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Hybrid Verso E–Bike

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ABSTRACT

In the world today, most of the specially challenged people are facing many problems in driving two wheelers. They can easily run a two-wheeler in a straight and broad path but face many hurdles while making sharp turns on the crossings, streets, any narrow pavements and even on the parking spot. Every normal person has to get down parking his two-wheeler, but it's practically not possible for a handicapped to do it on his own. To solve this problem, reverse drive has been added as a feature to the vehicle in the project. A handicapped person uses a two-wheeler with the help of two wheels attached externally for his comfort, so in all there are 4 wheels and a drive for the working. But in our project, we have reduced the wheel's count to 3 but with the same single motor drive system. The vehicle is battery operated, so it is much smoother in operation than the traditional petrol and diesel engine powered vehicles. Also with the use of battery as a source to power the vehicle, it causes no pollution to the environment, less maintenance and better speed control. Nowadays, our world is looking forward for the solar energy, so by considering that we also did our vehicle which operates in solar as well. And in the top most, we have included an indicator which precisely shows the distance it can travel further and time to drain in kilometers (km) and hours (hr). From economic point of view, the vehicle is more cost effective, enhances long distance travel with the use of solar power and requires less maintenance check routine. In short, with this E-bike the physically challenged can have ease of travel through cities with less need of help from the passers-by.

Keywords: BLDC motor, E–Bike, Solar panel, Battery, Relay and Boost converter.

1. INTRODUCTION

Electric bikes are a new and promising alternative form of urban transportation. They provide all the advantages of a regular vehicle while eliminating one of the main drawbacks, lack of power. Instead of using the engine use the motor all the time just to make riding easier and faster.

There's no question that electric bikes are far better for the environment than petrol-powered car engines. But that doesn't mean they're completely perfect. Making and disposing of batteries can be very polluting. Not only that, but an electric bicycle is still using energy that has to come from somewhere. You may think you're using clean green power, but the electricity you use for getting about might have come from an old, coal-fired power plant or one driven by nuclear energy. Electric bikes are nowhere near as environmentally friendly as ordinary push bikes, but nothing is ever perfect and, as people often say, "the perfect is the enemy of the good." Electric bikes are certainly a step in the right direction [4]. If everyone used them to get about instead of cars, global warming might be less of a problem, and the world would be a far cleaner and healthier place.

2. PROPOSED APPROACH

Our aim is that to modify the existing e-bike by making it to run both forward and reverse direction by two sources [1] of power that is.

- Battery which is used to operate the BLDC motor is charged by means of an AC supply from the house hold plug lines and also solar power supplied from a PV module. [2]
- By using two sources of power we can increase the efficiency of the bike and also it increases the mileage.
- By making charging time of the battery set 1 using solar power and discharging time of the battery set 2 increases the travelling distance of the bike [5].

3. OBJECTIVE

- To design a E-bike for specially challenged person
- To improve the Performance of E-bike.
- To enhance a Verso technology
- To use single Drive for achieving both forward and reverse motion.
- Design a simple relay switching Circuit for reversing of bike, simultaneous operation of battery set and online drive.
- To equalize the charging and discharging so it could cover more distances.
- To indicate the distance and hour it can run in proportion to the charge in the battery.

4. OVERALL BLOCK DIAGRAM

The Fig. 1 shows the block diagram which consists of various components that are used to build up the Hybrid Verso Gearing E-bike. The System consists of two sets of Batteries and each set consists of two batteries [6]. These batteries can be charged either by using solar energy or power supply. The

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entire switching operation taking places in the system are carried out by the Relay circuits.

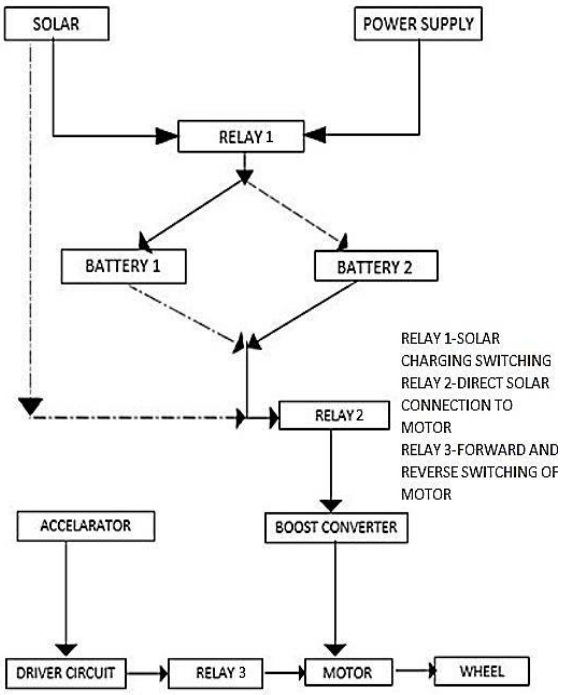

Fig. 1 Overall block diagram of Hybrid Verso E-bike

5. PROPOSED MODEL OF HYBRID VERSO E–BIKE

5.1 CHARGING TECHNIQUE

5.1.1 General Relay connection

The charging technique used in our proposed model is both external power supply and solar energy.

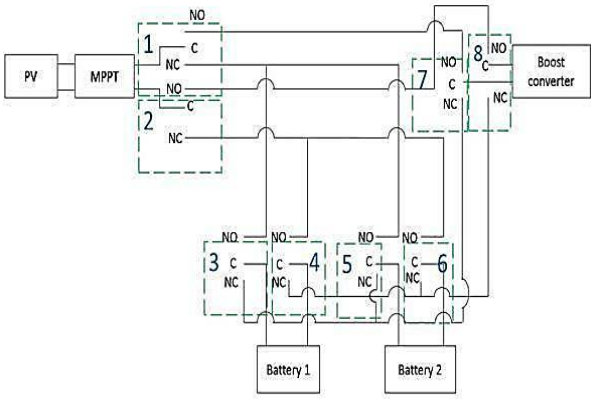

Fig. 2 General connection of Relays between solar charging and discharging

There are two set of batteries, in which Battery set 1 is connected to driving motor to operate the bike and at the same time the Battery set 2 is charged by using solar panel. If the battery set 1 which is connected to motor drains then the battery set 2 which are charged by solar panel will be connected to motor to continue the operation. Battery sets are switched vice versa using relay. In peak time, the solar power is directly connected to the driving motor for efficient operation.

The Fig. 2 shows the general Relay connections of the relays 1,2,3,4,5,6,7 & 8 for switching from charging to discharging and vice versa. The switching operation is done manually by DPST switch which is controlled internally using 8 relays whose operation is explained below in 3 modes of operation.

5.1.2 Battery 1 charging and Battery 2 discharging

MODE 1:

In this mode, the DPST (Double Pole Single Throw Switch) is made ON manually. The relays controlling the switch over of Battery 1 between charging and discharging is 3 and 4. The common points of these relays are connected to Normally Closed position. The relays controlling the switch over of Battery 2 between charging and discharging is 5 and 6. The common points of these relays are connected to Normally Open position. In mode 1, the Battery 1 is connected to motor through boost converter for supplying power and the Battery 2 is connected to the solar panel through MPPT for charging.

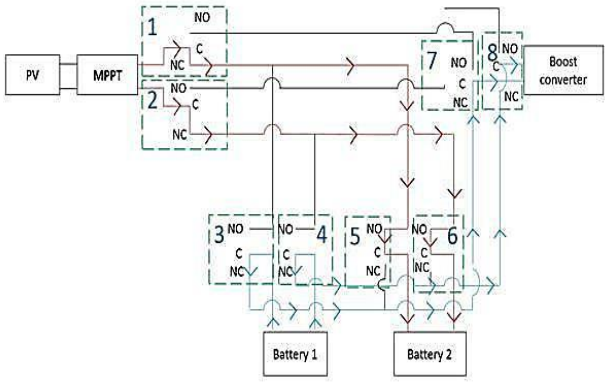

Fig. 3 Relay connection for Battery 1 charging and Battery 2 discharging

The Common point of rest of the relays 1, 2, 7 and 8 will remain in Normally Closed position as they are not operated. The Fig. 3 shows the Relay connections for Battery 1 charging and Battery 2 discharging.

5.1.3 Battery 1 discharging and Battery 2 charging

MODE 2:

When the Battery 1 is drained then it will be shifted to Mode 2. In this mode, the DPST is made OFF manually. The relays controlling the switch over of Battery 1 between charging and discharging is 3 and 4. The common point of these relays is connected to Normally Open position. The relays controlling the switch over of Battery 2 between charging and discharging is 5 and 6. The common point of these relays is connected to Normally Closed position. The

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Fig. 4 shows the Relay connections for Battery 1 discharging and Battery 2 charging.

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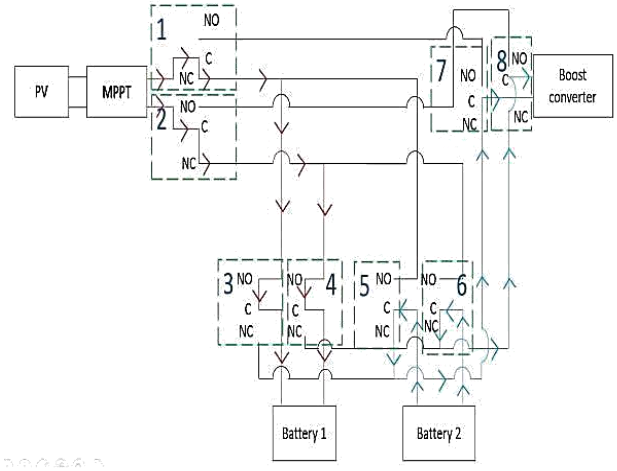

Fig. 4 Relay connection for Battery 1 discharging and Battery 2 charging

After switching is done in relays 3, 4, 5 and 6, the Battery 1 is connected to the solar panel through MPPT for charging and the Battery 2 is connected to motor through boost converter for supplying power. The Common point of rest of the relays 1, 2, 7 and 8 will remain in Normally Closed position as they are not operated in this mode also.

5.1.4 Direct Online drive

MODE 3:

In peak hours, the solar power is connected to the driving motor through MPPT and Boost converter. This mode of operation is called direct online drive.

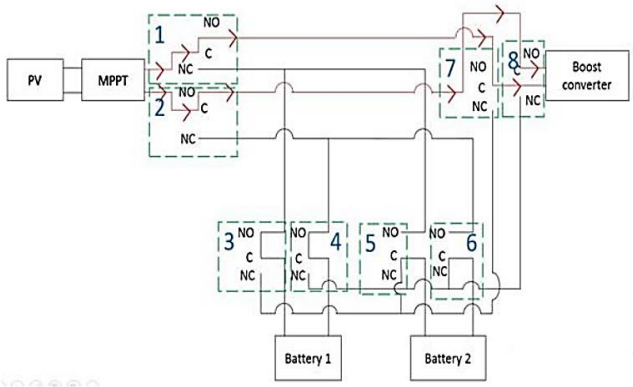

Fig. 5 Relay connection for direct online drive in peak hours

In this mode of operation the relays 1, 2, 7 and 8 are operated. As in a previous mode the common point of relays 3 and 4 will remain in Normally Open position and the common point of relays 5 and 6 will remain in Normally Closed position. To operate in direct online mode, the switching is done to connect the common point of relays 1, 2, 7 and 8 to Normally Closed position which is shown in Fig. 5.

5.2 REVERSING TECHNIQUE

5.2.1 Forward Mode

In forward mode, motor rotates in forward direction. The below Fig. 6 shows that Motor has three sequence and in each sequence hall effect sensor is placed to send the feedback signal to the controller for excitation. Relay contains two modes i.e. A Normally closed mode and Normally open mode. These two modes will change frequently to implement forward or reverse direction. In this mode, three sequences in BLDC motor i.e. B, G and Y are excited in clockwise direction and the relays are in normally closed condition.

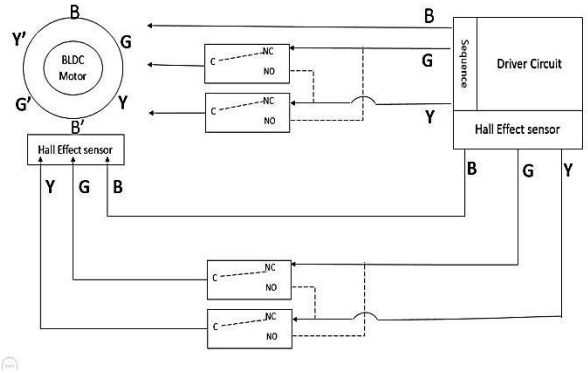

Fig. 6 Relay connection for Forward Mode

Initially, the relays are in off condition, so the output pulse from the driver circuit remains unchanged. At first, due to the command pulse received from the driver circuit, phase B is excited. Now, the Hall Effect sensor sends feedback to the controller which enables next phase i.e. phase G is excited. Similarly, the next phase Y is excited. Due to the repetition of clockwise excitation in the motor phase, the motor tends to rotate in forward direction.

5.2.2 Reverse Mode

The external connections in reverse mode are same as that of forward mode. The only difference in the reverse mode is the relays internal connections.

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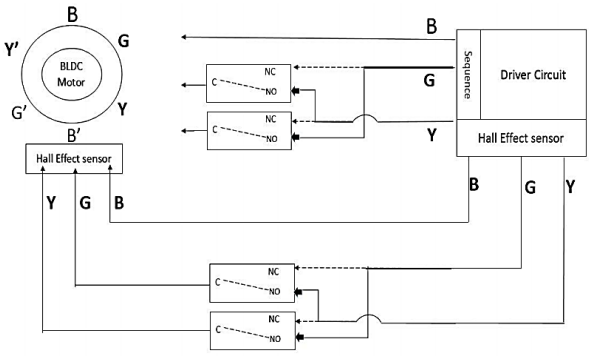

Fig. 7 Relay connection for Reverse Mode

In forward mode, the relays internal connections are in normally closed condition but in Revere mode, the relays internal connections are in normally open condition which is shown in Fig. 7. This change over is done manually by using DPST switch.

The control signals received from the driver circuit and Hall Effect sensor works in the same way as in that of forward mode. The sequence of excitation from the driver circuit is same as that of forward mode i.e. excitation sequence is B, G and Y. In order to reverse the direction of motor, we have to switch on the DPST switch which makes the internal connections of the relay changes from Normally Closed (NC) condition to Normally Open (NO) condition.

5.2.2.1 Operation of Reverse Mode

- First, the control signal from the driver circuit sends the excitation signal for the B phase. As it is directly connected to B phase of the motor, B phase of the motor gets excited.
- Then the control signal from the driver circuit sends the excitation signal for the G phase. Because of the change in the internal connection of the relay caused due to the manual switching of the DPST switch, instead of exciting G phase it excites the Y phase of the motor. So, Y phase of the motor gets excited.
- Finally, the control signal from the driver circuit sends the excitation signal for the Y phase. Because of the change in the internal connection of the relay caused due to the manual switching of the DPST switch, instead of exciting Y phase it excites the G phase of the motor. So, G phase of the motor gets excited.
- Due to the reversal of the phase sequence from B, G, Y to B, Y, G, the direction of the motor gets reversed.

6. SPEED, TIME AND DISTANCE INDICATION

The indicator is a device which gives visual information of Speed, Time and Distance in which the battery could run with full potential. It consists of Hall Effect sensor, current sensors, ATmega328 microcontroller and 8 bit display panel.

- The distance is calculated from current entering into the motor and detecting the remaining charge by differentiating with the available charge.
- The total hours withstand capacity for the charge remaining will be calculated from differentiating the total charge to the current flowing in the motor.

A magnet will be fixed in the rotating wheels of the e-bike, so when the vehicle moves, the magnetic field will be sensed by the Hall Effect sensor which gives information to the controller.

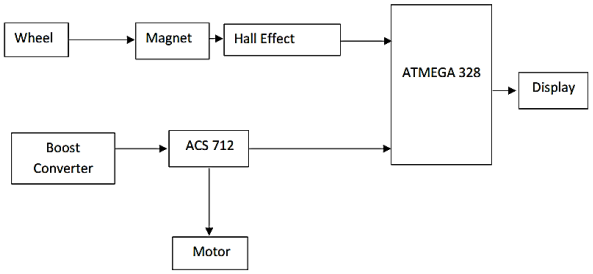

Fig. 8 Block diagram of Speed, Time and distance indication technique

The Fig. 8 shows the Block diagram of Speed, Time and distance indication technique. It clearly shows that there are two inputs to the ATmega328 which are wheel and boost converter. The Hall Effect sensor which is connected to wheel provides input signal to the microcontroller for the calculation of distance. Also, the boost converter which is connected to the ACS712 provides input signal to the microcontroller and operates the 8 bit display panel which actually displays the Speed, Time and Distance. It indicates the exact charge level left in the battery and the distance it could run using the available remaining charge. The maximum speed of proposed E–Bike is approximately 70 km/hr.

7. SOLAR PANEL OUTPUT

The below Table 1 shows the different voltages that are obtained during different hours of a day for certain time period.

Table 1
Solar panel output

S. No.	Time(Hour)	Voltage (Volts)
1.	10 to 11	18
2.	11 to 12	19.5
3.	12 to 1	24

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4.	1 to 2	24
5.	2 to 3	24
6.	3 to 4	22.3
7.	4 to 5	19

The solar panel output voltage with respect to time displayed in the form of graph which is shown in the Fig. 9.

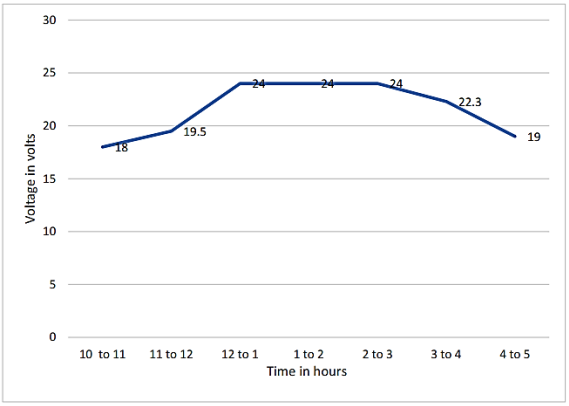

Fig. 9 Output Voltage of solar panel vs Time

8. HARDWARE IMPLEMENTATION OF HYBRID VERSO E–BIKE

The below Fig. 10 shows the Hardware implementation of Hybrid Verso E–Bike.

Fig. 10 Hardware implementation of Hybrid Verso E–Bike

9. COMPARISON BETWEEN EXISTING MODEL AND PROPOSED MODEL

The below Table 2 shows the various advantages when compared to the conventional model.

Table 2

Comparison between Existing model and Proposed model

S.No.	Existing model	Proposed model
1.	It has four wheels	It contains only three wheels
2.	It moves only in forward direction	It moves in both forward and reverse direction
3.	It is back driven mechanism	Our model is front driven mechanism
4.	It has single motor for forward direction	Our model has single motor for both forward and reverse direction
5.	It is not solar powered. Its only battery powered from external supply.	It has battery powered from external supply and it's also solar powered
6.	It does not contain any switching circuits	It has relay switching for solar charging and reversing
7.	It has no indication	Our model has indication for further distance the bike can travel.
8.	Travelling distance i.e. mileage is less	Travelling distance i.e. mileage is high.

10. CONCLUSION

The concept of this proposed model provides the importance of E-Bike for physically challenged and senior citizens which enable them to avoid the help of others in private and public areas. Because the drive used in this project moves in both forward and reverse direction.

The vehicle is more economical as it enhances long distance travel with the use of battery and solar power which requires less maintenance. This may reduce the price of the e-bike which makes it easy to afford for all the people and it causes no pollution to the environment. The goal of verso e-bike is to see the future under roof of the advanced technology, thereby helping the humanity in common.

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