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# Conversion of a Gearless Scooter into an Electric Scooter

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**ABSTRACT**:Different types of electric vehicles (EVs) have been recently designed with the aim of solving pollution problems caused by the emission of gasoline-powered engines. Environmental problems promote the adoption of new-generation electric vehicles for urban transportation. The electric scooter may provide the most feasible opportunity among EVs. They may be a replacement product for the primary use vehicle, provided that drive performance, safety, and cost issues are similar to actual engine scooters. Electric scooters run on a battery. The important parts of this machine thus are the electric motor, battery and inverter set. Besides saving money on gas and car maintenance costs, scooters allow commuters to bypass congested roads. A revised model is proposed in our project so that better performance is aimed than the electric scooters currently in market. In this proposed model an old gearless scooter is converted into an electric vehicle by means of an electric motor and power supply including the battery by using the continuously variable transmission (CVT) technology. Here an old vehicle is reused. The advantage of the model is that in addition to being non-polluting, it is more energy efficient, has quiet smooth operation and depends wholly on electricity. Moreover the recycle, reduce and reuse concepts are reinforced by our paper since all the components used were either found from the scrap or were designed. Hence this system is more economical compared to the conventional electric vehicles.

**KEYWORDS:** CVT, Inverter IC SG3525, Universal Motor, P80 MOSFET.

## I.INTRODUCTION

Increasing awareness of air quality and interest in innovative vehicles stimulate research activity to improve the propulsion system by reducing the vehicle emissions. Different type of electrical vehicles have being recently designed with the aim of solving pollution problems caused by the emission of gasoline powered engines. Environmental problems promote the adoption of new generation electric vehicles for urban transportation. Moreover, the torque generated by the electrical motor can be appropriately controlled, so that the vehicle stability and safety are greatly improved. An electric bike or scooter is a battery operated vehicle that is very economical with low maintenance cost and zero pollution. Electric scooter as a new green transport is accompanied by mankind in solving the environmental pollution, energy crisis and other social development. Electric scooter with battery as power, contains electrical, electronic, mechanical control and chemical technology and other high technologies, is a new clean and efficient transport. It provides auxiliary power through battery to the motor, at the same time improving the performance of scooter emissions, but also may solve some of the increasing depletion of oil resources. The batter of an EV can be charged easily using power connection. Electric vehicles are maintenances free. It has no gears, no engine, no belt or chain drive, zero emission, no pollution, electronic start and accelerator.

In this paper an old gearless scooter is converted into an electric vehicle by means of an electric motor and power supply including the battery by using the continuously variable transmission (CVT) technology (which isnormally used in gearless scooters). The advantage of the model isthat inaddition to being non-polluting. It is more energy efficient, has quiet smooth operation and depends wholly on electricity. Moreover the recycle, reduce and reuse concepts are

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reinforced by the paper since all the components used were either found from the scrap or were designed. Hence this system is more economical.

## II. LITERATURE SURVEY

A brief description about the literatures that had been surveyed is given below. In [1],the features of the main components of the scooter drive: Battery package, supply converter, motor and controller are given in detail. The main features of Electric Scooter(ES) are illustrated and the peculiarities of the most important components are described. A fundamental part of EVs is electric drive for traction. In the most of recent cases asynchronous motor drives are adopted for their better efficiency. But asynchronous motor, often used for simplicity has lower efficiency and less overload capability due to rotor losses. The redesigning of the different components for better efficiency were also described which include the cooling system and the battery monitoring system. With ever fluctuating oil prices there is fast growing interest to in EVs and HEVs. Thus, it is a pressing need for researchers to develop energy efficient devices for various kinds of EVs. The emerging energy efficient technology of hybrid electric vehicles is explained in [2]. The paper highlights the arrangements concerning the engine, continuously variable transmission (CVT) and the wheel. Electric vehicles may include battery electric vehicle, hybrid electric vehicle and fuel cell EV. Compared to conventional vehicles HEVs are more fuel efficient due to optimisation of engine operation and recovery of kinetic energy during braking. In [2], an energy efficient technology such as the integrated starter-generator with booster-propeller are investigated and developed. The controlling of the battery using controllers were also introduced in an efficient way in [2]. An on board battery charger arrangement, that is fully based on the use of power components of EV motor drive are discussed in [3].Electric vehicles are expected to drive reduction of air pollution in densely populated metropolitan areas. The increasing use of EVs will inevitably prompt the use of large number of battery chargers to supply the dc voltage required to charge battery packs. The methods for reaching the desired features of EV battery chargers such as minimum volume, low cost, high efficiency and high reliability are explained in [3]. Battery charges often designed to be used as on board arrangements because of large size and high weight. The use of on board charges increased the acceptance of EVs in urban mobility. Battery charger regulation law by implementing a reliable and non- expensive current control along with the whole charging operation is described in [3]. Design analysis and experimental results of on-board charger prototype are also presented. In [4], the evaluation of performance of the series dc motor with its rotational speed controller when different running cases of vehicle with different loads were discussed. Instead of using the low efficiency mechanical transmission mechanism or the complex flux weakening control technique, a new winding changeover technique is proposed in [5] to increase the low speed starting torque and also extend the high speed operation range for small to midsized electric or hybrid electric drives without increasing the rated size of the power switches, or decreasing the system efficiency/reliability. With the proposed technique, by eliminating the large friction loss of CVT and the extra copper loss accompanied with flux weakening operations, the driving performance of the zero emission scooters (ZES) can be improved significantly. In [5], instead of using the vector control based sinusoidal commutation strategy, namely the flux weakening operation, the cost effective commutation technique: six stepped commutation accompanied with various winding changeover methods is designed. Even though the v-belt linked pulley based continuously variable transmission (CVT), which has the advantage of increasing the starting torque and also extending the speed operation range of the engines or motor is adopted extensively in zero emission scooters (ZES), the efficiency of general CVT is relatively low. The paper was useful to understand the drawbacks of CVT and more efficient winding topology for wide speed range applications. In [6], the structure and control of a fuel cell hybrid electric scooter for mass production are presented. The development of zero-emission scooter can improve air quality and protect the environment, especially in Asia and Europe, where more than 25 million scooters are produced annually. The generic advantages of low-pressure hydrogen scooter are explained, and the control strategies of the hybrid scooter are presented. The main structure of the fuel cell hybrid electric scooter which include, fuel cell controller, motor driver, battery manager, boost converter and ultra-capacitor manager are illustrated in [6]. Additionally, experimental verifications and discussions are presented based on a prototype system controller. To improve efficiency and distance of electric scooter, synergic electric power supply was studied in [7]. The shortcomings of existing electric scooter such as limitation of operational range of battery, difficulty in meeting power requirements of the system when it climbs are studied properly and ways to overcome the problem are mentioned in [7].

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## III.SYSTEM MODEL AND WORKING

Every project needs proper selection of hardware and software. This project is hardware oriented. The project does not have any software. The system consist of a battery unit(2 lead acid battery 12V, 30Ah), inverter circuit(MOSFET P80), transformer, charging unit, universal motor(1200W), continuously variable transmission and PWM motor speed controller(IC3525). The current to the rotor conductors of the motor is supplied from a battery unit which consist of two 12V, 9Amps, 30Ah lead acid battery. The speed of the motor is controlled using a PWM motor speed controller. It consists of an IC 3525. This IC provides the PWM waves whose frequency is controlled using the external resistor and capacitor connected to the 5, 6 pins of the IC. Thus by controlling the duty cycle, the average DC value can be controlled and thus the speed of motor is controlled. A switch, usually MOSFET, is used in the output pins of the IC to control the speed of motor. There are 2 sets of MOSFET which switches alternately and thus produces an ac signal. This ac signal is passed through the transformer (24/230V). Thus the 230V is fed to the motor and it runs. A potentiometer is connected between pin 16 and the pin 2(non- inverting input) of IC3525 so that the duty cycle of PWM wave can be controlled by varying the resistance of the pot. PWM waves make sure that the switch (FET) is ON and OFF in the required intervals such that the average DC value is controlled. The shaft of the motor is connected to a continuously variable transmission (CVT) system through a gear set. Gears of different radius are used here which is discussed later in this report. CVT is similar to automatic gearless vehicles which are the main highlight of this electric vehicle compared to other EVs. It consists of two pulleys, a drive pulley and a driven pulley, connected through a belt. One pulley is connected to the shaft of the motor and the other pulley is connected to the back wheel of the vehicle. As the motor rotates the gear set rotates and hence the CVT and finally the wheel moves. Thus the vehicle works. A charging circuit is also fitted to the system. The same transformer of inverter set is used for the charging purpose also. There is also a 160V port for charging the battery.

**Block Diagram Of The System**

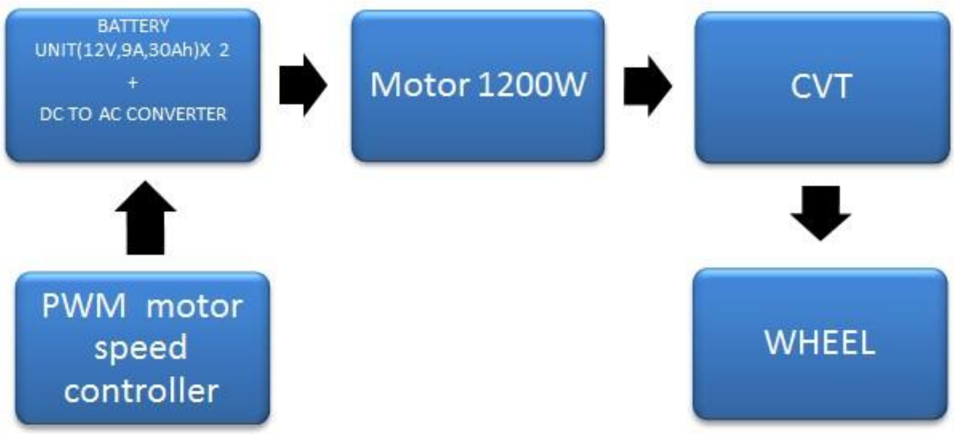


Figure1.1:Blockdiagram

The main components of the system are battery unit (lead acid battery), charging unit,inverter set, universal motor (1200W), continuous variable transmission (CVT) and PWM speed controller as shown in fig 1.1.

Motor is provided supply from another source and the PWM waves make sure that the switch is ON and OFF in the required intervals such that the average DC value is controlled. A potentiometer is connected between pin 16 and the pin 2 (non-inverting input) so that the duty cycle of PWM wave can be controlled by varying the resistance of the potentiometer. Hence the speed of the motor can be varied. The motor is connected to a continuously variable transmission (CVT) through a gear set. The shaft of the motor is connected to a continuously variable transmission system, which is similar to the automatic gear system of gearless vehicles. Thus the vehicle works.

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## IV.SIMULATION

Simulation is the transient and dynamic analysis of electronic circuits with the help of appropriate software. It is an attempt to model a real life situation on a computer so that it can be studied to see how the system works. Here we are using PROTEUS simulation. Proteus is a tool which can simulate microcontroller and peripheral devices. Here the generation of PWM waves is shown using PROTEUS simulation.

**Proteus simulation of PWM controller**

The PWM waves of certain frequency and duty cycle is produced using IC 3525. So first the system to be modelled in proteus is designed. The model consist of resistors, capacitors, potentiometer, IC 3525 and oscilloscope and IC 3525 is a pulse width modulator integrated circuit which has got the features of wide operating voltage range from 8V to 32V, inbuilt oscillator and frequency range of 100 to 500Hz, input and output synchronization terminals, variable dead time controller, soft-start facility, input voltage checking facility and dual source/sink output driver. Thus we are able to control the speed of motor by appropriately varying the duty cycle. The frequency of the PWM wave is decided by the value of external resistor and capacitor connected to pins 6 and 5 respectively i.e., R7 and C2 shown in fig.1.2. Here the frequency is taken as 50Hz and hence the value of R7 and C2 are adjusted so as to get 50Hz. The duty cycle of wave is varied by varying the potentiometer connected 16 and 2 pins. Thus by controlling the duty cycle the average DC value can be controlled and thus the speed of the motor is controlled. The connections can be seen from the simulation. A square output or PWM wave is obtained as the result. Thus it can be concluded that the analog IC 3525 can be used for the generation of PWM waves for speed control of motor.

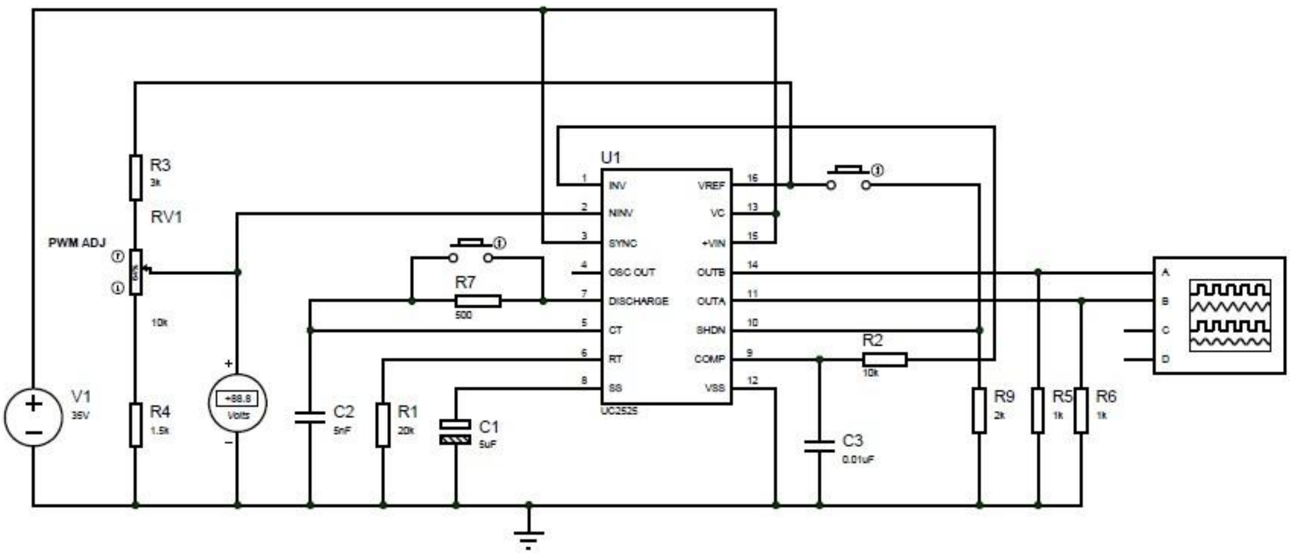


Figure1.2:Simulation ofPWMcontroller

**Proteus Simulation Result**

IC3525 generates pulse width modulated(PWM) wave which controls the motor speed. The result of proteussimulation is shown in fig.1.3. We are able to control the speed of motor by appropriately varying the duty cycle and hence the average DC value.

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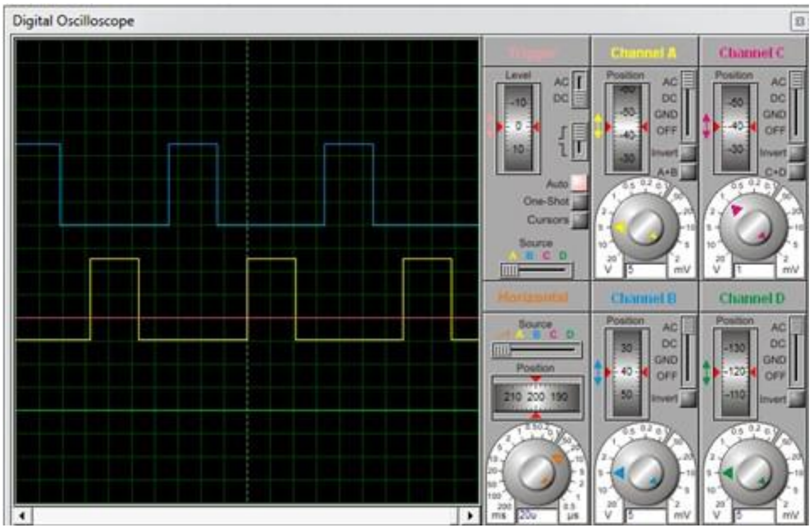

Figure1.3:Simulation result

## V. EXPERIMENTAL SETUP AND RESULT

Every project or system needs a very efficient design which should also concern about the cost. So designing is the first step. Then the steps for implementing should be planned and accordingly it should be implemented.The basic design involves connecting the crank shaft of the scooter to the 1200Watt motor. The motor is connected to the crank via chain drive. The crank is in turn connected to the wheel via the CVT. The motor when run at sufficient speed and torque rotates the chain drive with it and thus the CVT.The vehicle was tested at various road conditions as listed below. Most of the tests were successful and the vehicle seemed to be a success. The testing included strength, torque, load bearing capability and various other tests that the vehicle would face in a normal condition.

| Road | Distance Covered | Time Taken | Average Load Current | Cost per km |
|---|---|---|---|---|
| Highway | 3 Km | 6 min | 25 A | 36 paisa |
| Un tarred Road | 3 Km | 12 min | 40 A | 1.15 rupee |
| Hilly Ways | 3 Km | 9 min | 35 A | 75 paisa |

Table4.1:Test result

The results were that the vehicle could take load upto 150 kg with ease. It could goup to 50 kmph with driver only. The load bearing capacity of the vehicle was good enough. The value of current was seen to be increasing with roughter rain and more load.

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## VI. CONCLUSION

The idea of conversion of a gearless scooter with CVT into an electric vehicle is first of its kind. The CVT provides a much more load bearing capacity to the vehicle. The testing of the vehicle was a success. The required output was obtained from the project. The advantages of the vehicle were noted. This project is best suited for converting old scooters in your household into an electric vehicle at minimum cost and maximum efficiency. The project was a success and was wound up with almost Rs. 20000. There is no one best motor type, rather there are different types of motors to suit personal requirements, such as price and performance. In the early days of EVs there were lead acid batteries, DC brush motors, and contactor controllers. Today, none of these remain. Lead has been replaced by lithium and DC by either DC brushless or induction. Contactors, meanwhile, have given way to modulating inverters. Most people usually go for series DC motors and also three phase AC motors. With dc motor shifting speed instantly is practically not possible but they are known for their higher torque and it can handle heavy loads smoothly. DC motors were famous but now ac motor availability is increasing which has a lot more features than the latter. But the good thing about dc motors is that they cost less compared to an AC version of the motor. But here due to the ease of availability, universal motor is used. They can be easily found in local electrical shop.

Some of the improvements that can be made to the electric vehicle in the future are given below. Replacing the chain drive with the belt drive can reduce huge noise produced by chain drives. The belt drive would need pulleys instead of the gears. The use of electronic oscillator instead of the inverter circuit can be done. We tested the electronic oscillator circuit. This was a failure since the diodes couldn't withstand the current at low speeds. This is surely a subject to be tested upon. Use of a BLDC motor instead of a universal motor eliminates the use of an inverter circuit and can be controlled easily. The non-availability of BLDC motors that can withstand continuous current is a notable factor. Instead of large single batteries, we could use small array type batteries to produce the required voltage. This method is widely used in electric vehicles today. With no further improvements in the battery science the charging time remains a major drawback of the electric vehicle industry. Major breakthrough is required to produce batteries with long life and less charging time. With the mentioned future improvements the cost of the conversion can be further reduced and the efficiency increased.

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