DESIGN & CONSTRUCTION OF VERTICAL WIND TURBINE POWER GENERATION FOR ROAD SAFETY PURPOSE

A Thesis

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In partial fulfillment of the requirements for the award of the degree

of

Bachelor of Science in Mechanical Engineering

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Declaration

This is to certify that this thesis entitled **"Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose" is done by us under supervision of Md. Ahatashamul Haque Khan Shuvo**, Assistant Professor, Department of Mechanical Engineering, Sonargaon University. We have tried our best to make the thesis report accurate with information and relevant required data.

We hereby ensure that the work has been presented doesn't breach any existing copyright. We further undertake to indemnify the university against any loss or damage arising from breach of the forgoing obligation.

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Certification of Approval

This is to certify that the thesis titled **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** is carried out by following students of Mechanical Engineering. Mohammad Hossain, Salman Hosen Molla, Md. Jony Hossain, Md. Moshin, Billal Hossain, Md. Alamin Sheik, Accepted as satisfactory partial fulfillment of the requirements for the bachelor's degree in Mechanical Engineering.

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Abstract

Wind energy is one of the non conventional forms of energy and it is available in affluence. Electricity can be generated with the help of vertical axis wind turbine. This projects aims of utilizing this wind energy in most effective manner to get the maximum electric output, and therefore we selected highway as our installation site where we can take the advantage of the moving vehicles on both the sides of the road. In the present work, turbine is design and fabricated as per the specifications, the blades used are semi-circular shape and are connected to the disc which is connected to shaft. Shaft is then coupled with pulley with the help of bearing, and then pulley is connected to the alternator, which generates the power. The power developed is stored in battery and used it to road indication light for vehicle safety. In this project a small model has been created for testing purpose. This project also aims for maximum output with minimum cost indulges, so that the government can think over this project and can implement this type of vertical axis wind turbine on highways at low cost.

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Chapter 1
Introduction

1.1 Introduction

The main aim of this project is fabrication of a highway windmill. This project converts wind energy into electrical energy. The electrical energy produced here is used to drive the home appliances. A windmill is a type of engine. It uses the wind to make energy. To do this it uses vanes called sails or blades. The energy made by windmills can be used in many ways. These include grinding grain or spices, pumping water and sawing wood. Modern wind power machines are used to create electricity. These are called wind turbines. Before modern times, windmills were most commonly used to grind grain into flour. The windmill has been in history for many years.

The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels. An electrical generator is a machine which converts mechanical energy into electrical energy. Induced EMF is produced in it according to Faraday's law of electromagnetic induction. This EMF causes a current to flow if the conductor circuit is closed.

The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source. It just converts direct current into alternating current. In this project wind turbine uses wind’s kinetic energy and converts into mechanical energy. This highway windmill uses wind energy generated by the moving vehicles and converts into mechanical energy. The DC generator converts the mechanical energy into electrical energy. Inverter converts direct current into Alternating current and this is used to drive the home appliances.

1.2 Basics of Wind Turbines

Wind turbines convert the kinetic energy of the flowing wind into electrical energy. Wind turbine blades are made of airfoil sections which produce the aerodynamic lift forces that generate torque and therefore mechanical power, which is further converted to electric power in generator. A **vertical-axis wind turbine** (**VAWT**) is a type of wind turbine where the main rotor shaft is set transverse to the wind while the main components are located at the base of the turbine. This arrangement allows the generator and gearbox to be located close to the ground, facilitating service and repair.

VAWTs do not need to be pointed into the wind, which removes the need for wind-sensing and orientation mechanisms. Major drawbacks for the early designs (Savonius, Darrieus and giromill) included the significant torque ripple during each revolution, and the large bending moments on the blades. Later designs addressed the torque ripple by sweeping the blades helically (Gorlov type). Savonius vertical-axis wind turbines (VAWT) are not widespread, but their simplicity and better performance in disturbed flow-fields, compared to small horizontal-axis wind turbines (HAWT) make them a good alternative for distributed generation devices in an urban environment.

1.3 Motivation & Goal

Every invention has some motivation and goal. Our system is not outside of that. **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** has been done by many projects. The main difference between our project and their project is that our project power use for road safety purpose. In previous many project made with various technique but our system is useful for our country. In our electricity shortage moment we generate from vehicle side wind and indicate road turn for vehicle safety at night. This system will save electricity and prevent accident ration in night. Our **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** feature is expected to be very useful. So we are encouraged to do this system.

1.4 Objectives

There are several objectives involved in this thesis. These objectives are explained below

- To **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose.**
- To put the whole prototype under several tests by creating different scenarios to validate our work.
- To take notes from our real-time tests so that those can be used for future improvements.

1.5 Organization of Book

- **Chapter 1: Introduction.** This chapter is all about background study, motivation, Objectives, Basics of Wind Turbines, Multi Rotor wind Turbine and thesis book organization.

- **Chapter 2: Literature Review-** Here briefly describe about previous book review, Components List and Summary of this chapter.

- **Chapter 3: Research Methodology-** This chapter is discussed about our project methodology, block diagram, circuit diagram, working principle, hardware image, required instrument hardware and Software . Here we describe our hole instrument details.

- **Chapter 4: Result and Discussion–** Here briefly discuss about project result, evaluation of multi rotor wind turbines, result analysis, advantages, limitations application and discussion our system overview.

- **Chapter 5: Conclusion** – This chapter is all about our thesis future recommendation and this project conclusion.

Chapter 2
Literature Review

2.1 Literature Survey:

The use of wind energy for energy generation is one of the oldest methods for harnessing renewable energy. Use of renewable energy is an essential ingredient of socioeconomic development and economic growth. Renewable energy sources such as wind energy, tidal energy etc. is abundant and can help in reducing the dependency on fossil fuels. With increased concern for environment now days led to the research for more environment friendly sources of energy and with this considerations wind energy can be considered as a viable option in this regard. Different configurations of wind turbines such as horizontal axis wind turbine and vertical axis wind turbines are mainly used for energy extraction.

Horizontal axis mainly used in large scale applications and thus its implementation is generally a concern due to huge installment setup and initial cost; whereas vertical axis wind turbines offer promising solution for smaller ruler areas or medium sized residential spaces. Energy generation from wind turbines will surely be affected by geometry of blade it is using and its orientation in turbine. For effective use of turbine both parameters should be optimally set and determined.

This review work focuses on various stages for design and development of highway vertical axis wind turbine which will studies various parameters such as general wind energy scenario, different available energy extraction methods, design and aerodynamic performance analysis of highway vertical axis wind turbines. Project work will include design parameters of highway vertical axis turbine blades considering different parameters such as geometry orientation in assembly.

A vertical wind turbine is a type of wind turbine where the main rotor shaft is arranged vertically. Unlike traditional horizontal-axis wind turbines, which have blades that rotate around a horizontal axis, vertical-axis turbines have blades that rotate around a vertical axis.

Key features of vertical wind turbines:

1. **Design Variations:**
   - **Darrieus Design:** Vertical turbines often use a Darrieus design, characterized by curved blades that resemble an egg beater. This design is efficient in capturing wind from any direction.
   - **Savonius Design:** Another common design is the Savonius rotor, featuring scooped-shaped blades. While less efficient than Darrieus, Savonius turbines are simple and can start rotating with lower wind speeds.
2. **Omni-Directional:**
   - Vertical turbines can capture wind from any direction, making them suitable for locations with variable or turbulent wind patterns.
3. **Space Efficiency:**
   - They have a smaller footprint compared to horizontal-axis turbines, making them more suitable for urban or constrained spaces.
4. **Lowered Maintenance Needs:**
   - Vertical turbines often have fewer moving parts and can be more easily maintained due to their simple design.
5. **Start-Up at Low Wind Speeds:**
   - Some vertical-axis turbines can start generating power at lower wind speeds compared to their horizontal counterparts.
6. **Noise Reduction:**
   - Vertical turbines may produce less noise during operation, making them potentially more suitable for residential areas.
7. **Aesthetics:**
   - The unique design of vertical turbines can be visually appealing and may have less impact on landscapes compared to traditional wind turbines.

Despite these advantages, vertical-axis wind turbines also face challenges, including lower overall efficiency and potential structural issues due to the varying forces acting on the vertical axis. Advances in technology and ongoing research aim to address these challenges and improve the performance of vertical wind turbines.

Literature Survey of Vertical Axis Wind Turbines

The literature review pertaining to the pure experimental aspects of wind turbine and the literature related to experimental methods.

D.A. Nikam et al. analyzed the on design and development of vertical axis wind turbine blade. This paper explains that the wind mill such as vertical and horizontal wind mill is widely used for energy production. The horizontal wind mill is highly used for large scale applications which require more space and huge investment. Whereas the vertical wind mill is suitable for domestic application at low cost. The generation of electricity is affected by the geometry and orientation of the blade in the wind turbine. To optimize this by setting the proper parameter for the blade design. The experimental result indicates that the blade plays critical role in the performance and energy production of the turbine. The optimized blade parameter and its specification can improve the generation of electricity.

Altab Hossain et al. investigated the design and development of A 1/3 scale vertical axis wind turbine for electrical power generation. In this paper the electricity is produce from the wind mill by wind power and belt power transmission system. The blade and drag devices are designed in the ratio of 1:3 to the wind turbine. The experiment is conducted by different wind speed and the power produced by the windmill is calculated. The experimental result indicates that 567 W power produced at the speed of 20 m/s while 709 W power produced at the speed of 25 m/s. From this, the power production wills increases when the velocity is high.

M. Abid et al. analyzed the design, development and testing of a savonius and darrieus vertical axis wind turbine. This paper shows that vertical axis wind mill is more efficient when compare to horizontal axis wind mill. The darrieus turbine consists of 3 blades which can start alone at low wind speed. When savonius turbine is attached on the top of existing wind mill which provide the self-start at low wind speed. The result indicates that the darrieus vertical axis wind turbine acts as a self-starter during the testing. The function required the starting mechanism which can be provided by the combination of NACA 0030 aerofoil and savonius turbine. The high blade thickness of the NACA 0030 aerofoil will improves the self starting capability of the turbine.

2.2 Summary

The above discussion gives an idea about **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** All that work on the system has already been done here, and the results of their work, **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** in the situation are described in detail. From this we also got the direction of work of the project.

Chapter 3
Research Methodology

3.1 Methodology

Our used methodology for the project:

- **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** and designing a block diagram & circuit diagram to know which components need to construct it.
- Setting all components in a PCB board & soldering. Then assembling the whole block in a board and finally run the system & checking.
- To take necessary notes from the project for future improvements.

3.2 Block Diagram

The way of whole project works is generated power from wind energy. That store in a battery. Here we use wind turbine, charging system, battery, voltmeter, switch, light etc. All are in layout in below block diagram.

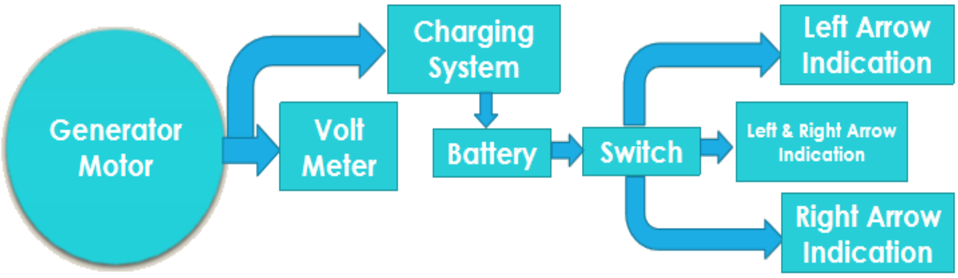

Figure 3.1: Block Diagram

3.3 Circuit Diagram

The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.

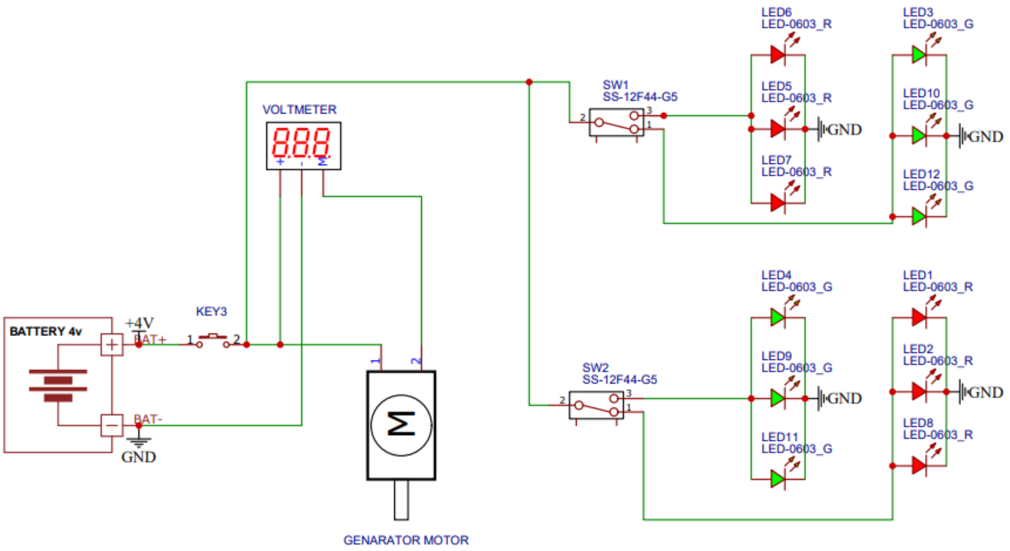

Figure 3.2: Circuit Diagram

3.4 Working Principle

This **Design & Construction of Vertical Wind Turbine Power Generation for road Safety Purpose** works on the principle of auto power generating from vertical turbine air sources. Here we use vertical turbine for power generating elements and restore it in a battery. In this project here generate some power from wind turbine and store it in the battery. This project will be place in road side. When a vehicle pass in-front of the turbine it will rotate. Rotor is connect to generator motor with the pulley belt. This generator motor rotate and create some energy from rotation. This power will store in a battery. This power use to road indication light for vehicle smooth movement. This is the main procedure of our project.

3.5 Project Hardware Image

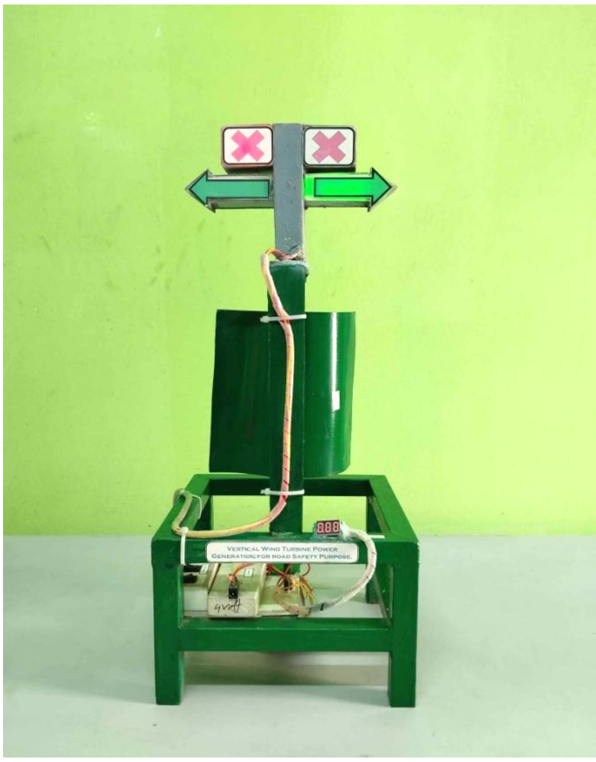

Figure 3.3: Project Hardware Image

3.6 Required instrument and Software

Hardware

- Wind Turbine
- Digital Indicator
- Voltmeter
- Battery
- Resistor
- Capacitor

Software

1. Easy EDA Software

3.7 Wind Turbine

A wind turbine is a rotating machine which converts the kinetic energy in wind into mechanical energy. If the mechanical energy is then converted to electrical energy, the machine is called a wind generator, wind turbine, wind power unit (WPU), wind energy converter (WEC), or aero- generator. Wind turbines can be separated into two types based by the axis in which the turbine rotates. Turbines that rotate around a horizontal axis are more common. Vertical-axis turbines are less frequently used.

Vertical Axis Wind Turbines

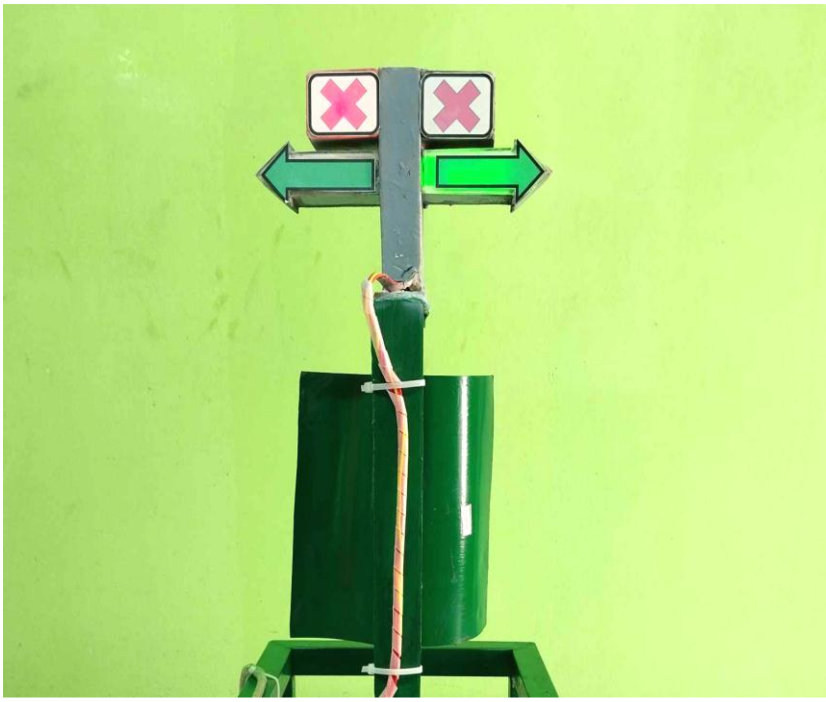

Figure 3.4: Vertical Axis wind Turbine

A **vertical-axis wind turbine** (**VAWT**) is a type of wind turbine where the main rotor shaft is set transverse to the wind while the main components are located at the base of the turbine. This arrangement allows the generator and gearbox to be located close to the ground, facilitating service and repair. VAWTs do not need to be pointed into the wind, which removes the need for wind-sensing and orientation mechanisms. Major drawbacks for the early designs (Savonius, Darrieus and giromill) included the significant torque ripple during each revolution, and the large bending moments on the blades. Later designs addressed the torque ripple by sweeping the blades helically (Gorlov type). Savonius vertical-axis wind turbines (VAWT) are not widespread, but their simplicity and better performance in disturbed flow-fields, compared to small horizontal-axis wind turbines (HAWT) make them a good alternative for distributed generation devices in an urban environment.

Advantages

VAWTs offer a number of advantages over traditional horizontal-axis wind turbines (HAWTs):

- Omni-directional VAWTs may not need to track the wind. This means they don't require a complex mechanism and motors to yaw the rotor and pitch the blades.
- Gearbox replacement and maintenance are simpler and more efficient, because the gearbox is accessible at ground level instead of requiring the operator work hundreds of feet in the air. Motor and gearbox failures generally are significant operation and maintenance considerations.
- Some designs can use screw pile foundations, which reduces the road transport of concrete and the environmental impact of installation. Screw piles can be fully recycled at end of life.
- VAWTs can be installed on HAWT wind farms below the existing HAWTs, supplementing power output.
- VAWTs may operate in conditions unsuitable for HAWTs. For example, the Savonius rotor, which can operate in irregular, slow wind ground-level contexts, is often used in remote or unattended locations although it is the most 'inefficient', drag-type, VAWT.
- Reduced noise compared to HAWTs
- Reduced danger for birds

Disadvantages

When the velocity of a VAWT wind turbine grows, so does the power, however at a certain peak point, the power progressively decreases to zero even while the wind turbine velocity is at its greatest. Such that, disc brakes are used to slow the velocity of a wind turbine at high wind conditions. However, sometime due to disc brake overheating, the turbine can catch fire. VAWTs often suffer from dynamic stall of the blades as the angle of attack varies rapidly. The blades of a VAWT are fatigue-prone due to the wide variation in applied forces during each rotation. The vertically oriented blades can twist and bend during each turn, shortening their usable lifetimes. Other than the drag-types, VAWTs have proven less reliable than HAWTs, although modern designs have overcome many early issues.

3.8 Generator Motor

A **motor–generator** (an **M–G set**) is a device for converting electrical power to another form. Motor–generator sets are used to convert frequency, voltage, or phase of power. They may also be used to isolate electrical loads from the electrical power supply line. Large motor–generators were widely used to convert industrial amounts of power while smaller motor–generators (such as the one shown in the picture) were used to convert battery power to higher DC voltages.

Figure 3.5: Generator Motor

While a motor–generator set may consist of distinct motor and generator machines coupled together, a single unit **dynamotor** (for dynamo–motor) has the motor coils and the generator coils wound around a single rotor; both the motor and generator therefore share the same outer field coils or magnets.[1] Typically the motor coils are driven from a commutator on one end of the shaft, while the generator coils provide output to another commutator on the other end of the shaft. The entire rotor and shaft assembly is smaller, lighter, and cheaper than a pair of machines, and does not require exposed drive shafts.

3.9 4V Battery

A **battery** is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells; however, the usage has evolved to include devices composed of a single cell.

Applicable fields

Widely used in electronic test, LED flashlight, table lamp, electric mosquito swatter and other electronic products.
Biggest features:

- Sealed construction, safety and no leakage
- Maintenance-free, convenient for installation
- Broad operating temperature range
- High capability, high energy density
- Low self-discharge rate, more deep cycle times
- Long service life, Excellent recharge and discharge performance

Quick Details

- Nominal Capacity: 0.25Ah-2.5Ah
- rechargeable 4v dc battery pack: 1PCS
- Production Capacity: rechargeable 4v dc
- Voltage: 4V

Figure 3.6: 4V Battery

3.10 Digital Voltmeter

A voltmeter is an instrument used for measuring electric potential difference between two points in an electric circuit. It is connected in parallel. It usually has a high resistance so that it takes negligible current from the circuit. An ammeter (abbreviation of Ampere meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in Amperes (A), hence the name. The ammeter is usually connected in series with the circuit in which the current is to be measured. An ammeter usually has low resistance so that it does not cause a significant voltage drop in the circuit being measured.

Features:

- Display color: Red & Blue LED (dual display).
- Display: 0.28″ LED digital.
- Operating voltage: DC 4.5 ~ 30V.
- Measure voltage: DC 0 ~ 100V.
- Minimum resolution (V): 0.1V.
- Refresh rate: ≥500ms / times.
- Measure accuracy: 1% (± 1 digit).

- Minimum resolution (A): 0.01A.
- Operating Current: <20mA.
- Measure current: 10A (direct measurement, built-in shunt).
- Operating temperature: -10 to 65°c.
- Operating Humidity: 10 to 80% (non-condensing).
- Mounting cutout: 45.5mm x 26.1mm.

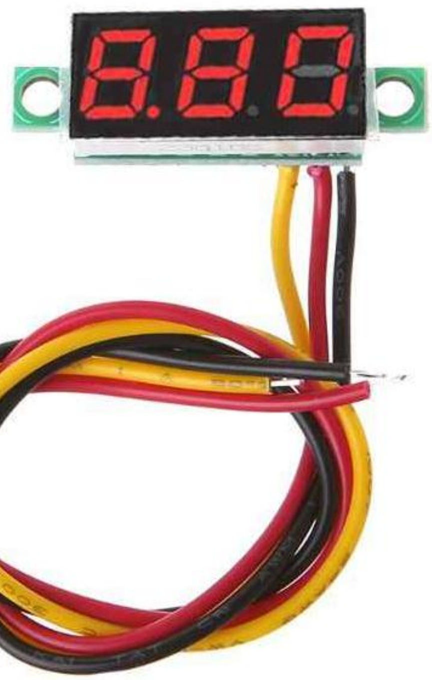

Figure 3.7: Mini Digital Voltmeter

3.11 Capacitor

When there is a potential difference across the conductors (e.g., when a capacitor is attached across a battery), an electric field develops across the dielectric, causing positive charge (+Q) to collect on one plate and negative charge (-Q) to collect on the other plate. If a battery has been attached to a capacitor for a sufficient amount of time, no current can flow through the capacitor. However, if an accelerating or alternating voltage is applied across the leads of the capacitor, a displacement current can flow.

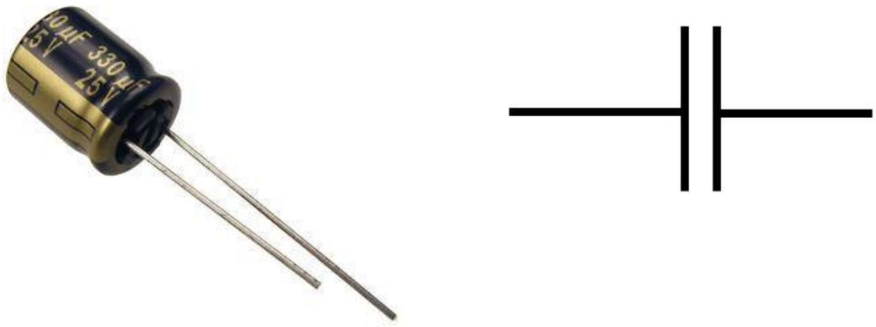

Figure 3.8: Capacitor

An ideal capacitor is characterized by a single constant value for its capacitance. Capacitance is expressed as the ratio of the electric charge (Q) on each conductor to the potential difference (V). The SI unit of capacitance is the farad (F), which is equal to one coulomb per volt (1 C/V). Typical capacitance values range from about 1 pF (10−12 F) to about 1 mF (10−3 F).The capacitance is greater when there is a narrower separation between conductors and when the conductors have a larger surface area.

In practice, the dielectric between the plates passes a small amount of leakage current and also has an electric field strength limit, known as the breakdown voltage. The conductors and leads introduce an undesired inductance and resistance. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass. In analog filter networks, they smooth the output of power supplies. In resonant circuits they tune radios to particular frequencies. In electric power transmission systems they stabilize voltage and power flow.

3.12 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the sometime, act to lower voltage levels within circuits. Resistors may have fixed resistances or variable resistances, such as those founding thermostats, visitors, trimmers, photo resistors, hamsters and potentiometer. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law

Figure 3.9: Resistor

Theory of operation

The behavior of an ideal resistor is dictated by the relationship specified by Ohm ‘slaw:

$$V = I.R$$

Ohm's law states that the voltage (V) across a resistor is proportional to the current(I), where the constant of proportionality is the resistance (R).

Equivalently, Ohm's law can be stated:

$$I = V/R$$

This formulation states that the current (I) is proportional to the voltage (V) and inversely proportional to the resistance (R). This is directly used in practical computations. For example, if a 300-ohm resistor is attached across the terminals of a12 volt battery, then a current of12 / 300 = 0.04 amperes flows through that resistor.

3.13 Diode

A rectifier diode is used as a one-way check valve. Since these diodes only allow electrical current to flow in one direction, they are used to convert AC power into DC power. When constructing a rectifier, it is important to choose the correct diode for the job; otherwise, the circuit may become damaged. Luckily, a 1N4007 diode is electrically compatible with other rectifier diodes, and can be used as a replacement for any diode in the 1N400x family.

Figure 3.10: Diode

1N4007 1000V 1A General Purpose Diode.

Features

- Peak Repet. Reverse Voltage (Vrrm): 1000V
- Max. RMS Reverse Voltage (Vr): 700V
- Average Rectified Current (Io): 1.0A
- Max. Reverse Current (Ir): 0.01mA
- Max. Forward Voltage Drop (Vf): 1.1V

3.14 Easy EDA Software

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share publicly and privately and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

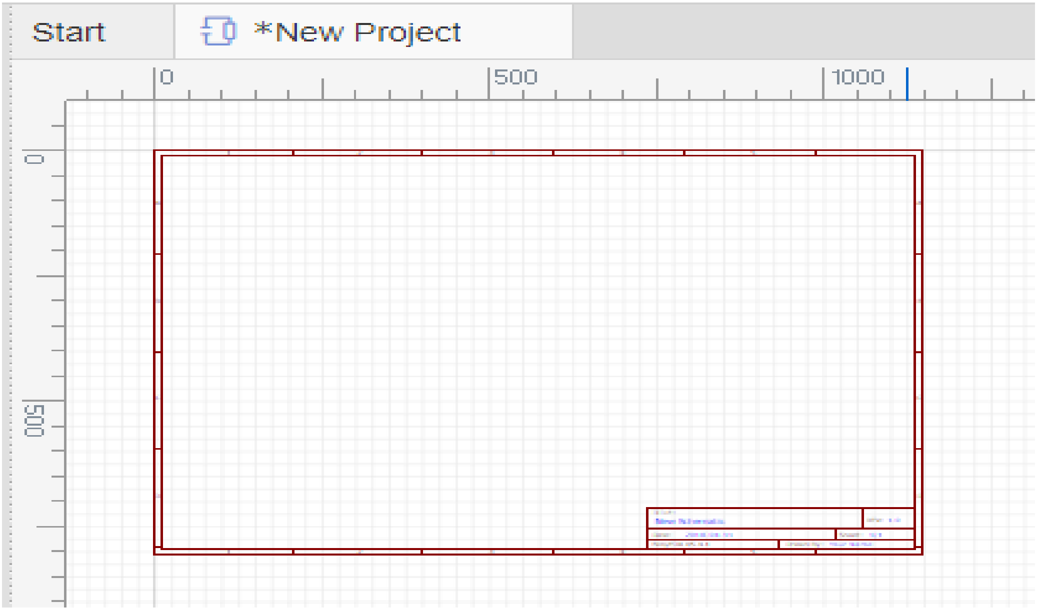

Figure 3.11: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription. Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

Chapter 4
Result and Discussion

4.1 Result

Now, it's time to talk about the results. We have written our commands using the Arduino IDE and the following things can happen:

- We install our system in road side .
- When a vehicle goes in-front of this vertical turbine then it will rotate.
- Then generator motor create some charge and it store in a battery.
- And we use it to road indication light.

* Mathematical Calculation :

When average wind speed is 5m/s & density of air is normal

The Generator motor induced voltage is V= 0.85 V

Current I= 0.24 Amp

Power P= VI

= 0.85* 0.24= 0.204 watt

4.2 Advantages

There are many advantages of our system because of its accuracy. Some of the advantages are pointed out below:

- Simple air produce more power.
- No extra cost include here.
- No Oil consumption
- Less skill technicians is sufficient to operate.
- Installation is simplified very much.
- Less time and more profit.
- Simple construction.

4.3 Limitations

Though this project has many advantages but it has some limitations as well and they are listed below:

- Used cheap Chinese products for the prototype so there’s some processing delay present in the circuit
- This project can now be only used for small scale purposes
- In air shortage situation it will not produce energy.

4.4 Application

The application areas for this system in this modern and practical world are huge and some of these are given below:

- It can be used for natural power generation.
- It can used in road side.
- It can use alternative power generator.

4.5 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

Chapter 5
Conclusion

5.1 Conclusion

By using this technology all the highways can be indicator lightened without use of non- renewable energy resources. Also, if this method is implemented in all national highways it can able to produce large amount of power. And it can also provide job for many educated fellowship. By increasing numbers it can develop more energy & light up the highways so that the percentage of accidents gets minimized.

5.2 Future Scope of Study

As we have already discussed about the limitations of this system so definitely there's room for improvement and thus we have lots of future scope of work available to us for this system. Some of these are listed below:

- We can add a more power generator option in future.
- In future we can use various sensor to measure current, voltage and frequency from this system.
- In future we can add lot load control which can control this load with lot far away from home.

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