-cadmium (NiCad), nickel-metal hydride (NiMH) or lithium-ion polymer (Li-ion). Batteries vary according to the voltage, total charge capacity (amp hours), weight, the number of charging cycles before performance degrades, and ability to handle over-voltage charging conditions. The energy costs of operating e-bikes are small, but there can be considerable battery replacement costs. The lifespan of a battery pack varies depending upon the type of usage. Shallow discharge/recharge cycles will help extend the overall battery life. The range is a key consideration with e-bikes, and it is affected by factors such as motor efficiency, battery capacity, efficiency of the driving electronics, aerodynamics, hills and weight of the bike and rider. Some manufacturers, such as the Canadian BionX or American E+ (manufactured by Electric Motion Systems), have the option of using regenerative braking, the motor acts as a generator to slow the bike down prior to the brake pads engaging. This is useful for extending the range and the life of brake pads and wheel rims. There are also experiments using fuel cells. E.g. the PHB. Some experiments have also been undertaken with super capacitors to supplement or replace batteries for cars and some SUVs. E-bikes developed in Switzerland in the late 1980s for the Tour de Sol solar vehicle race came with solar charging stations but these were later fixed on roofs and connected so as to feed into the electric mains. The bicycles were then charged from the mains, as is common today. While mainly bigger companies in past, many small to medium produced e-bike batteries companies have started using innovative new methods for creating batteries that are more durable.

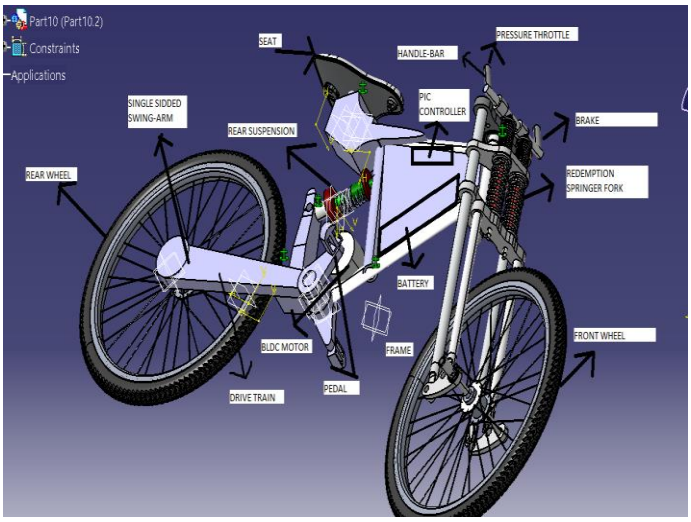
c) PIC Controller

Here we use PIC16F72 controller to control the electric bicycle system. In this electric bicycle system, some components are installed such as brushless dc motor; PIC controller and battery are required to the controller for controlling the different component of electric bicycle system. There are different functions of this controller such as under voltage protection, over current protection, control power supply, also to drive and control the Brushless dc motor. There are different signal was transmitted to pin of PIC controller to drive and control brushless dc motor, such as current detection signal, motor speed control signal, capacity detection system. In this PIC16F72 controller has 28 pins, 22 I/O pins that are user configurable on a pin-to-pin basis. There are 35 number of instructions in this PIC controller. The operating frequency is 20 MHz Also in this controller there are three I/O port are use such as PORTA, PORTB and PORTC and three Timers are use Timer0, Timer1 and Timer2. In this pin diagram RA1, RA4 and RA5 pin there are transmitted speed control, helping signal, current detection signal. The current detection signal use here because, if any heavy current situation electric bicycle is running at heavy load the current is increasing in the motor. Then it will be damages winding of motor and component of motor. Here required current detection signal for controlling the current. Also, there are under voltage protection is required because of avoiding the low voltage supply, which is effect on electric bicycle running normally, then controller should be provide capacity checking. The voltage consists with resistance then it transmitted to PIC controller. If voltage supply signal transmitted to PIC controller then checking supply voltage.
The pins RB2 to RB7 are used for signal for driving motor. Here RB2, RB3 and RB4 are connecting with higher-level signal of Phase A, B and C. In addition, RB4, RB5, RB7 are also connecting with lower level signal of Phase A, B and C. The A/D is allowed a conversion of the analog input signal to the 8-bit digital number. Here pins AR0-AR4 support for analog to digital conversion. If the signal transmitted to pins of PIC controller then after analog to digital conversion the brushless dc motor driven through this signal.



The pins RB2 to RB7 are used for signal for driving motor. Here RB2, RB3 and RB4 are connecting with higher-level signal of Phase A, B and C. In addition, RB4, RB5, RB7 are also connecting with lower level signal of Phase A, B and C. The A/D is allowed a conversion of the analog input signal to the 8-bit digital number. Here pins AR0-AR4 support for analog to digital conversion. If the signal transmitted to pins of PIC controller then after analog to digital conversion the brushless dc motor driven through this signal.

2.2 CONSTRUCTION



(FIG.2.2.1 SHOWS CONSTRUCTION OF "DEMON")

It contains following component shows in fig3.1

i. **REDEMPTION SPRINGER FORK: -** It is an old-school front suspension system, which are used in CUSTOM MOTORCYCLE. The springer fork is an early type of leading link fork. A springer fork does not have the suspension built into the fork tubes, but instead has it mounted externally, where it may be integrated into the triple clamp. This style of fork may be found on antique motorcycles or choppers, and is available today on Harley-Davidson's Softail Springer.

While it may have an exposed spring near the triple clamp, a springer fork is distinguishable from a girder fork by its two parallel sets of legs. The rear is firmly fixed to the bottom triple clamp (usually brazed or welded). A short leading link holds the wheel and the forward leg, which actuates the springs (usually mounted on the triple clamp).

ii. **FRONT AND REAR WHEEL: -** It is a main component of an automobile. There are many types of wheel are available in the market with high specs. However, we are using 36 spokes 24-inches tubeless wheel on both front and rear for better performance.

iii. **BRAKE: -** Brake is the most important because by the help it, we can stop the vehicle. There are many types of brakes are present in the market but we are using the most suitable brake with our requirement which is DISC BRAKE. A disc brake consists of a metal disc, or "rotor", attached to the wheel hub that rotates with the wheel. Calipers are attached to the frame or fork along with pads that squeeze the rotors for braking. As the pads drag against the rotor, the wheel - and thus the bicycle - is slowed as kinetic energy (motion) is transformed into thermal energy (heat). Disc brakes may be actuated mechanically by cable, or hydraulically.

iv. **PRESSURE THROTTLE: -** Throttle is the main component by which we can control the power delivered to the wheel with the help of a motor and engage and disengage the motor to the wheel as well. There are many types of throttle available in the market but we are using an advance throttle, which is a pressure sensitivity button which is connected to PIC controller and by which we can control the input power by pressing the button at definite pressure.

v. **PIC CONTROLLER: -** It is a controller box, which acts as a brain of the e-bike. It controls all the electrical system as well as BLDC motor and the throttle also. Throttle are connected with the PIC controller and controller are connected with battery and motor.

vi. **BATTERY: -** To, drive the motor electricity is required and to fulfill this requirement we are using a power source in term of the battery. There are many types of battery are available in the market but we are using rechargeable LI-ION battery with 48 volts to fulfill our requirement.

vii. **FRAME: -** It is a backbone of every automobile. The entire component is mounted in it. We are using an

aluminum-based frame with more rigidity and for better space management.

viii. **PEDAL: -** It is a component, which is connected on both side and with the front sprocket, and front sprocket are connected with chain and chain are connected with rear sprocket and doing pedaling, we can drive the rear wheel.

ix. **BLDC MOTOR: -** To provide a drive to rear wheel without the necessity of human power, we need an alternative such as a motor. Therefore, we are using 32 volts, 250-watts brushless motor that can fulfill our requirement.

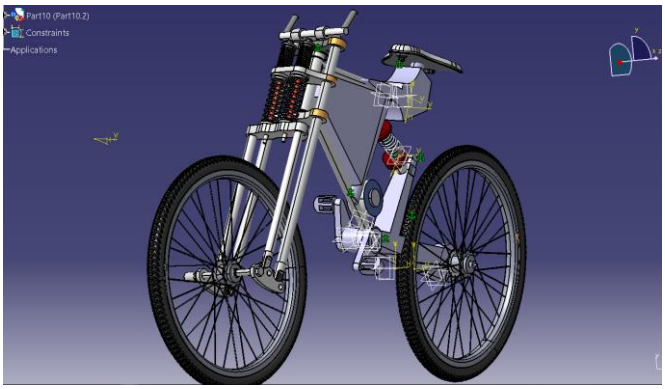
x. **DRIVETRAIN: -** It is an arrangement by which we can provide a drive to the rear wheel with the help of pedal or motor. It is used to engage and disengage the motor with the help of gear mechanism so that the rider can use the power of motor when he desires.

xi. **SINGLE-SIDED SWING ARM: -** E-bike or mountain bike both have double-sided swing arm for better support the rear wheel but it increases the weight of e-bike. To overcome such problem single sided swing arm are introduce on a sports bike. Therefore, we are using the same technology in an e-bike. The advantages proposed there include reducing unsprung weight, giving easier access to the rear tire, reducing total e-bike weight.

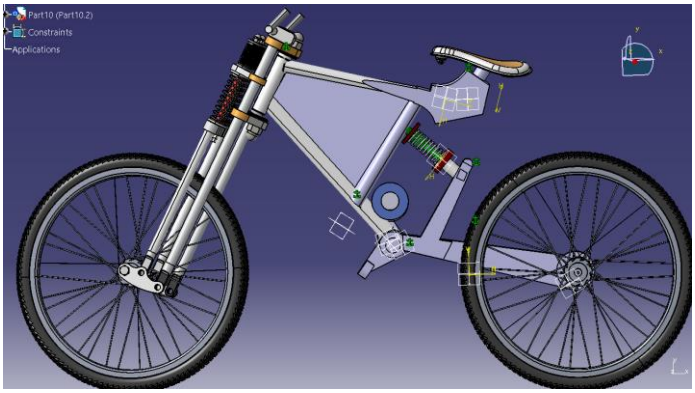
xii. **SEAT: -** It is mounted on top of the frame with a comfortable cushion, so that rider sit comfortably.

xiii. **REAR SUSPENSION: -** It is mounted on the single sided swing arm and frame of the e-bike. Here we are using coil-spring type suspension for providing riding comfort to the rider and safety to the frame.

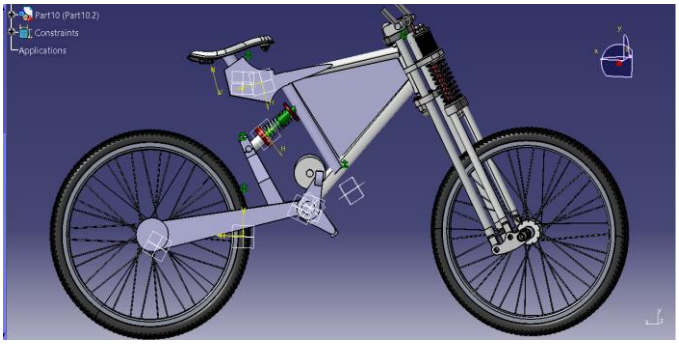
xiv. **HANDLEBAR: -** It is used to control the vehicle and give direction as well. Therefore, we are an aggressive style handlebar for better grip and control to the rider.



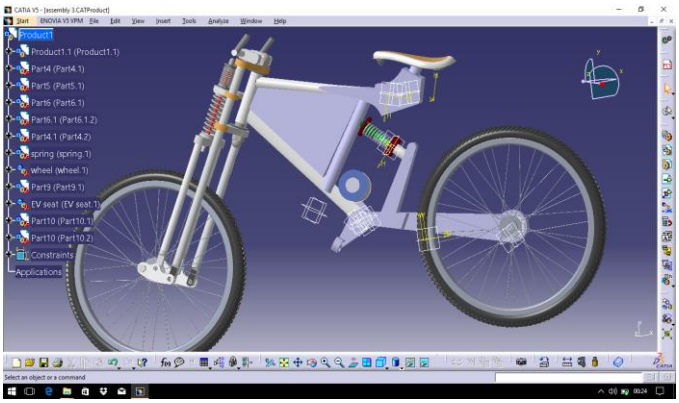
(FIG 2.2.2 SHOWS THE ASSEMBLY of "DEMON")



(FIG. 2.2.3 SHOWS SIDE VIEW OF "DEMON")

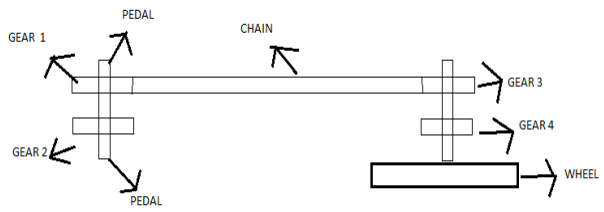


(FIG. 2.2.4 SHOWS SIDE VIEW OF "DEMON")



(FIG. 2.2.5SHOWS A RENDERING DESIGN OF "DEMON")

2.3 WORKING OF DRIVETRAIN



(FIG. 2.3.1 SHOWS WORKING OF DRIVETRAIN)

The following component are -

GEAR 1: - It is a gear sprocket, which is connected with the motor with the help of a secondary chain.

GEAR 2: - It is a gear sprocket, which is connected to the pedal with the help of shaft and at that same shaft GEAR 1 is mounted.

GEAR 3: - It is a gear sprocket which are connected with the wheel through a shaft in a parallel alignment with GEAR1

GEAR 4: - It is a gear sprocket, which is connected to the wheel through a shaft in a parallel alignment with GEAR1

Drivetrain mechanism consists of 4 gears. The chain are mounted on GEAR 1 and GEAR 3 so that the drive is transferred through motor to the rear wheel but when we want to drive the rear wheel with pedal, we can switch the chain through gear changing mechanism so that the chain is moved to GEAR 2 and GEAR 4 and then the drive is moved through the only pedal and it goes through vice-versa.

The motor does not rotate through pedal because we are mounted a one-way clutch, which is operated when we change the GEAR

3. CONCLUSIONS

By providing an alternative which can be used in transportation and save fossil fuel is "DEMON".

By the help of "DEMON", we can save our environment with minimum human effort and make life easier by a future technology. The experimental research will show them how this system is useful and it may be published as soon as possible.

REFERENCES

[1] Ziwen Ling, Christopher R. Cherry, John H. MacArthur and Jonathan X. Weinert "Differences of Cycling Experiences and Perceptions between E-Bike and Bicycle Users in the United States" is an ARTICLE Published in www.mdpi.com journal on 19 September 2017.

[2] Tim Jones, Lucas Harms, Eva Heinenc "Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility" Published by Elsevier in Journal of Transport Geography 53 (2016) 4149

[3] Kunjan Shinde Literature "Review on Electric Bike" Published by IJRMET Vol. 7, Issue 1, Nov 2016 - Apri l 2017

[4] Jose A. Afonso, Member, IAENG, Filipe J. Rodrigues, Delfim Pedrosa and Joao L. Afonso "Automatic Control of Cycling Effort Using Electric Bicycles and Mobile Devices" Published by World Congress on Engineering 2015 Vol I WCE 2015, July 1 - 3, 2015, London, U.K.

[5] Chetan Mahadik ,Sumit Mahindrakar, Prof. Jayashree Deka "An Improved & Efficient Electric Bicycle system with the Power of Real-time Information Sharing" Published by Multidisciplinary Journal of Research in Engineering and Technology, Volume 1, Issue 2, Pg.215-222 on 2014

[6] R.S Jadoun & Sushil Kumar Choudhary "Design and fabrication of dual chargeable bicycle" Published by Innovative Systems Design and Engineering www.iiste.org ISSN 2222-1727 (Paper) ISSN 2222-2871 (Online) Vol.5, No.8, 2014

[7] Darshil G. Kothari, Jaydip C. Patel, Bhavik R. Panchal "Hybrid Bicycle" Published by IJEDR Volume 2, Issue 1 ISSN: 2321-9939 in 2014

[8] Ian Vince McLoughlin, I. Komang Narendra, Leong Hai Koh, Quang Huy Nguyen, Bharath Seshadri, Wei Zeng, Chang Yao "Campus Mobility for the Future: The Electric Bicycle" Published by Journal of Transportation Technologies, 2012