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Internet of Things (IoT) based remote sensing of low Voltage Grid parameters To Cloud system using ESP8266 and Arduino

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***Abstract*— In this paper an advanced solution for monitoring the weather conditions and low voltage grid for a particular geographical location and make the information visible anywhere in the world through IOT platform has been presented .Internet of Things (IoT) is the technology adopted in the scenario which is an advanced and efficient solution for connecting the things to the web and to connect the entire world of things in a network. Things might be electronic gadgets, sensors and automotive electronic equipment. The system deals with monitoring and controlling the environmental conditions like temperature, relative humidity, light intensity and sound level with sensors and voltage sensor , current sensor , which send this information to the cloud and then plot the sensor data as graphical statistics. The data updated from the implemented system can be accessible in the internet from anywhere in the world.**

Keywords*—Arduino, ESP8266-12E, IOT, Thingspeak, Renewable energy source, Distributed generation.

I. INTRODUCTION

Use of Renewable Energy Sources (RES) is increasing in a steep manner due to depletion of fossil fuels for the near future and associated environmental problems. Internet of Things where 'things'- sensors and devices transmit data directly to the Internet has become an enabling technology eco-system with several application areas are Smart Home, Smart Farming, Smart Grid, Industrial Internet, Connected Health, Smart Supply Chain etc. Since most of the renewable energy sources are intermittent in nature therefore it becomes a challenging task to integrate RES into the power grid infrastructure [1].Also it is important to sense this data every time for control of distributed energy sources.The technologies involved are many- sensors, microcontrollers, wireless networking, cloud based services, mobile apps, web pages -practical implementation of an IoT application is complex. Present innovations in technology mainly focus on controlling and monitoring of different activities. These are increasingly emerging to reach the human needs. For maintaining a reliable and cost effective supply, new efforts have to be undertaken for the management of energy networks, integration of RES and DO in the distribution networks, for generation and load management and for a range of other technical and socio economic aspects of decentralized energy markets.Most of this technology is focused on efficient monitoring and controlling different activities. An efficient environmental monitoring system is required to monitor and assess the conditions in case of exceeding the prescribed level of parameters (e.g., noise, CO and radiation levels). When the objects like environment equipped with sensor devices, microcontroller and various software applications becomes a self-protecting and self-monitoring environment and it is also called as smart environment. In such environment when some event occurs the alarm or LED alerts automatically. The effects due to the environmental changes on animals, plants and human beings can be monitored and controlled by smart environmental monitoring system.

In this paper PV and wind energy sources have been considered under study. The increasing penetration level of PV and wind systems is raising the concerns of some utilities due to the possible negative impacts of the power fluctuations generated from these systems on the network operation [2]. By using embedded intelligence into the environment makes the environment interactive with other objectives, this is one of the application that smart environment targets.

This trends leads to numerous technical and non-technical challenges. In this paper PV and wind energy sources have been considered under study. The increasing penetration level of PV and wind systems is raising the concerns of some utilities due to the possible negative impacts of the power fluctuations generated from these systems on the network operation . Also, the fluctuation in the power of these systems can lead to unstable operation of the electric network prior to the fault conditions, high power swings in the feeders [3] and unacceptable voltage fluctuations at certain nodes in the electric network [4]. Moreover, the random fluctuations of the power output generated these systems does not allow for considering them in the scheduling process of electricity generation

II. EXISTING SYSTEM MODEL

In today’s world many pollution monitoring systems are designed by considering different environmental parameters.

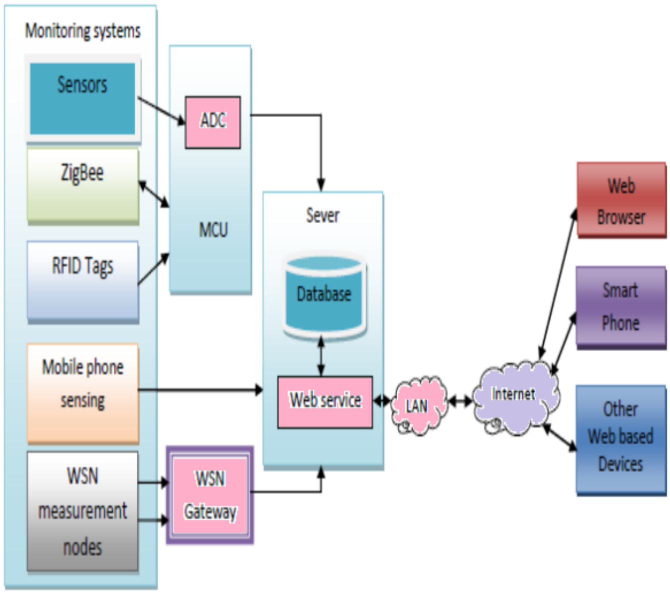

Fig.1 Existing System Model

Existing system model is presented in figure 1 uses Zigbee [3] based wireless sensor networks to monitor electrical parameters and environmental conditions with thousands of application in different fields. The sensor nodes directly communicated with the moving nodes deployed on the object of interest which avoided the use of complex routing algorithm but local computations are very minimal. RFID [4] is a means of storing and retrieving data through electromagnetic transmission to an RF compatible integrated circuit. It is usually used to label and track items in supermarkets and manufactories. Mobile phones [5] or smart phones that are enabled with sensors are used for impact on social including how mobile technology has to be used for environmental protecting, sensing and to influence just-in-time information to make movements and actions environmental friendly. Mobile phone sensors were deployed and used on urban areas for monitoring. A Wireless Sensor Network [6] consists of many inexpensive wireless sensors, which are capable of collecting, storing, processing environmental information, and communicating with neighboring nodes. In the past, sensors are connected by wire lines.

The access method of WSN gateway node is convenient because data can be received from a WSN via the gateway at any time and any place. A server is an instance of a computer program that accepts and responds to requests made by another program; known as a client. Less formally, any device that runs server software could be considered a server as well. Servers are used to manage network resources. The services or information in the servers are provided through the Internet that are connected through LAN and made available for users via smart phones, web browser or other web browser devices to make the system more intelligent, adaptable and efficient.

III. PROPOSED MODEL SYSTEM ARCHITECTURE

The proposed model consists of a Microcontroller (Arduino Uno) as a main processing unit for the entire system and all the sensors and devices can be connected with the microcontroller. The sensors can be operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and updates into the cloud through Wi-Fi module connected to it. Here we are using Arduino Due because it is compatible with 3.3v ESP8266 Wi-Fi module and it also contain more than one on chip UART's so we can connect more number of Serial devices.

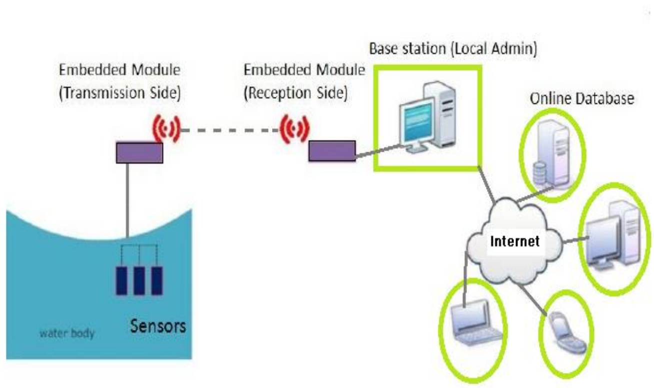

Fig. 2 Proposed System

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno is compatible with all Arduino shields that work at 5V; the Arduino Uno board runs at 5V and3.3V. The maximum voltage that the I/O pins can tolerate is 5V. Arduino IDE: Arduino is an open source tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple micro-controller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP). Based on the Processing multimedia programming environment.. Sensors are connected to Arduino Due board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be

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evaluated. Thing Speak: Thing Speak is an Internet of Things (IoT) platform that lets you collect and store sensor data in the cloud and develop IoT applications.

Fig. 3 Arduino Uno

The Thing Speak IoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data. Sensor data can be sent to Thing Speak from Arduino, Raspberry Pi, Beagle Bone Black, and other hardware. Thing Speak has integrated support from the numerical computing software MATLAB from MathWorks Allowing Thing Speak users to analyze and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from MathWorks.

Wi-Fi Module Here we used ESP8266 Wi-Fi module which is having TCP/IP protocol stack integrated on chip. So that it can provide any microcontroller to get connected with Wi-Fi network. ESP8266 is a preprogrammed SOC and any microcontroller has to communicate with it through UART interface.

Fig.4 ESP 8266 WIFI Module

It works with a supply voltage of 3.3v. The module is configured with AT commands and the microcontroller should be programmed to send the AT commands in a required sequence to configure the module in client mode. The module can be used in both client and server modes. Sensors: The

These 4 sensors will measure the primary environmental factors light intensity, temperature, Humidity levels and sound intensity respectively. All these sensors will give the analog voltage representing one particular weather factor. The microcontroller will converts this analog voltages into digital Data.ESP8266 Wifi module send these sensor values to Thing speak platform(Cloud). DHT11 (Temperature and Humidity) sensor: The DHT11 humidity and temperature sensor measures relative humidity (RH) and temperature. This sensor includes a resistive element and a sense of wet NTC temperature measuring devices. It has excellent quality, fast response, anti-interference ability and high cost performance advantages. Relative humidity is the ratio of water vapor in air vs. the saturation point of water vapor in air. Relative Humidity = (density of water vapor / density of water vapor at saturation) x 100%

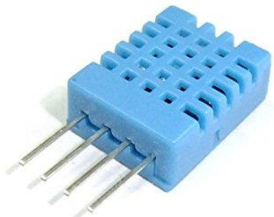

Fig.5 DHT 11 Module

The DHT11 calculates relative humidity by measuring the electrical resistance between two electrodes. The humidity sensing component of the DHT11 is a moisture holding substrate (usually a salt or conductive plastic polymer) with the electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes while lower relative humidity increases the resistance between the electrodes.

Inside the DHT11 you can see electrodes applied to a substrate on the front of the chip: The temperature readings from the DHT11 come from a surface mounted NTC temperature sensor (thermistor) built into the unit Implemented system consists of Temperature and Humidity sensor(DHT11 sensor) , LDR and sound sensor.

The Allegro ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection.The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a

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proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.

The output of the device has a positive slope (>$V_{IOUT(Q)}$) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor IC leads (pins 5 through 8). This allows the ACS712 current sensor IC to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. A lightdependent resistor (LDR) is a light-controlled variable resistor. The resistance of this decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. An LDR can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. An LDR is made of a high resistance semiconductor. In the dark, an LDR can have a resistance as high as a few mega ohms (MΩ), while in the light, an LDR can have a resistance as low as a few hundred ohms.

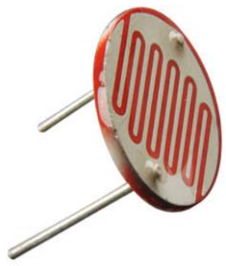

Fig6 Light dependent sensor

If incident light on an LDR exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their whole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of an LDR can substantially differ among dissimilar devices.

IV. IMPLEMENTATION

In this implementation model we used Arduino Due board, Sensors and ESP8266 Wi-Fi module as an embedded device for sensing and storing the data in to cloud. Arduino Due board consist of 12 analog input pins (A0- A11), 54digital output pins (D0-D53), inbuilt ADC. Wi-Fi module connects the embedded device to internet. Sensors are connected to Arduino Uno board.

Its read the sensors and on chip ADC will convert the corresponding sensor reading to its digital value and from that values the corresponding environmental parameter will be evaluated. Here we are connected ESP8266module to 19 (Rx1) and 18 (Tx1) pins of Arduino Due ,DHT11 sensor to one of the digital pin of (PIN 5)Arduino Due ,LDR circuit arrangement is connected to Analog pin (A4) and sound sensor is connected to Analog pin (A2).

The Wi-Fi connection has to be established to transfer sensors data to end user and also send it to the cloud storage for future usage.

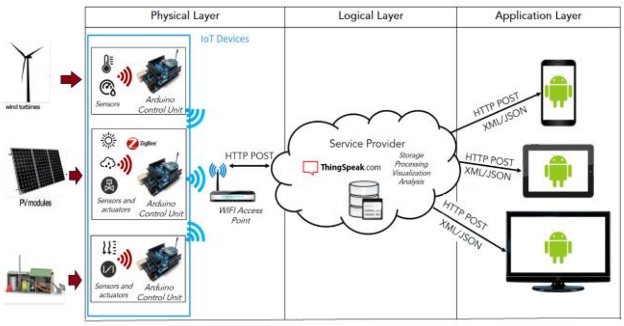

Fig.7 Schematic Diagram of implementation model

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An embedded system designed for environmental monitoring and its components are shown in figure 5.The embedded device is placed in particular area for testing purpose. The sound sensor detects sound intensity levels in that area and DHT11sensor and LDR will record the Temperature ,Humidity and Light intensity in that region, if the threshold limit is crossed the corresponding controlling action will be taken (like issuing message alarm or buzzer or LED blink).All the sensor devices are connected to internet through Wi-Fi module.

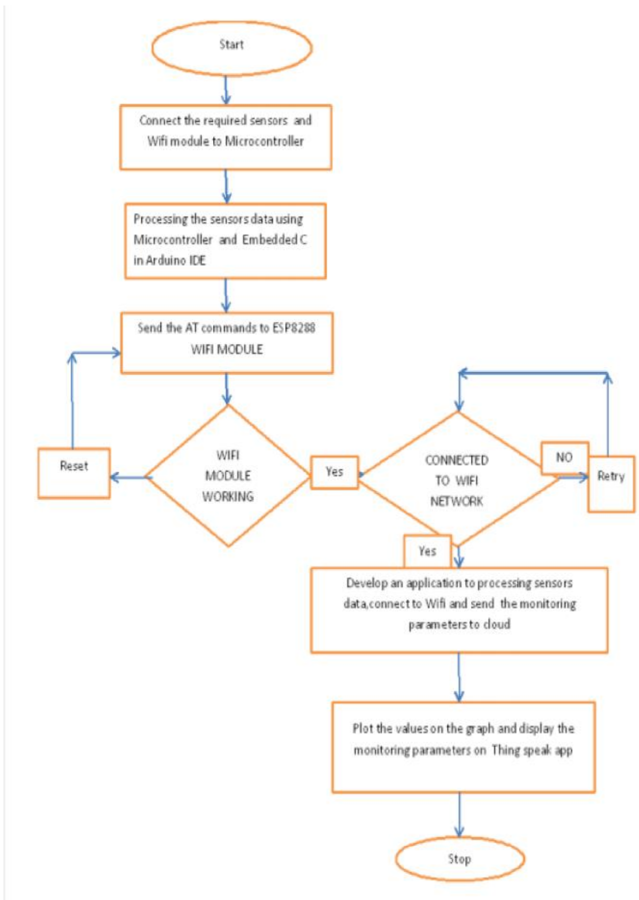

Fig. 8 Flow Chart

After sensing the data from different sensor devices, which are placed in particular area of interest. The sensed data will be automatically sent to the Thing speak platform (Cloud), when a proper connection is established with cloud

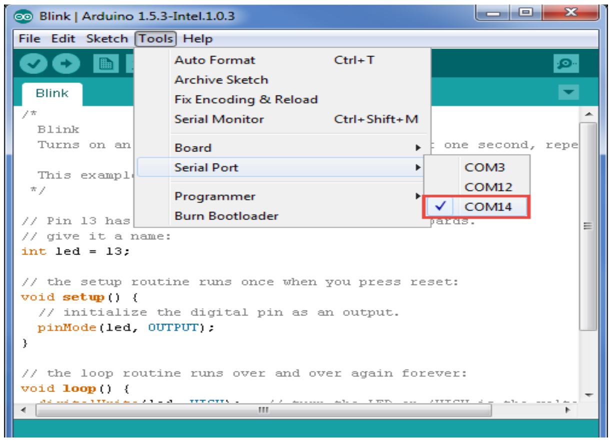

Fig .9 Selection of COM port

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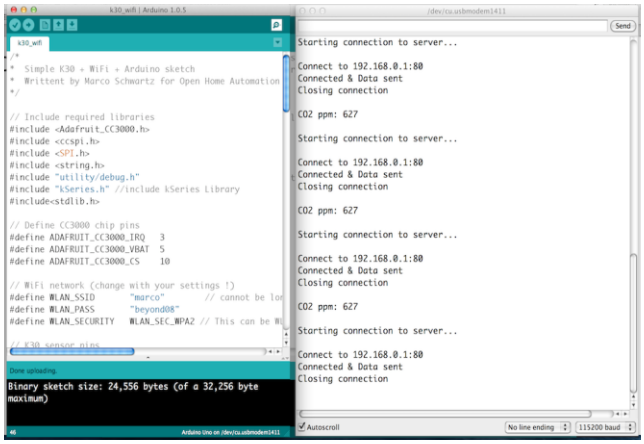

Fig. 10 Sensors Result and Wi-Fi status on Serial monitor

V. SIMULATION RESULTS

1. Create an account on Thing speak platform.

2. Connect Arduino Due board to system through USB cable.

3. After connecting select board and COM port in Arduino IDE.

4. Develop an Arduino Code for sensors to cloud system in Arduino IDE ,compile and upload the code in Arduino Due board

. Then Thing Speak platform analyze and visualize uploaded data using Mat lab Result:

Temperature =32°C,

Humidity = 30

Light intensity= 550

when light is present = 600-1000

when light is not present Sound level =45 db in normal

=60 db when present of sound

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Wind turbine Speed: 3Mtr/sec

PV Module Voltage:13.5V output

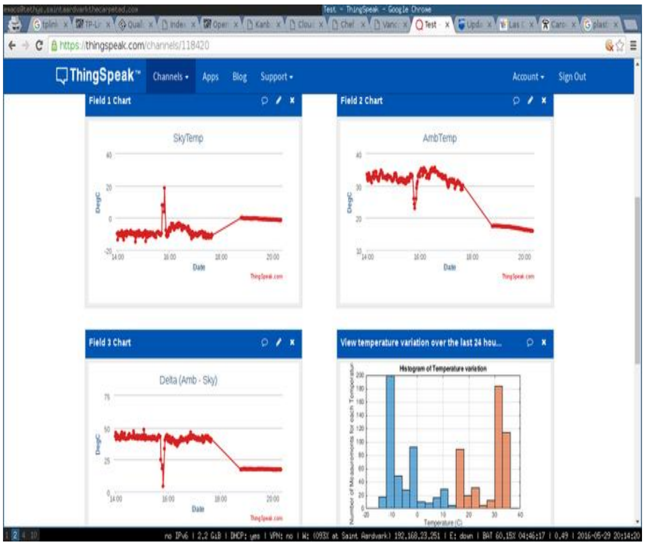

Fig. 11 Graphical view of monitoring parameters on Thing speak platform

the below figure the hardware setup to implement the above project

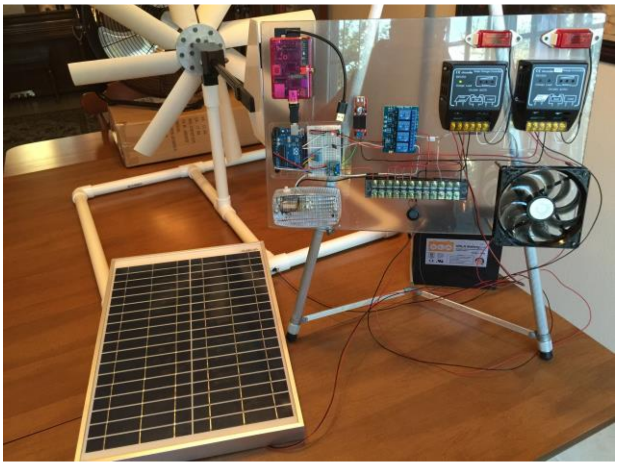

Fig.12 Hardware implementation of LV grid

VI CONCLUSION

By keeping the embedded devices in the environment for monitoring enables self protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e. it can interact with other objects through the network.

Then the collected data and analysis results will be available to the end user through the Wi-Fi. The smart way to monitor environment and an efficient, low cost embedded system is presented with different models in this paper. In the proposed architecture functions of different modules were discussed. The sensors to cloud system with Internet of Things (IoT) concept experimentally tested for monitoring four parameters.

It also sent the sensor parameters to the cloud (Thing speak). This data will be helpful for future analysis and it can be easily shared to other end users. This model can be further expanded to monitor the developing cities and industrial zones for pollution monitoring. To protect the public health from pollution, this model provides an efficient and low cost solution for continuous monitoring of environment.

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