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Design and Implementation of wind energy conversion system using LabVIEW

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Abstract— *There is developing enthusiasm for sustainable power source far and wide. Since most sustainable sources are irregular in nature, it is a testing undertaking to incorporate sustainable power source assets into the power lattice foundation. Accordingly, it is required to overhaul techniques and methodologies for plan and usage of WECS. Considering WECS as digital physical frameworks will empower twist vitality for the Internet of Energy. This paper presents possibilities of digital physical reconciliation of cutting edge WECS. Likewise this paper additionally studies the difficulties and advancements that empower WECS for IoT. At long last we diagram inquire about difficulties and conceivable arrangements about the correspondence framework for the reconciliation of sustainable power source asset.This paper proposes demonstrating the quickly advancing vitality frameworks as Wind Energy Conversion Systems.*

Index Terms— Internet of Energy (IoE), Internet of Things (IoT), LabVIEW, Wind energy, wind energy conversion systems (WECS).

I. INTRODUCTION

Wind vitality has the greatest piece of the pie of sustainable power source the world over. In spite of basic portrayals of present day wind vitality innovation as develop, there remains a tenacious disengage between the unfathomable worldwide wind vitality asset which is 20 times more noteworthy than aggregate worldwide power utilization and the constrained infiltration of existing wind vitality advancements as a methods for power era around the world. A way to deal with wind vitality reaping that can possibly resolve this distinction by geologically dispersing wind control generators in a way that all the more nearly mirrors the physical asset itself is required. The world's power request will develop by 50 percent throughout the following 20 years, and individuals need to arrive by utilizing solid, reasonable, and practical power. The world has driven advanced sending focuses of wind vitality. Worldwide development of wind vitality forces mechanical headways, for example, huge scale, seaward, gliding, and floating wind turbines. Sending these outlines, highlights requirement for more inflexible and complete techniques for harmless secure savvy systems for framework, establishment, operation, and upkeep. Because of stochastic environment of the wind control procedure, changes and unwanted element varieties in collected power are huge difficulties that face wind strength. What's more, a rotation turbine at high instability may encounter harming impacts like exhaustion and outrageous burdens. In this manner, wind turbine control frameworks fundamentally focus on the financially understanding catch of vitality, i.e., to empower effective era of vitality with few potentials by relieving burdens to figure the lifetime of the turbine and lessen support price. These destinations require unpredictable and proficient governing methodologies [1].

Vitality business and leaders are confronting many difficulties because of the expansion in vitality request and short supplies of non-renewable energy sources. These difficulties require the adjustment of creative answers for proficient and dispersed vitality generation, administration, and utilization. Concerning wind vitality, the present advances of wind vitality change framework (WECS) plans are moving from brought together and traditional structures to decentralized, conveyed, and more intricate ways to deal with match distinctive vitality generation necessities, utilization requests, and varieties in ecological conditions [1].

For a wind farm, amplifying power yield is clearly fundamentally imperative. A powerful and reliable

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registering stage is one of the keys to guaranteeing productive power era together with cutting edge programming to control the wind turbine and react to alter in wind speed and course. Constantly basic device status to guarantee they are working accurately. This enables administrators to take proper steps at an early stage and avoid turbine downtime. What's more, if the PC distinguishes an irregular circumstance, it sends a ready, so that auspicious repair and support can limit misfortunes.

Communicating continuously with the remote control focus, permitting the control focus to modify turbine cutting edge pitch edges and different parameters as indicated by changes in wind speed, wind heading and different conditions. As issues here and there go unnoticed by standard visual investigations, when issues happen, a sensor distinguishes the principal indications of potential harm and the PC makes an impression on the control focus. This warning permits maintenance staff to take appropriate steps at an early stage and to stay away from turbine failure. For significant issues, an alert sent to the control focus continuously enables staff to close down the turbine instantly, avoiding edge harm [4].

Understanding the Internet of things (IoT) idea, wind turbine farms include a large number of devices associated inside and remotely by a smart computing stage. Locally available industrial PCs permit all wind turbines inside a farm to speak with each other, sharing information to modify course and speed. A wind turbine not just changes its heading and speed in view of the climate, additionally representing the conduct of other wind turbines. This approach augments control era effectiveness without requiring human supervision.

Internet of things

IoT means covering the web pattern to the link, observing, and governor of the objects of day-to-day life. The famous structures of Internet uses will then become reachable for both human-to-machine and also machine to machine communications [1].Internet of Things is an arrangement of physical question that includes sensors, programming and electronic gadgets which can talk with each extraordinary and furthermore with customers. It is rapidly progressing a result of the joining of information and correspondence headways and the web. Web of Things gives dissents the capacity to remember it, see the enveloping data, interface with servers over the web and take off inquiries to change their state.

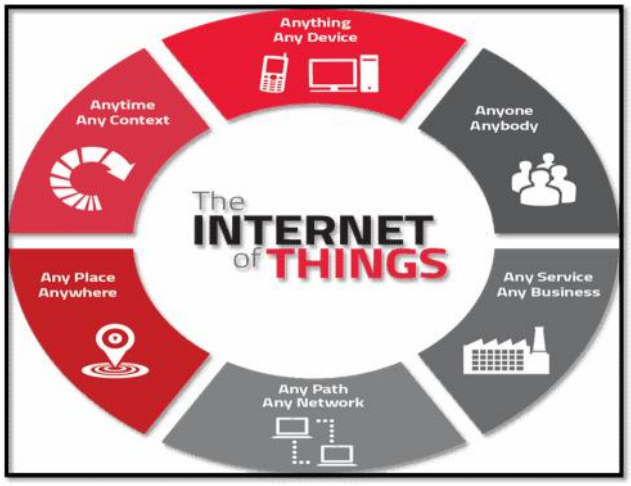

Figure 1: Internet of Things

The Web of Things is a new model change in IT ground. The saying Internet of Thing which is created from the two words i.e. the initial word is Internet and the following word is Things.

Internet of energy

Internet of Energy for Electric Mobility extend (IoE) is creating equipment, programming and middleware for consistent, secure network and interoperability by interfacing the Internet with vitality frameworks to make an electric portability foundation. Internet of Energy (IoE) alludes to the updating and robotizing of power frameworks for vitality makers. This enables vitality generation to push ahead more effectively and neatly with minimal measure of waste [8].

This paper present smart wind mill system monitored by LabVIEW, also introduces abilities of cyber-physical incorporation of next generation wind energy conversion system. LabVIEW software has the capability to monitor the significant processes in the system and makes the operators to be aware of the changes in the system. The user is able to collect, analyze and monitor data using internet of things and LabVIEW platform. Thus the efficient grid system can be recognized and installed more in number than installing many number of different configuration grid systems. First part of project presents monitoring various parameters such as voltage, current, power, energy, RPM, power coefficient etc

from yaw of nacelle to torque of generator and the speed blade tips. All the monitored parameters from wind turbine are extracted and sent to cloud wirelessly through WiFi module.

The second part of project deals with communication i,e web connection. The communication can be done through application software which namely react and cloud.

II. PROPOSED SYSTEM

The proposed framework shows the Wind mill simulation System. From a profound knowledge into layers of wind energy conversion system, they can be considered as intricate advances with installed embedded systems.

A. Simulation model of wind turbine

Physical segments of wind system contain nacelle, edges, rotor center point, and tower establishments. The nacelle incorporates generator, shafts, gearbox, and other mechanical and electrical frameworks. These parts have to be checked, analyzed and monitored through a mass of functional blocks in LabVIEW. For each parameter inside windmill logic has to be created .Graphical blocks as control and indicators as input and output has to be designed and are connected through set of wires and the code is made to run.

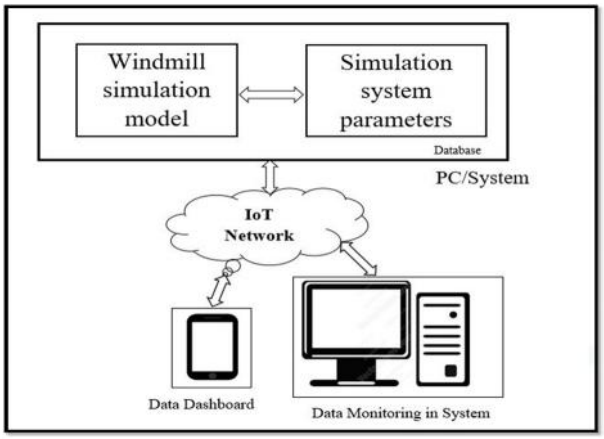

Figure 2: Wind mill simulation system

B. LabVIEW

LabVIEW gives administrations and capacities to WECS that surpass straightforward checking and monitoring of wind turbines. Research facility Virtual Instrument Engineering Workbench is an outline stage and advancement condition for a visual encoding language from National Instruments. The graphical language is called "G", not to be misguided for G-code. Formerly released for the Apple Macintosh in the year 1986, LabVIEW is generally used for information procurement, instrument device, and mechanical computerization on a variety of working framework, including Microsoft Windows, diverse interpretations of UNIX, L and macOS. The latest variant of LabVIEW is 2016, released in August 2016 [7].

C. Internet layer

The internet layer in the system joins various hardware and software skills that work together to obtain combined objectives.

D. Networking

Effective sending of WECS requires solid correspondence arranges amid subsystems within a wind turbine. It also attaches deeply embedded devices and intelligent machines for a wind farm. The primary part of systems administration is to give offices to proficient exchange of information and control motions between controls, actuators and information stockpiling stations. The scheme of communication linkages of wind farmhouses, mostly offshore one, has numerous aspects to be considered related to transfer charges and resilience.

E. Control Center

The control center acquires all data samples and monitor the required parameters and data can be stored in server. The relationship of wind system layers, as in figure shows an extraordinary level of heterogeneity and creates a classic system. Considering wind energy system as real time system includes novel layers of adjustment of the innovation and upgrades possibilities of WECS to be incorporated into keen matrices and IoE. Using the LabVIEW software platform, user can observe changes in the system by the LabVIEW front panel monitor screen and in data dashboard.

F. Web connection

Web assembly allows observing the changes and to monitor data using the LabVIEW software database through internet sitting anywhere in the world, in personal computer/Mobile as shown in Figure 2.

III. METHODOLOGY

Figure shows the flowchart of the wind mill system. In the beginning modes are checked to see if it is manual or automatic as two cases are specified.in

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manual mode the user can vary wind speed using a pointer present. In automatic mode pointer varies on itself for various wind speeds. In wind energy system for the wind speed presented if evaluated above, the pitch angle is organized to retain the created yield static so also the rapidity and regularity. A Comparative Integral control with gain K_p and gain K_i is used in pitch direction control loop**.** Comparative integral control is used to match required pitch angle and direction. It will tune generator as well as the wind turbine direction to make sure that required pitch angle and direction is reached or not. Pitch angle being constant the generator power will be converted to per unit values. A per unit value out of normal range is worth looking into for potential errors. Manufacturers usually specify the impedance of apparatus in per unit values. Use of the constant is reduced in three-phase calculations. Per-unit quantities are the same on either side of a transformer, independent of voltage level.

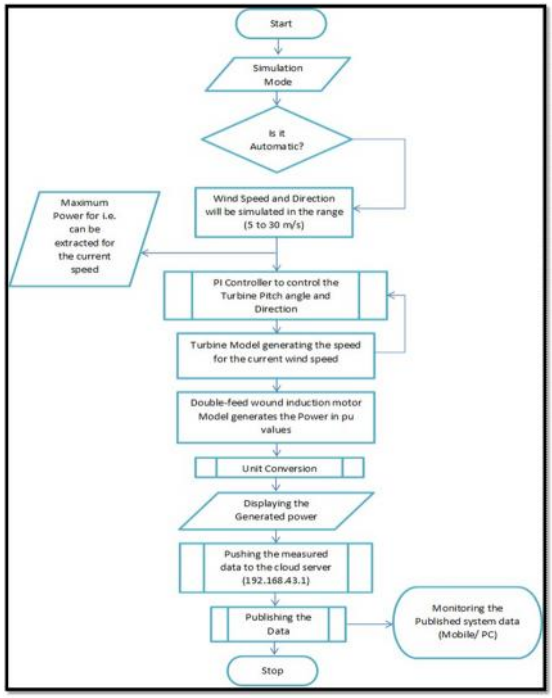

Figure 3: Flowchart

Double feed wound induction motor is used as it loops back power to stator so there is no power loss. Doubly encouraged electrical generators are like AC electrical generators, yet have extra components which enable them to keep running at speeds marginally above or beneath their characteristic synchronous speed. This is helpful for expansive variable speed wind turbines, since wind speed can change all of a sudden. At the point when a blast of wind hits a breeze turbine, the sharp edges attempt to accelerate, however a synchronous generator is bolted to the speed of the power network and can't accelerate. So vast powers are created in the center, gearbox, and generator as the power matrix pushes back. This makes wear and harm the system. In the event that the turbine is permitted to accelerate instantly when hit breeze blast, the burdens are lower and the power from the breeze blast is changed over to helpful power [10].

At the end all the wind turbine data collected and analyzed are displayed and data are sent to cloud server by publishing a IP address and giving the same IP address in other platform such as in PC/mobile the data can be monitored in the same. In this project Data dashboard app designed by National Instruments is used to monitor data of wind turbine in mobile. A data dashboard is a data supervision tool that visually trails, evaluates and shows key performance pointers, metrics and key information ideas to monitor the strength of a business, sector or specific course. They are customizable to meet the detailed needs of a sector and company.

IV. SOFTWARE

Research center Virtual Instrument Engineering Workbench (LabVIEW)" is a framework plan remain alongside extension condition intended to visual programming talk from "National Instruments". It is a "graphical programming condition" with the goal that individuals can make use for quickly manufacturing capacities that is stretched out finished a couple of stages and OSs. The vitality of LabVIEW is in its ability to associate through a numerous gear and materials using extensive characteristic libraries and prebuilt VIs to enliven the progression time and brisk get, examine, and demonstrate data. The graphical dialect is named "G"; ought not to mistake for G-code. sometime prior presentation for the Apple Macintosh in 1986, LabVIEW is reliably taken for data securing, device control, and current robotization on a decision of working framework (OSs), including Microsoft Windows, a determination of variations of Unix, Linux.

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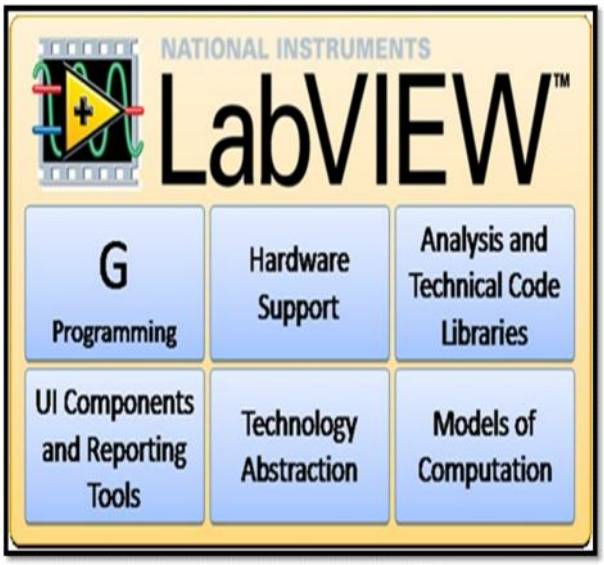
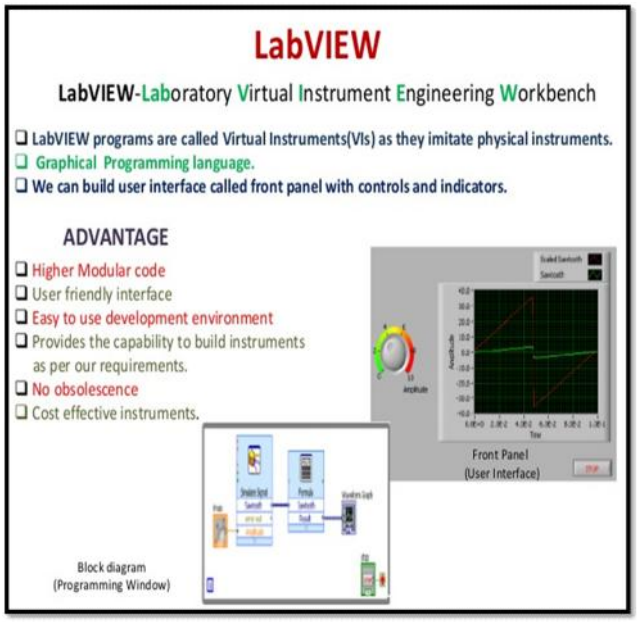


. Figure 3: LabVIEW Valuable Components



. Figure 4: Advantages of LabVIEW

In précis, LabVIEW VIs are graphical, controlled by dataflow and event based programming, additionally multi target and multiplatform gifted. They furthermore have protest arranged flexibility and multithreading and parallelism highlights. LabVIEW VIs can be sent to steady and FPGA items

V. RESULTS

Case 1. When the wind turbine is in automatic mode, it selects speed on its own by varying the pointer and gives out the power output.

Figure 5: Wind turbine in automatic mode

Case 2. When the wind turbine is in manual mode, user need to select speed by varying the pointer to obtain the power output.

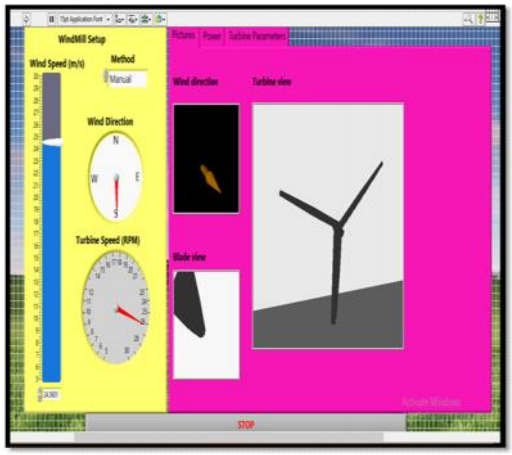


Figure 6: Wind turbine in manual mode

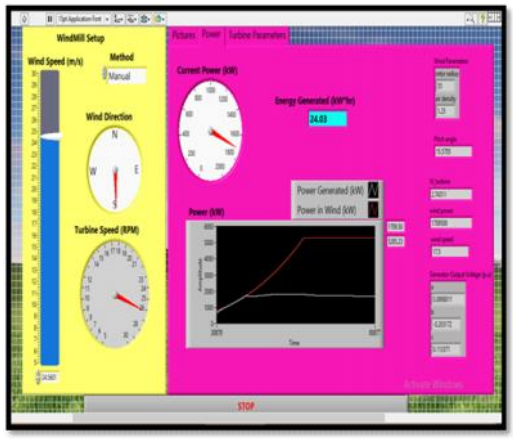


Figure 7: Power generation

International Journal of Electronics, Electrical and Computational System
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As the pointer selects speed as the wind flows, power is generated in the turbine which is turbine power. Rotation per minute, and wind parameters such as rotor radius, air density, pitch angle is obtained for power calculation.

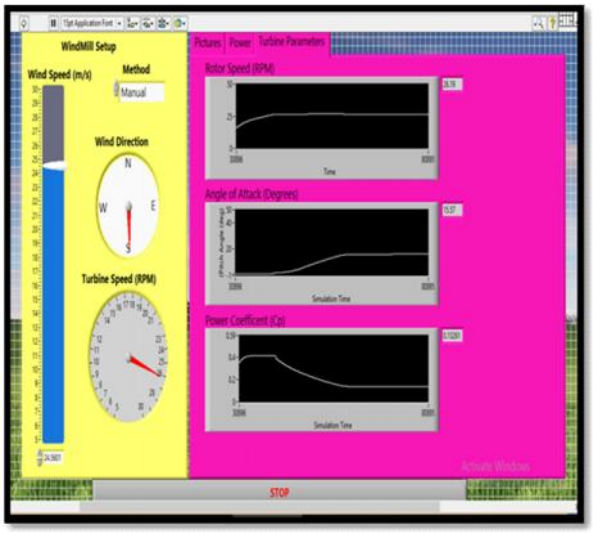

Figure 7: Different turbine parameters

Once all parameters are collected and analyzed, it has to be sent to cloud through web publishing tool present in LabVIEW platform.

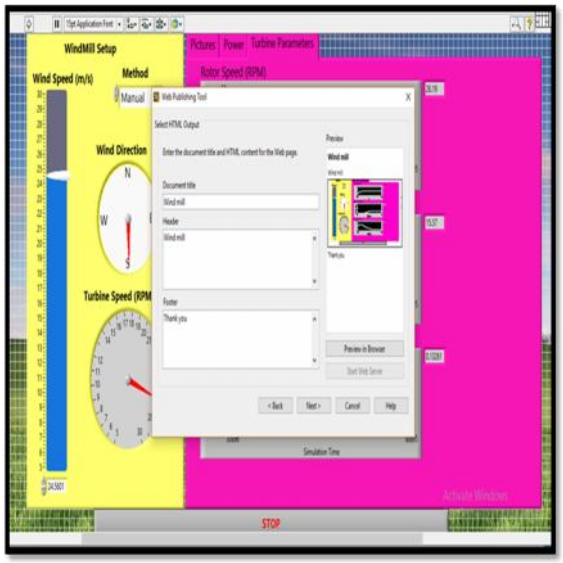

Figure 4: Web publishing tool

The data collected, analyzed and sent to web are stored in server and also can be monitored in other PC/mobile by giving the link or IP address.

Figure 5: High speed rotation

Data Dashboard results

By giving IP adress of the server to the mobile, data dashboard is connected to same network so as to monitor data of wind turbine.Various functions are present in Data Dashboard panel such as controller ,indicators,graphs,LabVIEW graph services ,text, shapes, lines and arrows and images.We can customize accordingly.Background can also be changed in this application.Any number of pages can be added as per our requirements.The results of data dashboard is shown in the below figure.

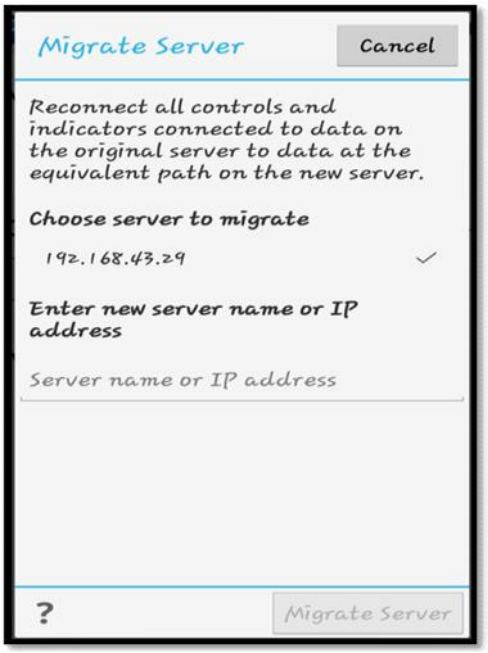

Figure 6: Migrate server using IP address

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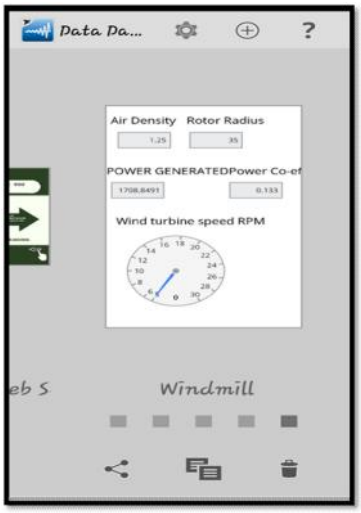

Figure 7: Data monitoring in mobile

Power calculation

The subsequent formula demonstrates features that are key factors to the presentation of a breeze turbine [11]. The wind rapidity, V has a proponent of 3 realistic to it. This shows that even a minor rise in wind speed marks in a huge rise in power. The formulation for computing the power from a breeze turbine is

$$\textbf{Power} = kCp1/2\rho AV^3$$

Where:

P = Power output, kilowatts

Cp =Maximum power coefficient, ranging from 0.25 to 0.45, dimension less (theoretical maximum =0.59)

ρ = Air density, lb/ft3

A = Rotor swept area, ft2 or n D2/4

V = Wind speed, mph

K =0.000133 A constant to yield power in kilowatts

1) The rotor swept area, A, is important because the rotor is the part of the turbine that capture the wind energy. So, the larger the rotor, the more energy it can capture.
2) The air density, ρ, changes slightly with air temperature and with elevation.
3) The coefficient of power of a wind turbine is a measurement of how efficiently the wind turbine converts the energy in the wind into electricity.
4) To find the coefficient of power at a given wind speed, we have to divide the electricity produced by the total energy available in the wind at that speed.

$$Cp = \frac{\text{Electricity produced by wind turbine}}{\text{Total energy available in the wind}}$$

Power calculation for the code

For the code power generated can be calculated as
The parameters are as follows

Power coefficient (Cp) = 0.13256
Rotor swept area $\pi r^2 = 22/7 * (35)^2$
Air density (ρ) = 1.25
Wind speed V = 17.5
Therefore, Power = $0.5*0.13256*22/7*(35)^2*1.25*(17.5)^3$

= 1707.93kW

VI. ADVANTAGES

1) Wind is a fresh source of renewable energy that yields no pollution. And since it is free, functioning costs are approximately zero once a turbine is initiated.
2) This course is exponentially effective as when compared to a solitary enthusiastic PC handling all the variables.
3) It permits resourceful generation of vitality with firm power abilities while modifying loads to rise the period of the turbine
4) Decrease conservation cost.
5) Large data analytics, quicker analysis of sensor outputs.

VII. FUTURE WORK

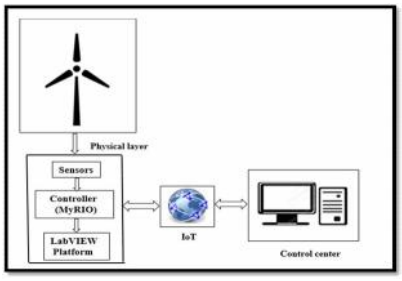

Figure 8: Future scope for wind energy conversion system

The above figure shows the future scope of project in which hardware can be implemented .In this system the wind turbine is mounted by dozens of sensors and actuators .Sensors inside wind turbine measure variables related to performance and health of each component. The control system manipulates and governs the wind turbine operation through a set of actuators. MyRIO controller which is a real time embedded evaluation board can be used to develop applications. This evaluation board make use of on board FPGA and microprocessor. The signals from sensors is sent to controller are monitored in LabVIEW platform. These signals are sent via Wi-Fi [Internet of things] and the data can be stored in server for real time operation.

VIII. CONCLUSION

With trade and population growth, energy depletion has increased considerably over the last three decades. The severe issue of exhaustion of assets like coal gas and petroleum at a very reckless rate has inspired countries around the globe to think about substitute natural assets which are unlimited, sustainable and ecological friendly. Among non-conventional assets for electricity, wind power has fascinated great interest in the past few decades and has unquestionably been the most quickly growing renewable energy source .Hence in this project we review the present best in class in models for digital physical framework and parts for WECS. By making utilization of LabVIEW software device practical pieces for the required parameters, for example, Power, RPM and wind speed are composed and a similar code is reproduced and chart is plotted. Front board has control and indicators as input and output and block diagram panel exhibits the graph and demonstrates the usefulness of the framework outlined. The speed at which the turbine first begins to pivot create controls and the varieties in the yield with enduring wind speed can be found in the front board. Henceforth analyzing and monitoring of the parameters of wind turbine can be seen. In this manner successful usage of Renewable assets which is considered as the dependable power sources in future and which is a heart of present day framework should be possible.

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