

Development of a PAS Integrated Electric Bike for Sustainable Transportation

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Abstract: One of the sustainable solution for local transportation is the utilization of e bicycles. In the current scenario e bikes have are used as means of compact and less pollution transportation tool. It would be used to one of the most promising means of transportation in large crowded cities. In developing countries there is an increased demand of electric bikes in order to combat the issue of pollution. In this regard, attempt has been made to develop E-Bike for city commute with 60 km range. A Pedal Assist System has been implemented.

Introduction:

Energy crisis is one of the major concerns in today's world due to fast depleting resources of petrol, diesel and natural gas. In combination with this, environmental decay is an additional factor which is contributing to the depletion of resources which is an alarming notification. The electric bike which works on the battery that is powered by the motor is the general mode of transport for a local trip. The solar panels can be alternative source for this by adding it to the system. The electric bike which will be running on battery, the power is supplied by the motor, thereby supplying this power to drive the other gear components. The main purpose of using this e-bike is that it is user friendly, economical and relatively cheap [1-5]. The efficiency of this system undeniable compared to conventional modes of transport.

With the advancement in the design of e bikes by the use of high efficiency batteries and lighter motors, they are being used by great variety of consumers. They provide environmentally tool for transportation and therefore is one of the sustainable mode of transportaion. [6-7]. As fossil fuels are depleting the utilization of electric bicycle can be a viable solution. E bike is becoming popular because of its various advantages such as less pollution, lighter weight and more economical in terms of fuel and maintenance [8-12]. Moreover, it does not require license and insurance.

In e-bikes a motor is controlled by a controlling system which can be powered by the battery. Earlier the ebikes were bulky due to the weight of the lead acid batteries. Recently, with usage of lithium-ion batteries the weight can be reduced and providing more power, durability and performance.

Methodology:

The methodology adopted for the study is presented below:

- i. A simple control strategy has to be developed for Indian city driving conditions with less fuel consumption for reducing emissions.
- ii. A conventional two-wheeler will be converted into a plug-in hybrid electric two-wheeler by retrofitting a hub motor in the rear wheel.
- iii. Experiments will be carried out on engine and electric hub motor to estimate the power and torque requirements for various operating conditions.
- iv. A detailed investigation will be carried out to estimate the battery energy and power requirements for various conditions.

Components:

Hub motor: Hub motors were used in this work. Hub motors have a number of advantages over others. Hub motors are found to be more efficient as compared to their counterpart. Figure 1 shows the schematic diagram and the image of the actual hub motor used.



Figure 1 Hub motor used in the study

Battery for E-Bike:

Li-ion battery is selected for the study. The LFP-3610S 36-V, 15-AH battery (figure 2) is selected with the following performance specification:

- Weight: approx. 4.5kg
- Battery Cell: Grade A 18650 battery cell
- BMS: Included

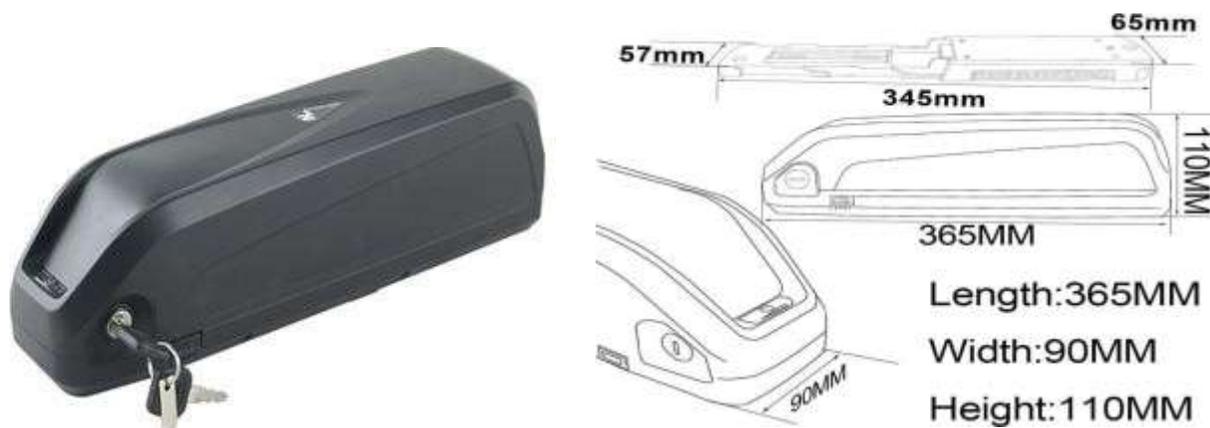
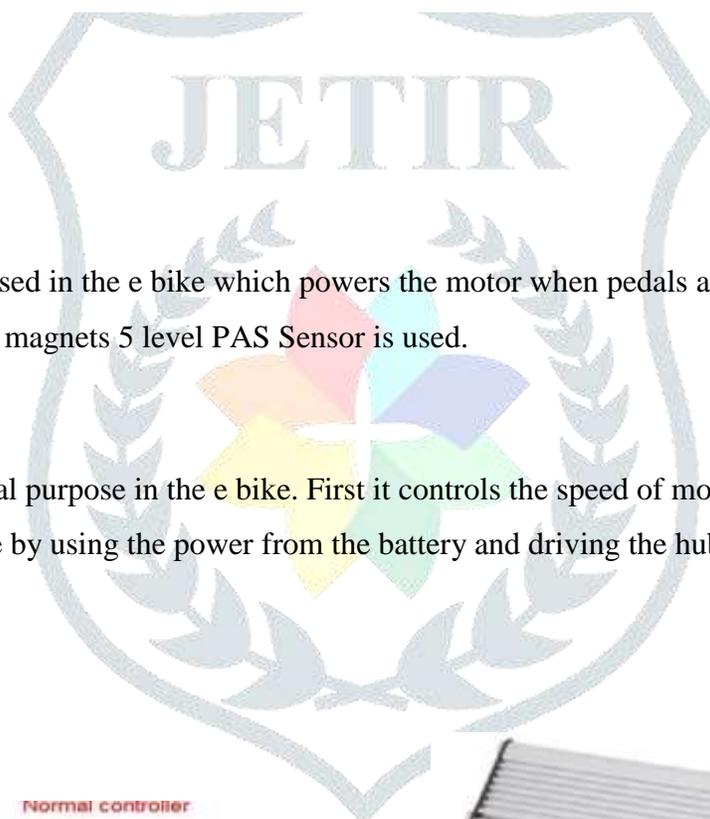


Figure 2 Battery used for the e bike



Pedal Assist System:

Pedal assisted system was used in the e bike which powers the motor when pedals are used without the need of throttling. In this study an 8 magnets 5 level PAS Sensor is used.

Speed Control Basics

The speed controller has dual purpose in the e bike. First it controls the speed of motor and also serves as dynamic brake. This is done by using the power from the battery and driving the hub motor. Figure 3 shows the speed control system.

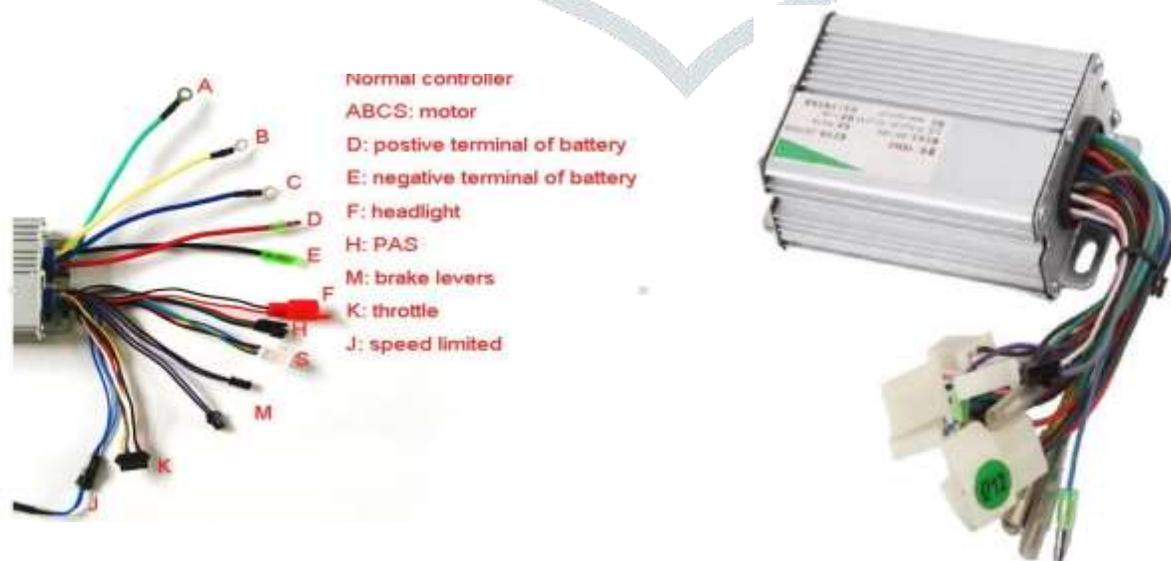


Figure 3 Speed control system for the e bike

LCD Display screen:

A LCD display was used in the system, specifications of the same is as follows:

Quick Details Brand name: Kunteng, Model Number: KT-LCD3 Plug: waterproof/nominal plug Voltage: 24v/36v/48v.



Figure 4 LCD display used in the system

Testing and Observation:

The testing was performed in the city of Nagpur, Maharashtra. The details are illustrated in table 1.

| Parameters | Observation |
|---------------------------|--|
| Ease of driving | Smooth driving experience |
| Maximum speed obtained | 28.5km/hr |
| Average speed obtained | 27km/hr |
| Range of e-bike | 57.5km/hr |
| User friendly | Very easy to use |
| Working of the display | The display showed correct reading of certain parameters displayed such as range, battery remaining. |
| Working of the controller | We were able to control the speed of the bike using the hand throttle |

| | |
|---------------------------|--------------------------------------|
| Charging time for battery | 3 to 4 hr |
| Stability of bike | The e-bike was stable while driving. |

Table 1 Testing and Observation

Conclusions:

The conclusions of the project are as follows:

In order to develop an alternative solution for transportation in local area an e bike is developed employing PAS integrated system. The speed of 28.5 km on a plane terrain was achieved. We are also able to achieve the range of 60km. Through the use of pedal assist system unnecessary power consumption can be saved and thus more range can be obtained. By using lithium ion battery we are able to obtain largest energy density for the battery, also for which low maintenance is required. By using hub motor we are able to obtain more power, low maintenance and longer lifespan. We are able to provide an e-bike at affordable cost for a daily use. As harmful gases are not emitted from the e-bike, we are able to achieve our objective of environmental friendly transportation. The removable battery helps us to charge it anywhere thus making the e-bike useful for any daily activities.

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