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IOT Based Vertical Axis Wind Turbine

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ABSTRACT

VAWTs, or vertical axis wind turbines, are a special kind of power generation technology. Because of their "yaw-less" construction, they have historically been limited to serving a tiny niche market in commercially accessible wind turbines. When compared to their Horizontal Axis Wind Turbine (HAWT) counterparts, current VAWT designs are less efficient in terms of power coefficient. New study, however, indicates that these wind turbine kinds would be more appropriate for wind farm deployments than earlier than previously believed. VAWT farm research will be examined and discussed in this chapter. An overview of the various VAWT design criteria will then come next, with an emphasis on designs that can be installed in an optimal wind farm. One of the unconventional energy sources is wind energy.This project aims to utilize this wind energy in the most effective manner to get the maximum electric output, and therefore we selected the highway as our installation site where the moving cars on both sides of the road can be used to our advantage. In the present work, the turbine is designed and fabricated as per the specifications, the blades used are semi-circular in shape and are connected to the disc which is connected to the shaft. The shaft is then coupled with a pulley with the help of a bearing, and then the pulley is connected to the alternator, which generates the power. The power developed is stored in the battery and can then be used for street lights, signals, or tolls. In this project, a small model has been created for testing purposes. 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.

KEYWORDS;- *Vertical Axis, Wind Energy, AT89C52 microcontroller, ADC0808, Batteries.*

I. INTRODUCTION

Vertical axis wind turbines (VAWT) do not require any adjustments because the blades rotate on a fixed axis perpendicular to the ground, regardless of the direction of the wind. On the other hand, this will reduce the efficiency of the wind turbine compared to HAWT because the blades will pass through aerodynamic dead zones during rotation, simply because they do not always point towards the wind. Especially for small projects in cities, VAWTs are more attractive than HAWTs because they produce less noise. It is also more suitable than HAWT in areas with strong winds or rapid environmental changes Additionally, VAWT is easier to maintain than the horizontal model because it can be done on the ground. The fact that VAWT is not a self-starting machine is one of its drawbacks.However, this problem can be solved after connecting to the grid, because the generator can be used as a generator to drive the rotor in the first case.

Vertical Axis Wind Turbine

Savonius wind turbine

Vertical Axis Wind Turbine Savonius Wind Turbine Savonius Wind Turbine was built in 1922 by Sigurd Johannes Savonius. However, these turbines are the simplest of the self-powered vertical axis wind turbines. From an aerodynamic perspective, they are cabin type units with two or three buckets. The differential motion causes the Savonius turbine to rotate. Some designs feature long spiral buckets to provide uniform torque. Since most of the swept area of all the Savonius rotor is close to the ground, the total power draw becomes ineffective due to the low wind speed at low altitude. Savonius says its best rotor tops out at 31 percent efficient-efficiency, while the standard model tops out at 31 percent. It turns out to be 37 percent. After Savonius, Newman, Sivasegaram and Khan conducted many experiments to study the effect of geometric parameters such as different teeth, overlapping etc. The most common application of Savonius wind turbines is in ventilation systems, usually on the roofs of pickup trucks and buses, where they are used as air conditioning units.

Darrieus wind turbine

The first attempts to generate electricity were made in the late 19th century and became more frequent in the first half of the following century. The Darrieus machine was invented in 1925 by G.J. It was invented and patented by. The French engineer Darrieus, who still gives his name to the best-known and most common type of VAWT. The Darrieus wind turbine is a VAWT designed to generate electricity from the energy carried by the wind. Darrieus wind turbines can rotate at high speeds with low power and can be used in small pumps and small generators. The efficiency of Darrieus type turbines is below 10% [7]. In some designs, the blade is angled in a spiral shape, distributing the force evenly throughout the rotation and thus preventing damage from vibrations. Modifications of Darrieus turbines are Giromill and Cycloturbines. The main advantage of this design is that the power output is nearly constant over a wide angle and has the advantage of self-starting by "moving the flat blades upwind" against the block wind to create drag and start the turbine engine. rotates at low speed. The disadvantage is that the wing pitch mechanism is complex and often heavy, requiring the addition of a wind direction sensor to adjust the wing pitch correctly. Composite rotors are often one of many ways to improve and overcome the low starting torque problem of Darrieus wind turbines. Although the power coefficient of the Savonius rotor is lower than the Darrieus rotor, its main features are high starting torque and low-speed self-starting. It works by generating a large starting force from the Savonius rotor but at a higher speed compared to the Darrieus rotor.

II. LITERATURE SURVEY

[1] Robert Howell et al. Presents a study on the aerodynamics and performance of small vertical axis wind turbines (VAWT). Straight-blade vertical axis wind turbines have the key advantages of simple appearance, ingenious structure and unaffected by wind direction, and are increasingly used in rural and marine environments. However, improving the performance of straight-blade vertical axis wind turbines is still difficult due to their complex aerodynamic properties.

[2] Mohammad Mahmood Aslam Buta et al. The design process for VAWT design was investigated. VAWTs are arranged closely together to form a better array than VAWTs operating alone. Current studies on VAWT arrays mostly focus on the non-ideal configuration of the VAWT, while little attention is paid to the real-time control of a rotor in the VAWT array. This study first investigates the sound quality control in the dual VAWT process. Due to the interaction between adjacent turbines, the noise control curve of the vertical axis wind turbine in the array must vary with the inlet conditions at different locations.

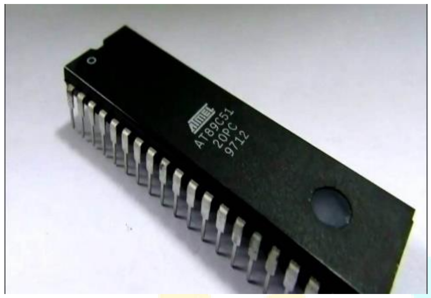
[3] Rakesh Kumar et al. Based on the latest knowledge on the subject, several recommendations are made for future research and adoption of wind turbines in cities. It is concluded that further research is required to make VAWT a feasible, reliable and affordable power generation system for many low power and energy distribution applications.

[4] Research by Senad Apelfrojd et al. The first is the flow tube model, which is a very quick way to measure turbine performance. This method was used to examine how turbine surface slopes affect turbines and how the effects of strut loss affect turbine performance and design. The second method used is the vortex method, which is a time-dependent model suitable for more complex situations. We have seen how to use conformal grids for accurate thread calculations. Just as the eddy current method is used to calculate the effect of flow restriction on turbine performance, it can also be used to calculate the efficiency of power plants with vertical axis turbines.

[5] The research and results conducted by Saurabh Arun Kulkarni and his colleagues are very encouraging that vertical axis wind energy conversion is possible even in ideal low-sitting conditions and can help in using wind to generate clean electricity. With the highway idea, it will have the power to light the way. In many cities, highways are the fastest way to travel every day and require constant sunlight, making them very useful for generating natural energy.

III. Component Selection and Functionality in the Vertical Axis Wind Mill

- **ADC0808**



- The ADC0808 is a single-chip CMOS device with the ADC0809 data acquisition device, 8-bit analog-to-digital converter, 8-channel multiplexer, and microprocessor-compatible control logic. 8-bit A/D converters use a full predictive conversion process. The converter features a high-impedance chopper-stabilized ratio, a 256R voltage divider with analog switch tree, and sequential approach registers. The 8-channel multiplexer provides direct access to each 8-channel analog signal. Latched and decoded multiplexer address inputs and latched TTL TRI-STATE® outputs provide easy interface to microprocessors. Optimized in the most desirable way. ADC0808, ADC0809 have the characteristics of high speed, high accuracy, low temperature dependence, excellent long-term and repeatability and low power consumption. These features make the device suitable for applications such as process and machine control for consumer and automotive applications. See the ADC0816 documentation for a 16-channel multiplexer with output (sampling/hold port).

FEATURES

Easy to interface with all microprocessors
Operate proportionally or adjust voltage using 5 VDC or analog scale
No reset or full adjustment required
8-channel multiplexer with address application- 0V to 5V input range, 5V supply driven
Output meets TTL voltage level specifications
Standard sealed or molded 28-pin DIP package
28-pin molded Chip Carrier Package
Equivalent to ADC0808 MM74C949
ADC0809 MM74C949 is equivalent to -1

- **Microcontroller: AT89C52**

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash Programmable Erasable Read-Only Memory (PEROM). The device uses Atmel's high-density non-volatile memory technology and is compatible with industry standard 80C51 and 80C52 instruction sets and pinouts. On-chip flash memory allows program memory to be reprogrammed in the system or in a regular non-volatile memory programmer. Combining the versatile 8-bit CPU with memory on a single chip, the Atmel AT89C52 becomes a powerful microcomputer that provides flexibility and cost-effectiveness for many applications, making it a good solution implementation.

Features:-

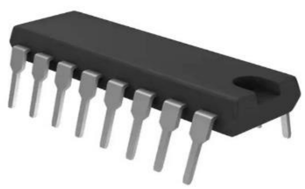
Compatible with MCS-51 products
8K bytes in-system reprogrammable flash memory
Endurance: 1,000 write/erase cycles
Full static operation: 0 Hz to 24 MHz

Level 3 program memory lock
256 x 8-bit RAM
32 programmable I/O lines
Three 16-bit timers/counters
Eight interrupt positions
Programmable serial channels
Low power idle and power shutdown mode

- **Wi-Fi Module: ESP8266**

The ESP8266 is a key component enabling our smart notice board to connect to a Wi-Fi network and achieve remote communication. This highly-integrated chip from Espressif Systems offers a cost-effective and feature-rich solution for wireless connectivity in IoT projects. Here's a closer look at the factors that influenced our decision to utilize the ESP8266 in this project:

Wi-Fi Connectivity: The ESP8266 integrates a complete Wi-Fi transceiver, enabling the notice board to connect to a wireless network. This allows for remote updates of the displayed message content and potential interaction with the board through a web interface or mobile application (depending on future software development).



Microcontroller Unit (MCU): The ESP8266 incorporates a Tensilica Xtensa LX106 core, essentially an embedded microcontroller unit (MCU) within the module. This MCU offloads Wi-Fi networking tasks from the main AVR ATmega8 microcontroller, improving overall system efficiency and allowing the ATmega8 to focus on core processing functionalities.

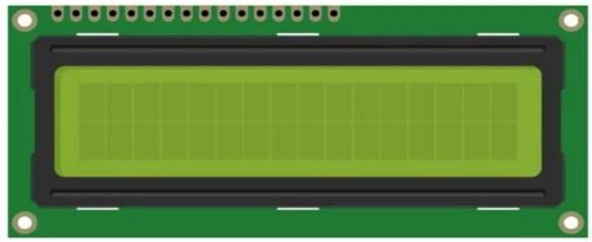
TCP/IP Stack: The ESP8266 comes pre-loaded with a TCP/IP stack, which manages communication protocols essential for internet connectivity. This eliminates the need for implementing complex networking protocols in the ATmega8 program, simplifying software development for the project.

Cost-Effectiveness: Similar to the ATmega8, the ESP8266 is a budget-friendly Wi-Fi module solution. This aligns with the goal of creating a cost-efficient smart notice board system.

Low Power Consumption: The ESP8266 offers various operating modes that optimize power consumption based on the required functionality. This is crucial for potentially deploying the notice board in battery-powered scenarios.

- **Seven Darlington Arrays**

ULN2001A, ULN2002A, ULN2003, and ULN2004A are high-voltage, high-current Darlington arrays that have seven open-collector Darlington pairs, each with a common emitter. Each channel is rated at 500mA and can withstand a maximum current of 600mA. Reaction diodes are used to drive inductive loads, and the input and output are set to make the board easier to install. These versatile devices can be used on or drive a variety of loads such as solenoids, relay DC motors, incandescent lamps with LED displays, thermal print heads and high-power pads. to give. They are also available in small packages (SO-16) such as ULN2001D/2002D/2003D/2004D.



- **16 x 2 LCD Display**

The term LCD means liquid crystal display. It is an electronic device widely used in many circuits and devices such as mobile phones, computers and televisions. The main benefit of using this mode is its low cost; easy programmability, animation and the ability to create special symbols, custom features and even animations etc. No restrictions on viewing.

Pin1 (Ground/Source Pin): It is the GND pin of the monitor and is used to connect to the GND terminal of the microcontroller unit or power supply. Connect the supply pin of the power supply. Control pin): This pin switches between command or data recording and is used to get 0 or 1 (0 = data mode, 1 = command mode) by connecting to the microcontroller unit pin. /write/control pin): This pin changes the representation of the read or write operation, it is connected to the microcontroller pin to get 0 or 1 (0 = write operation, 1 = read operation). Pins 7-14 (data pins): These pins are used to transfer data to the display. These pins are connected by two wires such as 4-wire type and 8-wire type. In 4-wire mode, only 4 pins from 0 to 3 are connected to the microcontroller unit, while in 8-wire mode, 8 pins from 0 to 7 are connected to the microcontroller unit. (+ve pin of microcontroller LED): This pin is connected to +5V Pin 16 (-ve pin of LED): This pin is connected to GND.

Features :-

5 x 8 dots with cursor
Onboard controller (KS 0066 or equivalent)
+5V power supply (can also be used with +3V)
1/16 duty cycle
B / L Pin 1, Pin 2 or Pin 15, Pin 16 or A.K (LED)
N.V. optional +3V power supply

- **DC Generator**

Permanent magnet DC generators actually mean that they use permanent magnets to provide the magnetic field needed to generate electricity. This type is not widely used because it is difficult and inexpensive to make permanent magnets large enough to produce significant results. The use of permanent magnets is still ineffective as it is not possible to replace the magnets required to control the output of the generator. Therefore, the use of this type of generators is limited to situations where lower emissions are achieved. Some uses for this are electronic tachometers, electronic manuals, and large electronic components for large transformers.

- **Voltage Sensor**

Numerous items are monitored and controlled by voltage sensors. Both consumer goods and industrial equipment can use them.Their advantages include: 24/7 monitoring of equipment Alerts if voltage data is critical (too high or too low) Their degree of accuracy for voltage monitoring is high Generally are environmentally friendly Since it monitors and stops overheating or underpowering, it can help you save money on electrical circuits and equipment.

- **Relay**

Relays are electromechanical switches that are used to control high-power electrical devices by using a lowpower signal. They are crucial components in various applications, especially where low-voltage control circuits need to control high-voltage circuits. Here's some information about relays: Basic Structure: - Coil: When energized, it generates a magnetic field. - Contacts: These are the switch terminals that open or close when the relay is activated. - Enclosure: Houses the coil and contacts, protecting them from external elements. Working Principle: - Electromagnetism: When a low-voltage signal passes through the coil, it creates a magnetic field that attracts or repels the contacts, either opening or closing the circuit. - Isolation: Relays provide electrical isolation between the control circuit and the circuit being controlled, preventing damage to control devices from high voltages or currents.

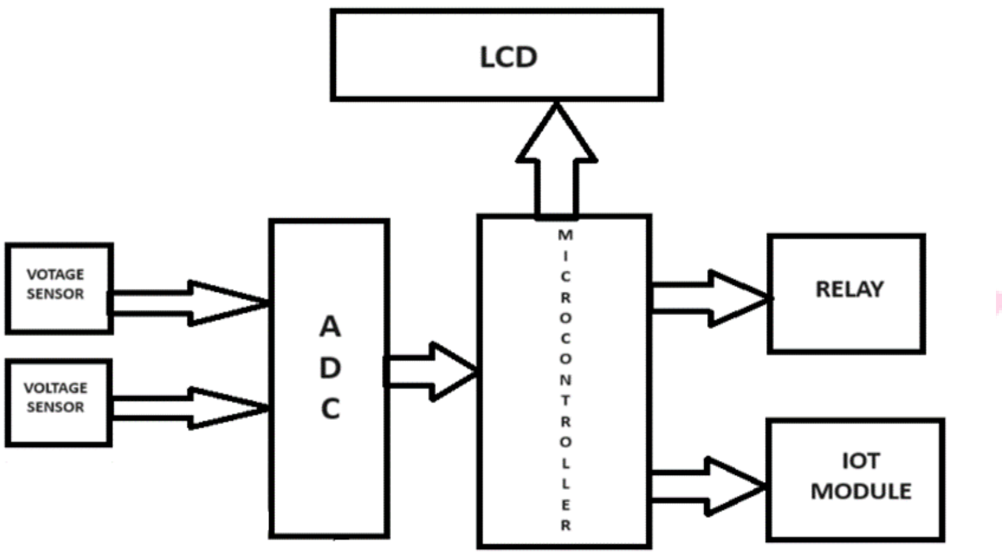
- **Battery**

Batteries are electrochemical devices that use a chemical reaction to store and produce electrical energy.They are crucial components in a wide range of applications, powering devices from small electronics to electric vehicles. Here is some fundamental information about batteries:

Basic Structure: - Batteries typically consist of one or more electrochemical cells. Each cell comprises positive and Page 34 of 44 negative electrodes, an electrolyte, and a separator. The chemical reactions between the electrodes and the electrolyte generate electrical energy.

Chemistry: - Batteries come in various types based on their chemistry. Common types include: - Alkaline Batteries:Often used in household devices. - Lithium-ion Batteries:Widely used in portable electronics and electric vehicles. - Lead-Acid Batteries: Commonly used in automotive and uninterruptible power supply (UPS) systems. - Nickel-Metal Hydride (NiMH) Batteries: Found in some rechargeable applications.

IV. Block Diagram: Depicting the Overall System Flow



The block diagram presented above illustrates the functional architecture of our IoT-based Vertical Axis Wind Mill. It comprises several key components that interact to achieve renewable energy and display the energy obtained on the LCD. Here's a breakdown of the core blocks and their functionalities:

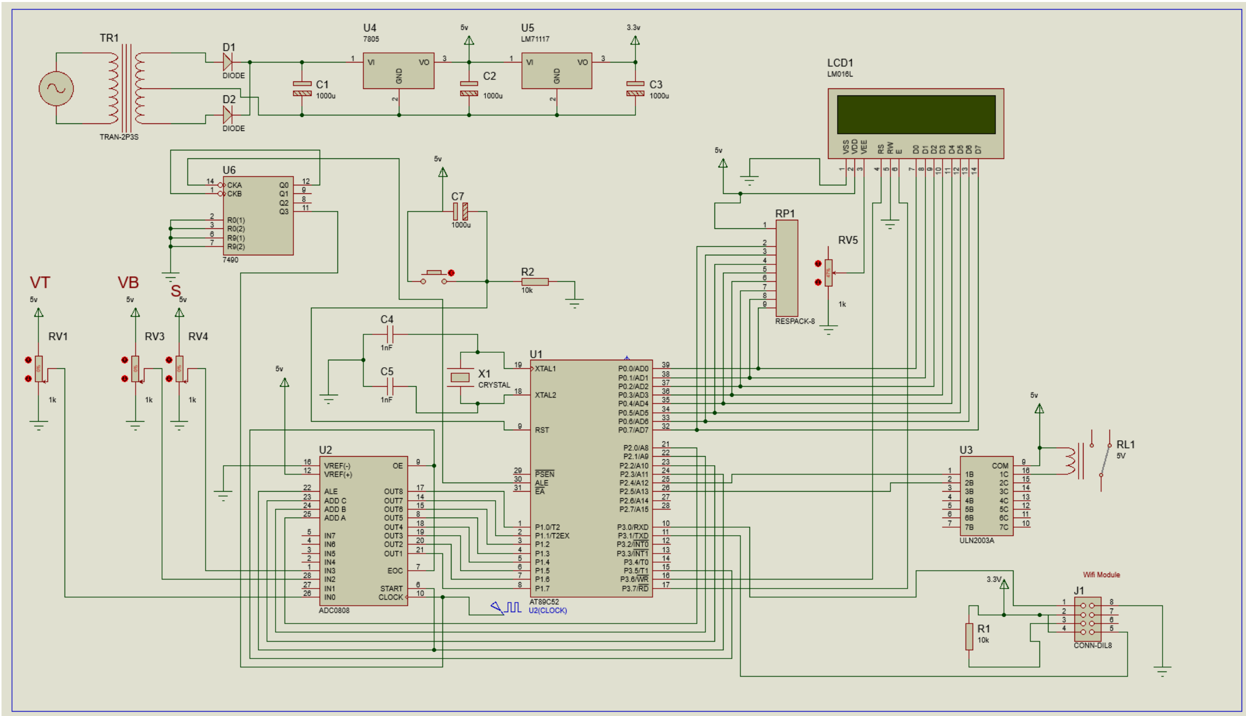
LCD Display: LCD displays work by using individual pixels to display visuals, moving or stationary. The RGB color filter will mix each pixel's display color, with each color's filter corresponding to one of the pixel's sub-pixels.The sub-pixels are where the degree of light is determined, thus affecting the degree of prominence of its respective color. And it collects the information from the microcontroller and it displays it on the screen.

Microcontroller AT89C52: AT89C52 is an 8-bit microcontroller and belongs to Atmel's 8051 family. The AT89C52 features 256 bytes of RAM and 8KB of programmable and erasable read-only memory (PEROM) in Flash. The AT89C52 may be wiped and programmed up to 1000 times thanks to its endurance of 1000 Write/Erase cycles. It performs the code and manages the information from the sensors.

Microcontroller ADC0808: ADC0808 is an 8 bit analog to digital converter with eight input analog channels, i.e., it can take eight different analog inputs. Using three address lines, the input to be transformed to digital form can be chosen. The Vref+ and Vref- pins can be used to set the voltage reference. It converts the information from the sensors from analog to digital and provides the correct readings.

Wi-Fi Module ESP8266: The ESP8266 Wi-Fi module enables wireless communication between the wind mill and a Wi-Fi network. It receives data and content updates from a remote source (e.g., web application or mobile application) via the Wi-Fi connection . It communicates with the microcontroller unit (MCU) to exchange information.

V. CIRCUIT DIAGRAM



The circuit diagram presented above depicts the internal hardware connections and component interactions within the Vertical Axis Wind Turbine. Here's a breakdown of the key components and their functionalities based on the circuit:

Power Supply Circuit (VCC and GND Rails): The circuit receives AC input power(230V, 50Hz).

Transformer(TR1): This is a 12-0-12V,1A center-tapped step-down transformer. The transformer acts as a step-down transformer reducing 230VAC RMS to 12VAC RMS.

Diodes(D1 and D2): Two 1N4007 diodes are used to form a full wave rectifier which converts 12V AC to DC.

Capacitors (C1-C7): These capacitors are placed at various points in the circuit, typically near the power supply and each IC, to filter out electrical noise and ensure a clean, steady voltage supply for the components.

Microcontroller Unit (MCU) AT89S52: The AT89S52 microcontroller is the central processing unit (CPU) of the system.

ADC0808: The ADC 0808 facilitates the conversion of analog signals from sensors into digital form for processing by the microcontroller. It acts as an intermediary, capturing real-world data and transforming it into a format understandable by the digital system. Through its precise analog-to-digital conversion, it enables the microcontroller to make informed decisions based on the received sensor inputs.

Crystal Oscillator (X1 and Associated Capacitors): This section provides a clock signal that regulates the timing of the microcontroller's operations. The specific frequency of this clock signal is determined by the crystal and its capacitors.

Reset Circuit: The pushbutton switch and resistor form a reset circuit. Pressing the button momentarily resets the microcontroller, which can be useful for troubleshooting or restarting the system.

Relay: The relay serves as a safety mechanism by interrupting power transfer to the battery when the voltage surpasses the predetermined limit, safeguarding against potential damage or overcharging.

Wi-Fi Module ESP8266: The ESP8266 Wi-Fi module enables wireless communication between the microcontroller and a Wi-Fi network.

VI. DESIGN METHODOLOGY

Developing an Vertical Axis Wind Mill involves careful consideration of hardware components, software development, and system integration. Here's a breakdown of the design methodology employed for this project:

- **System Requirements Definition:**

The initial stage involved defining the core functionalities and desired features of the Vertical Axis Wind Mill. This included: Remote content updates via Wi-Fi , LCD to display the measurements obtained and functionality of the relays to act as switches.

- **Hardware Selection:**

Based on the defined requirements, suitable hardware components were selected. Key factors considered included:

Microcontroller Unit (MCU) AT89S52: The AT89S52 microcontroller is the central processing unit (CPU) of the system.

ADC: The ADC 0808 facilitates the conversion of analog signals from sensors into digital form for processing by the microcontroller. It acts as an intermediary, capturing real-world data and transforming it into a format understandable by the digital system. Through its precise analog-to-digital conversion, it enables the microcontroller to make informed decisions based on the received sensor inputs.

Relay: The relay serves as a safety mechanism by interrupting power transfer to the battery when the voltage surpasses the predetermined limit, safeguarding against potential damage or overcharging.

Wi-Fi Module: The ESP8266 offered a cost-effective and feature-rich Wi-Fi connectivity solution with an integrated TCP/IP stack.

DC generator: DC generators actually mean that they use permanent magnets to provide the magnetic field needed to generate electricity.

LCD Display: 16 X2 displays mostly depend on multi-segment LEDs. There are different types of displays available in the market with different combinations such as 8×2, 8×1, 16×1, and 10×2, however, the LCD 16×2 is broadly used in devices, DIY circuits, electronic projects due to less cost, programmable friendly & simple to access

- **Circuit Design and Schematic Development:**

A circuit diagram was created using schematic capture software. This diagram depicted the connections between all the chosen components, including power supply ,LCD Display, Relays, ADC0808, AT89C52, capacitors,transformer, and communication interfaces (SPI for ESP8266).

- **Software Development:**

The software development process involved :

Proteus: The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. Depending on the scale of designs being generated and the needs for microcontroller simulation, it can be acquired in a variety of configurations. An autorouter and basic mixed mode SPICE simulation capabilities are included with all PCB Design solutions.

Diagrammatic Recording With the Proteus creation Suite, schematic capture is used for PCB layout project creation as well as design simulation. As a result, it is an essential part that comes with every product configuration.

System Integration and Testing:

Once the hardware components were assembled based on the circuit diagram, and the software was developed, the system integration phase began. This involved: Programming the AT89C52 microcontroller with the developed firmware. Connecting all the hardware components according to the circuit design. Testing the functionality of individual components and overall system operation. This might involve verifying Wi-Fi connectivity, data transmission between the sensors and the microcontroller, and the proper display of content on the LCD display.

- **Refinement and Iteration:**

Based on the testing results, the design might undergo refinement. This could involve software code adjustments, hardware component replacements (if necessary), or user interface improvements. The iterative development process ensures the final system functions as intended and meets the desired user experience.

VII. CONCLUSION

This research paper presented the design and development of a Vertical Axis Wind Turbine. The system utilizes an AT89C52 microcontroller for core processing, an ESP8266 Wi-Fi module for wireless communication, voltage sensors to measure the energy generated, relays to prevent over charging and battery draining , a generator for the wind mill and a LCD display for dynamic information presentation. The hardware components were carefully selected based on their functionalities and cost-effectiveness. A detailed circuit diagram was created to illustrate the connections and interaction between these components. The design methodology emphasized a systematic approach, encompassing requirement definition, hardware selection, circuit design, software development, system integration, and testing. Wind energy is the most popular alternative energy source because it is a clean, emission-free energy production technology and is based on harvesting energy from natural sources without the harmful emissions associated with fossil fuels. Wind turbines are machines that convert the kinetic energy contained in the wind into energy. Modern wind turbines are divided into two main types according to their rotation: HAWT and VAWT. The performance of VAWT largely depends on the aerodynamic properties of the wings. Propeller wind turbines with blades that are thinner than straight blades. This is because wind turbines have a high coefficient, which allows them to capture wind energy. These types of wind turbines are efficient and can produce electricity better at low wind speeds. The new turbine has a simple structure and can be constructed using simple tools and inexpensive materials, Composite rotors are often one of many ways to improve and overcome the low initial speed problem of Darrieus wind turbines.

VIII. FUTURE SCOPE

The developed Vertical Axis Wind Turbine prototype presents a promising foundation for further exploration. Here are some potential areas for future development:

Urban Environments: VAWTs are well-suited for urban areas due to their ability to capture wind from any direction and their compact design. They can be integrated into cityscapes, on rooftops, and in other constrained spaces, providing a localized source of renewable energy.

Offshore Applications: VAWTs may find applications in offshore wind farms, particularly in regions where water depths or seabed conditions make the installation of traditional horizontal axis turbines challenging. Their unique design could offer advantages in certain offshore environments.

Innovative Blade Materials and Designs: Research into advanced materials and aerodynamic designs for VAWT blades could significantly improve their efficiency and performance. Lighter, more durable materials could enhance energy capture and reduce maintenance costs.

Vertical Integration with Energy Storage:Integrating VAWTs with energy storage technologies, such as advanced batteries or pumped hydro storage, can help address the intermittent nature of wind energy. This would enhance the reliability and stability of VAWT-generated power.

Vertical Axis Wind Turbines for Distributed Energy Generation: VAWTs can play a significant role in distributed energy generation systems, where power is generated close to the point of use. This can reduce transmission losses and improve grid resilience.

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