On Board Power Generation For E-Bikes

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Abstract- *This study focuses on the development of a wind turbine that will be installed on an electric vehicle and used to generate electricity to charge the vehicle's batteries while it is in motion. Wind energy is an example of a pollution-free renewable energy source. To put it into practice, it was planned and decided to start with and test it on a bicycle. The basic concept is simple: drive a cycle with wind energy, similar to a vehicle, such that no human effort is required. This point would aid in the implementation of green cars in daily life, making the environment cleaner and more conducive to living, as well as reducing reliance on fossil fuels. Wind energy will be one of the most significant sources of energy for humans in the future, replacing fossil fuel energy. Wind energy has several obstacles, such as noise pollution and expensive maintenance costs. The goal of this project is to create a little wind turbine that can be mounted on top of a car and charge a battery. The project entails the design and production of a wind turbine that will be mounted on top of a vehicle [to profit from the wind speed owing to the automobile's height].*

Keywords- Renewable, Wind Energy, Automobile.

I. INTRODUCTION

Electric Vehicles are a new growing future, and much R&D is going into managing the battery heating issues, optimization, and extension of a battery range. The testing of various methods is ongoing like solar energy with the help of solar panels to generate charging while driving or while stationary. The problem with solar energy is that it is only available for a limited time a day; second, it is less efficient and will require ample space on the roof or all over the vehicle to generate that required amount of electricity. But it is possible to generate the required amount of electricity in a limited area using a wind turbine application. The generator will charge the battery and can be utilized for load applications such as driving an EV motor. As kinetic energy is variable from region to region, but the battery needs a constant supply of the energy, So it is decided to provide it with the application of a buck converter and voltage regulator. Also, the use of two batteries is held either of the one big capacity of the battery. The workload and the task of charging the battery will be divided simultaneously, as it will help maintain battery life and increase travel range.

II. REVIEW OF LITERATURE

Sampath SS et. al.[vol 7, 2018] Has discussed in detail about the wind turbine design and construction of propeller for wind turbine design, also mentioned the results of their fabricated model in the paper.

Gideon Quartey and Stephen Kwasi Adzimah [vol 4, 2014] This research targets the design of a wind turbine that will be mounted on the electric car to generate electrical power to charge the car batteries when in motion.

Karthik Upadhyay et. al.[2017-2018] This paper discusses about the fabrication of the model and the road test result of the fabricated model.

Nichannant semseri et. al.[2016] The paper describes about the generation of electricity by using wind turbine with the help of electric motor.

Annette Muetze and Ying C. Tan [2007] This paper targets research on efficiency and current standards of current E-bikes.

E.A. Demeo et. al. [2005] Has discussed aboutthe wind plant integration and also briefs about design and consideration for propellers.

Dr. Anass Bentamy and Dr. Sedki Samadi [2016] The paper relates to design of main shaft of small turbines.

III. COMPONENTS USED AND METHODOLOGY:

Arduino UNO Circuit:

Arduino UNO

It's an open-source computer platform supported basic microcontroller boards that's want to construct and programme electrical devices. it's going to also act as a minicomputer, receiving inputs and regulating the outputs of various electrical devices, almost like other microcontrollers. With the help of several Arduino shields, which are detailed during this article, it also can receive and send data over the net. For code development, Arduino uses hardware called the Arduino development board and software called the Arduino IDE (Integrated Development Environment). These microcontrollers, which are made with Atmel's 8-bit AVR microcontrollers or a 32-bit Atmel ARM, is also readily programmed using the Arduino IDE's C or C++ language. Arduino boards, unlike other microcontroller boards in India, were introduced to the electronic market only some years ago and were first confined to small-scale applications. People with an interest in electronics are progressively developing and accepting Arduino's position in their personal projects. By connecting it to a computer through a USB cable, this development board may additionally be wont to burn (upload) fresh code to the board. The Arduino IDE may be a simplified integrated platform that enables users to create Arduino programmes in C or C++ on conventional personal computers.

LCD Display:

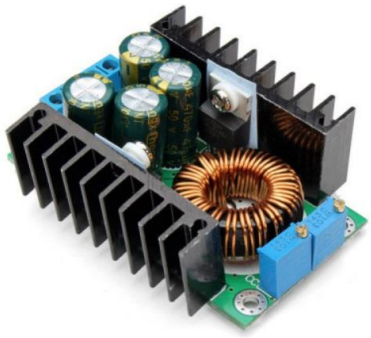
The LCD Display is 20x4 (2 rows and 16 character per row) with HD44780 built with industrial standard equivalent LCD controller which operates with 5V DC.

Relay:

One Channel 5V Relay Module

When a circuit requires a separate low-power signal to regulate it, or when numerous circuits must be controlled by one signal, relays are used. Long-distance telegraph circuits initially used relays as signal repeaters, refreshing the signal coming in from one circuit by broadcasting it on another. Relays were frequently utilized in telephone exchanges and early computers to perform logical functions. the first sort of relay uses an electromagnet to shut or open the contacts, but other working principles, like solid-state relays, are created that govern without the necessity of moving components. In current wattage systems, calibrated operating characteristics and, in certain circumstances, several functional coils are employed to safeguard electrical circuits from overload or flaws. These duties are still handled by proactive relays, which are digital instruments

Buck converter:



Buck Converter

A buck converter (also referred to as a step-down converter) could be a DC-to-DC converter that drops the voltage from the input (supply) to the output (while drawing less average current) while drawing less average current (load). it is a form of switched mode power supply (SMPS) that has a minimum of two semiconductors (a diode and a transistor, though in synchronous buck converters, the diode is usually replaced with a second transistor) and a minimum of one energy storage element, like a capacitor, inductor, or both together. Capacitor based filters (often in conjunction with inductors) are commonly added to the output (load-side filter) and input (input-side filter) of such a converter to decrease voltage ripple (supply-side filter). The voltage across the inductor "bucks," or opposes, the provision voltage, which is why it's called a buck.

Current Sensor:

Current Sensor ACS712

Conduction Pathway A magnetic flux formed by current passing via this copper conduction pathway is measured by the Hall effect sensor. The Hall sensor, which is employed to observe current, produces a voltage proportionate to the observed force field, this Sensor measures the present during a wire or conductor and outputs an analogue voltage or digital signal proportional to the present measured. Current is also measured in two ways: directly and indirectly. In direct sensing. law of nature is employed to detect current by measuring the dip in a very wire as current runs through it. A current-carrying conductor generates a field of force. The force field is calculated using either Faraday's or Ampere's equations in indirect sensing. A transformer, hall effect sensor, or fibreoptic current sensor is employed to live the force field. The Indirect Sensing technique is employed by the ACS712 Current Sensor to see current. To detect current during a liner, this IC uses a low-offset Hall sensor circuit. This sensor is on the IC's surface, next to a copper wire.

Diode:

Diode

A diode could be a two-terminal electrical component with low resistance (preferably zero) in one direction and high resistance (ideally infinite) within the other. It conducts current preferentially in a technique (asymmetric conductance). A thermionic diode may be a thermionic tube with two electrodes, a heated cathode and a plate, through which electrons can only flow in one direction, from cathode to plate. A crystal rectifier, which may be a crystalline piece of semiconductor material with a tangency linked to 2 electrical terminals, is that the most prevalent form today. Semiconductor diodes were the earliest semiconductor electronic devices. Asymmetric conductivity across the contact between a crystalline mineral and a metal was found by Ferdinand Burn, a German scientist, in 1874, the bulk of diodes nowadays are fabricated from silicon, however other semiconducting semiconductors including gallium arsenide and germanium are employed.

Battery:

A battery may be a device that stores energy and transforms it to electricity, within the chemical warfare of battery, electrons result one material (electrode) to a different via an external circuit. The movement of electrons generates an electrical current which will be used to try and do work. Two 5000mAh batteries are utilised during this project, one as a support battery and also the other as a loaded battery. When the primary battery runs out of power, the second battery steps in to assist.

INSTRUMENTS:

The basic instruments used to measure the current are:

- Tachometer
- Multimeter
- Anemometer

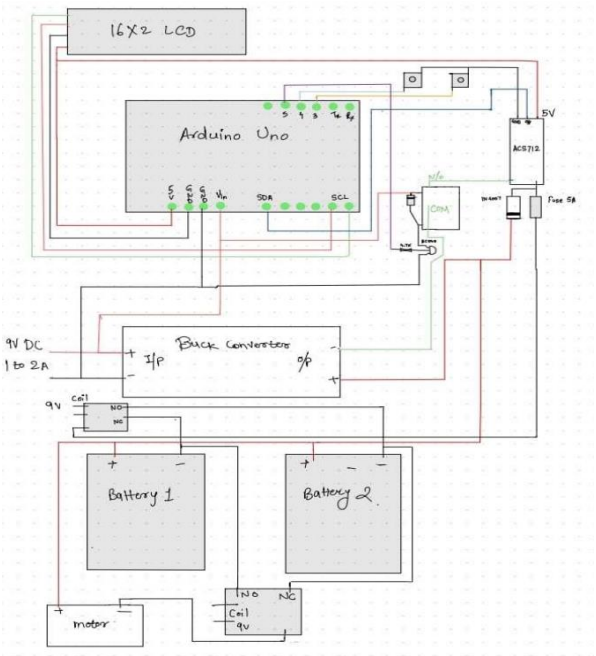
METHODOLOGY:

The most significant feature of the literature review is to select the type of vertical axis blade and other components required for the project. The data was gathered from reference books and a research articles for the calculation purposes. Selected an electrical component, such as a battery or an Arduino. The work of design and analysis of the wind turbine, as well as the components was done. Then the PLC material was used to construct this design in a 3D printer. It took 1–2 days to complete. Finally, the testing of the prototype model to capture output data using instruments such as a tachometer and a Multimeter was introduced. A small-scale prototype was created utilising 3D printing to test the design's success. A circuit was built to store the electricity generated. Motor at 2000 rpm gives 6V output (fluctuating), that's why 7806 voltage regulator is being operated to steady 6V output, voltage of voltage regulator will connect to buck convertor, the buck convertor will reduce the 6V input to 5 V output and it’s connected current sensor as well as portable battery the come Arduino: the Arduino decides whether to charge the battery via constant current or constant voltage. This process of charging will be displayed on the LCD display and the operator have the liberty to regulate current with respect to

different batteries. If the current sensor senses the set current or higher, then it'll will cut off the relay or cut off the supply via Arduino.

IV. STUDIES AND FINDINGS

3D printing is a process of making a 3-dimensional object from a CAD or a digital 3D model. This term refers to several processes in which material is deposited joined or solidified under computer control to create a 3D object, with the material being added in a systematic layer-by-layer method. The vertical access bled models were provided to the vendor for 3D printing. The material uses to print the blades and set up the body is PLC with a 25% infill. This way the set-up is lightweight the time taken to print all components is roughly 12 hours. The printed parts are then stuck together using a glue gun. The parts were given a moist vibe with acetone to remove the burr on the edges and give the surface a smooth profile. 3D printing is a preferred method of manufacturing because of its numerous benefits such as fewer parts needing to be outsourced, it creates a lot less waste material, and materials used in 3D printing are generally recyclable and cost-effective.



Circuit Diagram

NUMERICALS AND SOFTWARE ANALYSIS:

Propeller calculation

$\lambda = \frac{4\pi}{B}$ x=rip speed ratio

$= 4\pi/3 = 4.189$ B=No. of blades

$cp \cong 0.38$

$cps = 0.38+1.38 = 1.76$ (cps=shaft power coefficient)

$KE = \frac{1}{2} mv^2$

$KE = \frac{1}{2} \times \omega v^3$

For shaft power

$pw = \frac{1}{2} \times cps \times \delta A V^3$

$= \frac{1}{2} \times 1.76 \times 1.225 \times 0.004 \times (6.9)^3$

KE for shaft power = 1.416 kw

Torque on rotor

$Ps = T\omega$ (T=Torque ,ω = angular velocity)

$\omega = \frac{\lambda v}{R} = 4.189 \times \frac{6.9}{0.036} = 802.89 \frac{rad}{sec}$

$T = \frac{ps}{w} = \frac{1.416 \times 10^3}{80289} = 1.7636\ N.m$

$N = \frac{60 \times 4.184 \times 6.9}{2 \times \pi \times 0.036} = 7667.05\ rpm$

Now angle of twist θ

$\theta = tan(\pi \times \frac{0.2 \times 7667.05}{6.9}) = 89.91°$

F1= lift force = $\frac{1}{2} C2pv^2\ At$

FD=Drag force= $\frac{1}{2} CDpAt^2$

$At = 2.9 \times 10^{-4} m$

FL = $\frac{1}{2} \times 1.052 \times 1.225 \times 6.9^2 \times 2.19 \times 10^{-4}$

FL = $6.71 \times 10^{-3} N$

$FD = \frac{1}{2} \times 0.064 \times 1.225 \times 1.225 \times (6.9^2) \times 2.19 \times 10^{-4}$

$FD = 0.408 \times 10^{-3} N$

$Thrust = F = FLcos(90-\varphi) - Fdsin(90-\varphi)$

$= 6.71 \times 10^{-3}$ cos(90-89.91)-0.408×10^{-3} sin(90-89.91)

Cos(90-89.91)=1 sin(90 − 89.91)=1.57×10^{-3}

=6.71×10^{-3}(1) -$0.408 \times 10^{-3} \times 1.57 \times 10^{-3}$

Thrust =6.71×10^{-3}N for 1 blade

W1=resultant velocity

VA= axial velocity

U=peripheral speed

B1=inlet air angle

B2= outlet air angle

W2=exit velocity

Let,

x=u.c2u Va=C2a

$Va = \frac{mass\ flow\ rate}{swept\ area}$

Padding assist

Mass flow rate=ρA^V

$= \frac{\pi}{4} \times (0.81)^2 \times 5 \times 1.225 = 0.03155\ kg/s$

Swept area = 0.004

$$Va = \frac{0.0355}{0.004} = 7.88\ m/s$$

$$\lambda = \frac{60 \times 4.184 \times 5}{2 \times \pi \times 0.036} = 5.556\ rpm$$

$$= 32.6 rps$$

$$\mu = 2\pi nr = 2\pi \times 92.6 \times 2.036 = 20.94\ \frac{m}{s}$$

$$\beta 1 = ta^{n-1}\left(\frac{u}{va}\right) = tan^{-1}\left(\frac{20.94}{7.88}\right) = 69.37$$

$$v^{a^2} + \mu = \omega^{l^2}$$

$$\mu 1 = (7.88)^2 + (20.94)^2 = 22.37\ \frac{m}{s}$$

$$Cv = \frac{va}{u} = \frac{7.88}{20.94} = 0.376$$

$$\beta 2 = ta^{n-1}\left(\frac{x}{c2a}\right)$$

$$tan15 = \left(\frac{x}{7.88}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots x = 2.11\ m/s$$

$$0.26 \times 6.44 = x$$

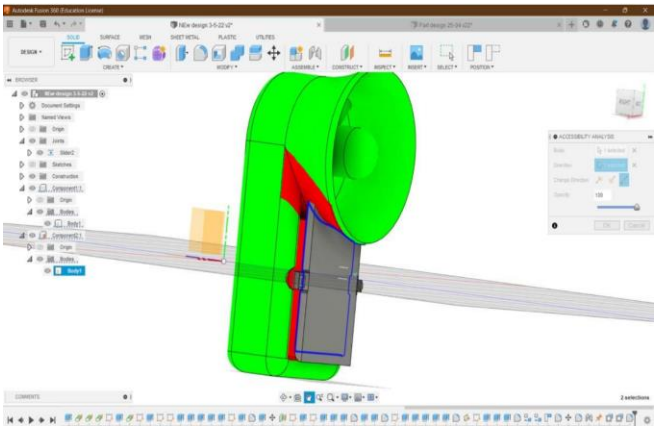
$$W2 = \sqrt{x^2 + c2a^2} = \sqrt{4.45 + (7.85)^2}$$

= 8.15 m/s

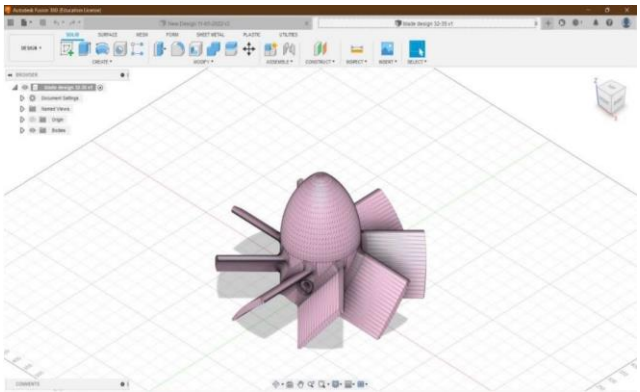
C2u=20.94-2.11

=18.83 m/s

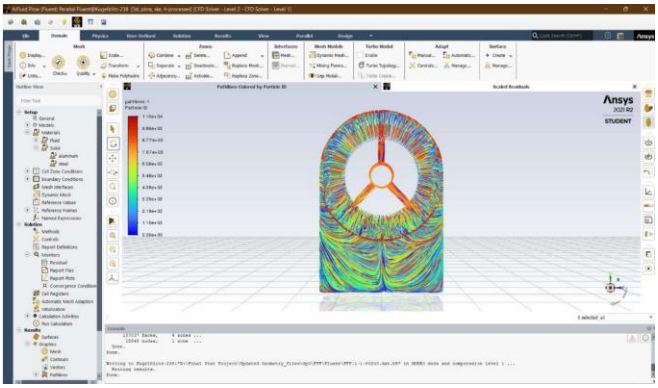
Stress Analysis:



Casing



Blade

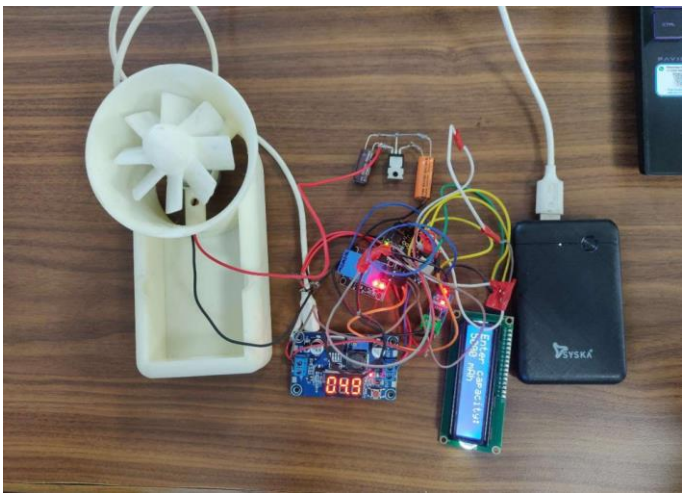


Wind flow analysis on model

Above figures shows the modelling of respective models tested and prototype in fusion-360 as well as analysed in ANSYS R222 software. The above fig also shows the various stresses induced on model such as stress induced due to wind flow and as well as engaging and disengaging of back cover.

Results:

- In the first condition, the road was filled pack with trees and bushes around the road side.
- The bike speed (20-25kmph) – volts generated (13-15v) The second was done on the wide-open road with full openness. The bike speed (25-30kmph) – volts generated (16-17v).
- In the third trial on the same road.
- The bike speed was (45-50kmph) – volts generated (18-21v).



Photograph of the project

V. CONCLUSION

The closure of this project states that the results from model which generates electric energy from kinetic energy

produced by the wind turbine. At the intake air velocity at speed of vehicle at 25 kmph is around 20kmph which generates enough charge to charge the respected battery and switch the given load such as motor or a battery. The Arduino will auto cut off the electric supply if the set current limit is exceeded. The display display's if the charging is constant current or constant voltage.

VI. FUTURE SCOPE

- Electric Bikes.
- All types of Electrical Appliances which consumes less wattage.
- Domestic appliances and portable mobile chargers.

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