A Review on Design and Development of Future Bicycle with Use of Electric Energy Source

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Abstract— As we can see that the problem of traffic and pollution due to fossil fuels is increasing in the whole world. Due to gases like carbon dioxide, carbon monoxide and other gases rate of global warming effect is increasing, that will directly affect upon ambient temperature. The sources of conventional fuels is decreasing therefore increasing in the cost of fuels in India and all over the world, we need to do some research on converse of another source of energy. As we can see that the people in India use personal two wheeler vehicles to travel small distances, therefore the traffic problems in India is increasing very fast. To avoid we have to made very compact and environment friendly vehicle. Aim of present study is to learn about different types of alternative energy sources to run a bicycle & try to find some new idea in improving electric bicycle. A power assisted bicycle is form of transport system that attempts to merge both health and environmental benefit. Cleaner technology as well as lesser dependency on oils. It is very important that the time taken for travelling should be less, also it should be economical & easily available. This feature performs better than gasoline vehicles. It is very useful to travel small distance to moderate distances. We are going to prepare bicycle which is operated by BLDC (Brushless DC Motor) hub motor based electric propulsions. The Lop fit is a totally new way of moving. With the electric assist it takes no more effort to walk than "a walk in a park". The electric assist in combination with the gear is boosting your walking pace up to the speed of a regular bike. Such vehicle cost around $2495.00 [USD]. We have planned to make the vehicle similar to this kind of vehicle and reduce the maximum possible cost. We have planned to make a vehicle which will be compact enough equal to small kids bicycles having a standing and sitting platforms suitable for accommodate one person.

Key words: Bicycle, Two Wheels, Rechargeable Battery Operated, Can Accommodate One Person, Environment Friendly, Compact, Light Weight, Handy

I. INTRODUCTION

The "Dandy horse", also called Draisienne or Laufmaschine, was the first human means of transport to use only two wheels in tandem and was invented by the German Baron Karl von Drais. It is regarded as the modern bicycle's forerunner; Drais introduced it to the public in Mannheim in summer 1817 and in Paris in 1818. Its rider sat astride a wooden frame supported by two in-line wheels and pushed the vehicle along with his or her feet while steering the front wheel. The first mechanically-propelled, two-wheeled vehicle may have been built by Kirkpatrick MacMillan, a Scottish blacksmith, in 1839, although the claim is often disputed. He is also associated with the first recorded instance of a cycling traffic offense.

In the early 1860s, Frenchmen Pierre Michaux and Pierre Lallement took bicycle design in a new direction by adding a mechanical crank drive with pedals on an enlarged front wheel (the velocipede). Another French inventor named Douglas Grasso had a failed prototype of Pierre Lallement bicycle several years earlier. Several inventions followed using rear-wheel drive, the best known being the rod-driven velocipede by Scotsman Thomas McCall in 1869. In that same year, bicycle wheels with wire spokes were patented by Eugène Meyer of Paris. The French *vélocipède*, made of iron and wood, developed into the "penny-farthing" (historically known as an "ordinary bicycle", a retronym, since there was then no other kind). It featured a tubular steel frame on which were mounted wire-spooked wheels with solid rubber tires. These bicycles were difficult to ride due to their high seat and poor weight distribution. In 1868 Rowley Turner, a sales agent of the Coventry Sewing Machine Company (which soon became the Coventry Machinists Company), brought a Michaux cycle to Coventry, England. His uncle, Josiah Turner, and business partner James Starley, used this as a basis for the 'Coventry Model' in what became Britain's first cycle factory.

The dwarf ordinary addressed some of these faults by reducing the front wheel diameter and setting the seat further back. This, in turn, required gearing—effected in a variety of ways—to efficiently use pedal power. Having to both pedal and steer via the front wheel remained a problem. Englishman J. K. Starley (nephew of James Starley), J. H. Lawson, and Shergold solved this problem by introducing the chain drive (originated by the unsuccessful "bicyclette" of Englishman Henry Lawson). Connecting the frame-mounted cranks to the rear wheel. These models were known as safety bicycles, dwarf safeties, bicycles for their lower seat height and better weight distribution, although without pneumatic tires the ride of the smaller-wheeled bicycle would be much rougher than that of the larger-wheeled variety. Starley's 1885 Rover, manufactured in Coventry is usually described as the first recognizably modern bicycle. Soon the seat tube was added, creating the modern bike's double-triangle diamond frame.

Further innovations increased comfort and ushered in a second bicycle craze, the 1890s *Golden Age of Bicycles*. In 1888, Scotsman John Boyd Dunlop introduced the first practical pneumatic tire, which soon became universal. Soon after, the rear freewheel was developed, enabling the rider to coast. This refinement led to the 1890s invention of coaster brakes. Derailleur gears and hand-operated Bowden cable-pull brakes were also developed during these years, but were only slowly adopted by casual riders.

The Svea Velocipede with vertical pedal arrangement and locking hubs was introduced in 1892 by the Swedish engineers Fredrik Ljungström and Birger Ljungström. It attracted attention at the World Fair and was produced in a few thousand units. By the turn of the century, cycling clubs flourished on both sides of the Atlantic, and touring and racing became widely popular.

Bicycles and horse buggies were the two mainstays of private transportation just prior to the automobile, and the grading of smooth roads in the late 19th century was stimulated by the widespread advertising, production, and use of these devices. More than 1 billion bicycles have been manufactured worldwide as of the early 21st century. Bicycles are the most common vehicle of any kind in the world, and the most numerous model of any kind of vehicle, whether human-powered or motor vehicle is the Chinese Flying Pigeon, with numbers exceeding 500 million. The next most numerous vehicles, the Honda Super Cub motorcycle, has more than 60 million units made, while most produced car, the Toyota Corolla, has reached 35 million and counting.

Torque sensors and power controls were developed in the late 1990s. For example, Takada Yutky of Japan filed a patent in 1997 for such a device. In 1992 Vector Services Limited offered and sold an e-bike dubbed Zike. The bicycle included Ni-Cd batteries that were built into a frame member and included an 850g permanent-magnet motor. Despite the Zike, in 1992 hardly any commercial e-bikes were available.

Production grew from 1993 to 2004 by an estimated 35%. By contrast, according to Gardner, in 1995 regular bicycle production decreased from its peak 107 million units. Some of the less expensive e-bikes used bulky lead acid batteries, whereas newer models generally used NiMH, NiCd, and/or Li-ion batteries, which offered lighter, denser capacity batteries. Performance varies; however, in general there is an increase in range and speed with the latter battery types.

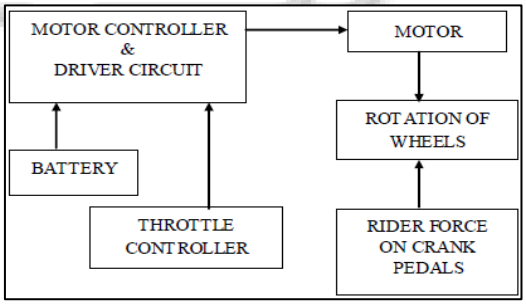

Fig. 1: Components of Electric Bicycles [2]

II. LITERATURE REVIEW

A. Kunjan Shinde, "Literature Review on Electric Bike Dept. of Mechanical Engineering, University of Mumbai, India(1, Nov 2016 - April 2017)[1]

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 cores 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.

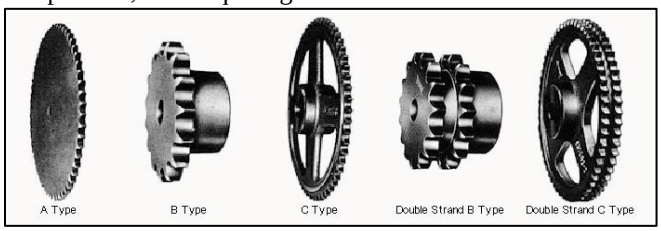

Fig. 2: Various Types of Sprocket [1]

B. Priyadarshini J Patil et al ISSN 2319-2690 International Journal for Research in Science & Advanced TechnologiesIssue-3, Volume-2, 047-053 (April 2017)*[2]

The results illustrated in this paper can help in designing an electric bicycle to the ratings of one's requirement & can be extendable to tricycle application for physically challenged society. Here suitability of BLDC motor with smooth running operation is shown & in future sensor less operation can be adopted to overcome limitations & expenses of sensors. The system performance can be improved if renewable energy sources or fuel cell technology is integrated as a source of power. Hence we conclude that use of BLDC motor for the power transmission in our project is appropriate.

Parameters	Li-ion	Li-MH	Lead Acid
Voltage (V)	3.7	1.2	2.0
Gravimetric Density	130-200 Wh/kg	60-90 Wh/kg	30-40 Wh/kg
Volumetric Density	340-400 Wh/L	200-250 Wh/L0	130-180 Wh/L300
Cycle Life	500	400	300
Capacity Self Discharge Rate	5%	30%	10%
Energy Efficiency	99%	70%	75%
Weight Comparison For Same Capacity	1	2	4
Size Comparison For Same Capacity	1	1.8	3.5
Reliability	High	Low	High

Table 1: Performance Comparison of Three Battery Technologies[2]

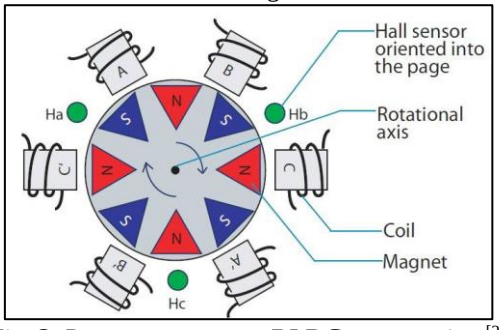

Fig. 3: Permanent magnet BLDC construction [2]

C. Vivek V Kumar, Karthik A, Ajmal Roshan, Akhil J Kumar "Modeling of BLDC motor Powered from Li-ion Battery for Electric Bicycle Application" International Conference on Innovations & Advances In Science, Engineering And Technology (5, July 2014)[3])

It is clearly seen that hybrid economy ensures a cleaner and more economical solution to the energy crisis. People use bikes and fuelled vehicles for even travelling short distances without making use of cycles and other non –fuelled vehicles. Most number of people from the list have been those which think riding a cycle is equivalent to providing extra effort for cycling. In order to avoid this an electric assistance has been provided to the cycle that will ease the user to ride the unit with the help of a motor. Even the hardship of climbing slopes and riding on rough terrains has been reduced. All these aspects are available keeping in mind the factor of pollution being affected at all. The factors that our prototype provides to the market are: 1. Simplified riding with minimal effort on flat as well as gradients. 2. Easiness of riding on rough terrains.

D. Ivan EVTIMOV, Rosen IVANOV, Gergana STANEVA, Georgi KADIKYANOV, "A Study on Electric Bicycle Energy Efficiency", Volume 10 Issue 3. (Year 2015)[4]*

Without regeneration of the energy in urban conditions the range of the electric bicycle is about 35km.Considering the average value of the regenerating energy in a town of Ruse, the run of the electric bicycle could be increased from 5 to 10%. At day time periods with not so heavy traffic, the run of the electric bicycle could be increased with about 11% due to the less number of braking and accelerations.

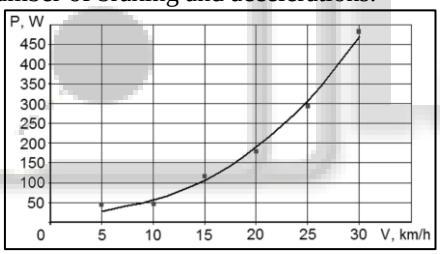

Fig. 4: Dependence of the used motor power P by the speed V

E. 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", Journal of Transportation Technologies (November 6, 2011)[5]

Bicycle use is known to be healthy, efficient, environmentally friendly and in some localities is even faster than driving (either due to traffic conditions, or the distance of available parking spaces from origin and destination respectively). Unfortunately, bicycle adoption rates are not high in many places, due to various barriers and perceived barriers to more widespread use. This paper first explored the barriers to bicycle adoption, in particular for a tropical university campus environment, and hence propose technological means to overcome these barriers by defining and testing a range of electric bicycle alternatives to converge on a suitable solution. The electric bicycles in question use a pedicel sensor to control 200 to 250 W electric motors in a rider-assist configuration (chosen to be in compliance with Singaporean or European laws). The rider must pedal, causing the motor to contribute to the motion. The main aim in this environment being to ensure that whether the rider is going up hill, down, or riding on the flat, their rate of energy expenditure can be maintained low enough to prevent excessive perspiration.

Country	Motor Power Output (Watt)
Australia	200
Canada	500
Europe	250
India	250
Japan	250
New Zealand	300
Singapore	200
United Kingdom	200
United states of America	250

Table 2: Maximum Power for Electric Motor Assisted Bicycles in Various Countries [5]

III. Conclusion

Hence we conclude that with the bicycle must be efficient in aesthetics as well as technical. We have decided that the li-ion battery is more efficient compared to other batteries so, we will be using the li-ion battery as our bicycle's main power source. We will also providing a alternate energy source from rider for health and emergency cases. We have planned to BLDC hub motor for the power generating device because it have maximum efficiency and compact in size as compared to other motors. We have also planned to provide hinge points in bicycle to carry it easily at different places and enjoy ride at their. Deployable battery is provided so that the rider or owner can carry it away for the charging purpose and safety purpose. We will design a bicycle with maximum design considerations like compact lees, easy to handle, deployable battery, light weight, etc.

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