IoT facilities for Laboratories of College using ESP8266

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Abstract:

Internet of the thing is a distinct combination of physical entities and virtual entities, to sense the physical parameters, gain control, and make a high tech environment. In this paper, the main objective is to sense and record the physical parameters like temperature, humidity, and dew point, room light, human inhabitancy, a hazardous condition in the selected environment. The use of a distinctive combination of components like Arduino uno and ESP8266 with Physical entities namely; DHT22 for temperature, humidity, and dew point sensing, PIR sensor for detection of human inhabitancy, LDR to detect the luminance, MQ7 Gas sensor for detection of the hazardous condition like LPG leakage. With help of virtual entities such as ThingSpeak IoT and Virtuino, Data of the sensors are uploaded on the cloud of ThingSpeak IoT Platform for further analysis and monitored with help of the HMI platform of Virtuino on Android devices. The decision and conclusion are drawn on these data are used to control the real-time situation depending upon the parameters variation.

Keywords: IoT, ThinkSpeak, Virtuino, Arduino uno, ESP8266

Introduction:

The new spirit to make the process of accreditation and assessment of the National Assessment and Accreditation Council (NAAC) more robust, objective, transparent, and scalable as well as make it ICT enabled. NAAC has given new guidelines and data analysis for the accreditation. The NAAC has been carrying out the process of quality assessment and accreditation of HEIs over the past two decades. Several HEIs have gone through this process and a sizeable number has also undergone subsequent cycles of accreditation. NAAC vision has been moved from quantitative-based judgment to data-based qualitative indicator evaluation with increased objectivity and transparency, towards extensive use of ICT confirming scalability According to its new guideline, effective from 2017, infrastructure utilization is an important aspect to work on for the affiliated colleges. According to criteria IV, especially in 4.1.1, Institute should show the adequate use of facilities for teaching-learning viz, classroom, laboratories, computer equipment, etc. In this question, it has been pointed out to show usage of the laboratories for their full stature. Similarly, 4.4.2 of the criteria talks about the procedures of maintains physical facilities [1].

Internet of Things (IoT) is a unique combination of hardware, software, and a component of the internet. According to Bahga and Madisetti, The main focus in IoT is in the configuration, control, and networking via the Internet of devices or "things" that are traditionally not associated with the Internet. IoT does not just connect the thing to Internet but also work on communication, exchange of data, and execution of goal [2]. Adrian and Hakim summarized the component in a simple thought as:

"**Product Object + Controller, Sensor and Actuators + Internet = Internet of Things"**

The Lab utilization Up-gradation and safety of the laboratories are an area that needs the attention of the improvement, especially in the college. The new technology IoT in safety and security provides a way to study a unique combination of the different actuators and sensors for the purpose. This type of combination may result to fulfill the basic requirement of the NAAC in a quantity manner and support the college infrastructure for better maintains.

Methodology:

IoT systems incorporated multiple components and deployment blocks. There were six levels for the IoT system. Each level was specified for different applications and required different components and deployment configuration. The system became complex when multiple components, network resources, web service, analytics components, application software, and database service play their parts. Figure 1 below shows the different steps involved in the IoT system design methodology.[2-3]

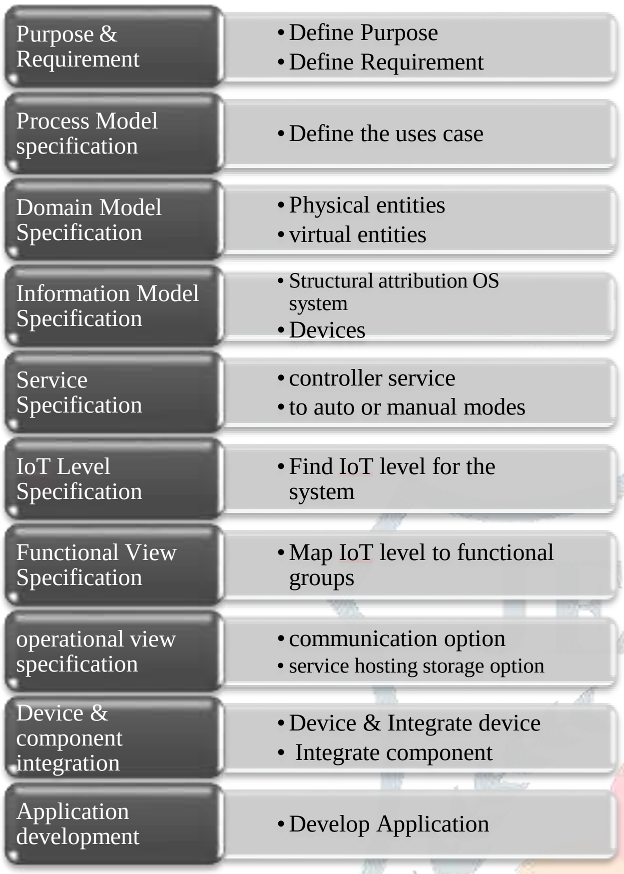

Figure 1: Steps involved in the IoT system design methodology.

Process Model specification:

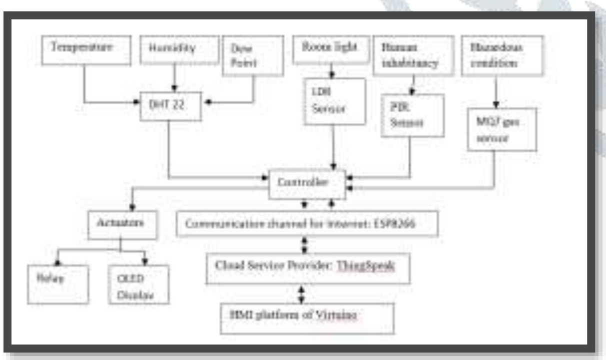

Figure 2: Process Model Specification.

The controller is the main key entity of the system. The DHT 22 is the sensor that measures temperature, humidity. According to Sonntag D, For Dew point, the following formula had been applied

$$G = \log\left(\frac{H}{100}\right) + \left[\frac{17.26\,T}{243.5 + T}\right]$$

$$Dew\ Point = \frac{243.5G}{17.62 - G}$$

where G was the variable, T was observed temperature (in degrees Celsius), and H was relative humidity (in percent).

Information Model Specification:

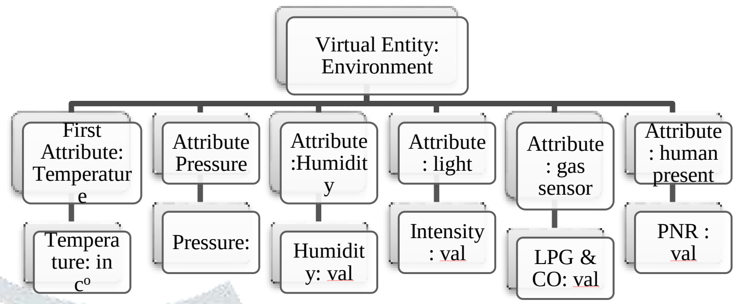

Figure 3: Model Specification [4-5]

This model represents the concept and relationships, constraints, rules chosen for this domain. The main purpose is to model the objects at a conceptual idea, specify the implementation and protocol to transfer data. The virtual entity which created should have all the information of physical entities. Here, the virtual entity is named as Environment. The remaining attributes are named as per their performance; the unit of measurement also had been specified in model.

Algorithm for the system:

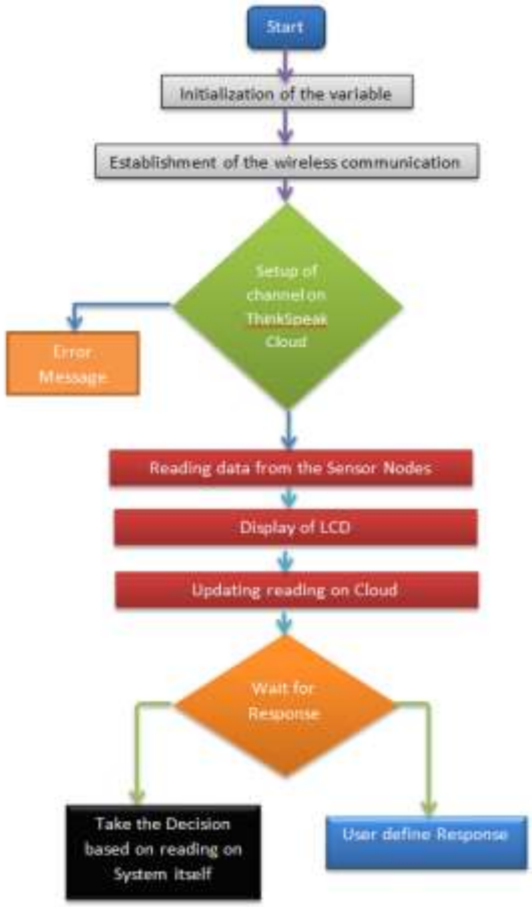

Figure 4: Algorithm for the system

The program started with adding the necessary header file in the program for DHT 22 and Serial communication. The initialization part of the program included the creation object for the DHT class and the initialization of the string type variables for the data storage. The program included the software serial class for esp8266 to establish communication with the cloud. The program used ThinkSpeak cloud for the system. Setup function began the serial communication at 115200 baud rate to support communication with ESP 8266 chip. The channel was set up and linked with the system. The main loop of the program included the reading of the data from the sensor, analyzing it. Then, data sent to the LCD Display. Data had been updated on the cloud for the analysis.

The system waits for a return response, otherwise, on a predefined algorithm and measured data, the system would command the actuator to work.

Program:

The program had been divided into four parts:

A. Header files: The serial communication header file included making the communication between the core of the system and ESP 8266 chip, as the chip itself is a standalone system. DHT 22 also needed a header file, therefore 'dht.h' included for this purpose.

B. Initialization of the Globe variables: The DHT header file included a class. To access the class, an object had been created. All other variables for different sensors were defined in string data type as the serial communication with the ESP 8266 support only the transferring of a string data type.

C. Establishment of a channel with the cloud:
ESP8266 is connected with the core with the help of pin no. 3 and 4. One can use 1 and 2 pin also for communication with ESP8266, but to separate the serial communication between PC and ESP8266, the system designed to use pin 3 for RX and 4 for TX with ESP8266 and left 1 and 2 for PC serial communication.
The SSID (service set identifier) and Password had to be defined with the help of the global variable. A string type function sendAT had been defined for sending the command line to the ESP8266. Debug to be check for the true condition if it is true then the response had to print on the PC screen through the serial.print() function.

D. Setup:
It started with setting up the baud rate at 115200 for serial communication within the core and PC, core and ESP8266. Using sendAT function reset command had been sent to ESP8266 and the command set it as station mode. Again sendAT function had been used to send the SSID and password details to ESP8266 to connect the Wifi router. Once the connection was established between ESP8266 and the wifi router, an assigned dynamic IP address will be assigned to ESP 8266. It was always recommended to convert this dynamic IP address to a static IP address.

E. LOOP:
The main loop consists of recording all the sensor data and sending data to three main functions. Firstly, to the LCD display for display, secondly to ESP8266 to update on the cloud, thirdly to the actuator function to take the decision manually.

F. Functions:
This part of the program contained three main functions by the name of 'display', 'updateTS', and 'fRelay'. Using the AT command CIPSTART and showing the TCP address of

AT+CIPSTART="TCP","api.thingspeak.com",80 established the connection with the ThingSpeak cloud channel. Using the command line of GET /update?key=sixteenAPIwritekey="+T+"&field2="+P+"&field3="+D+"&field4="+L+"&field5="+S+"\r\n" the data had been updated on the cloud. AT+CIPSEND command was used to send the GET command string. AT+CIPCLOSE was used to close the connection for that instant.

Result:

Systems were integrated and implemented into Laboratories. The temperature sensor DHT 22 has been seen to cover a much large area than DHT11. LDR sensor and PIR sensor provide digital data. The gas sensor is one of the peculiar sensors to be controlled, likely to overheat over a duration of time and start malfunctioning. Fire sensor provided a better alternative than the MQ7 to monitor the Hazardous condition of the lab. OLED display provides a beautiful display of the sensor value but very fragile to handle, broken, and lost twice. LCD display with an I2C connection is a better option than the OLED Display. ESP826 is one of the best options to work on IoT system but Ethernet shield also provide good support to the system.

ThingSpeak services were used to draw the graphical representation of the sensor data collected on the cloud of ThingSpeak[12]. Channel of ThingSpeak also provides security to data and easy accessibility. Every field of the channel of ThingSpeak shows an instantaneous value of the sensor that has been collected. To make it authentic, ThingSpeak also gives a geographical location view from where the data were collected. It also provides the excel sheet with the date and time of collecting data which may use for further analysis of the cloud. ThingSpeak application also provides the facility of MATLAB code execution for the posted data on its cloud. Virtuino is an HMI platform for IoT servers. It provides virtual screens on an android phone or tablet to control monitor the sensor anywhere. Virtuino also provide the facilities of emergency alarm, SMS, and Email to a bunch of people.

Figure 5: ThingSpeak website view

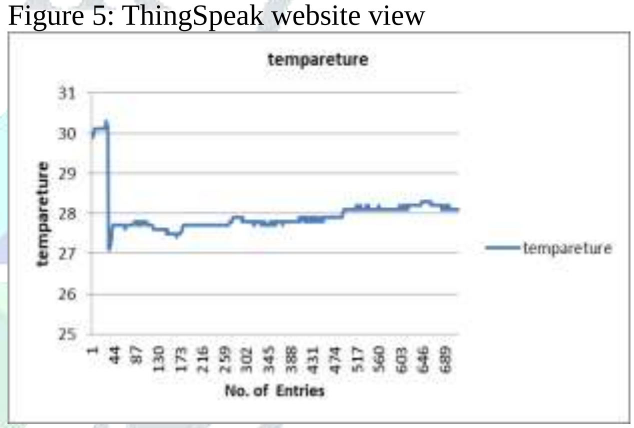

Figure 6: the temperature graph with the help of exported data from the ThingSpeak cloud

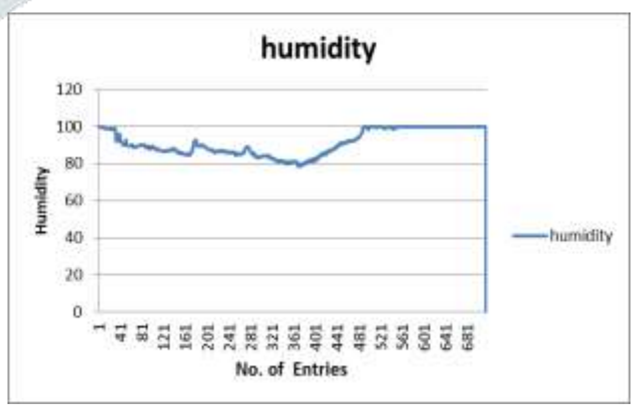

Figure 7: the humidity graph with the help of exported data from the ThingSpeak cloud

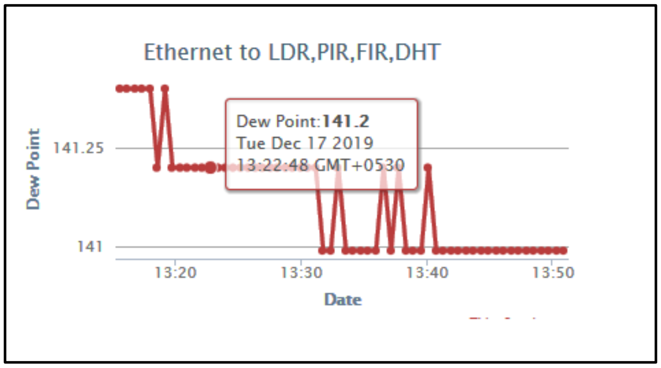

Figure 8: Plot of the Dew point on the ThingSpeak Cloud

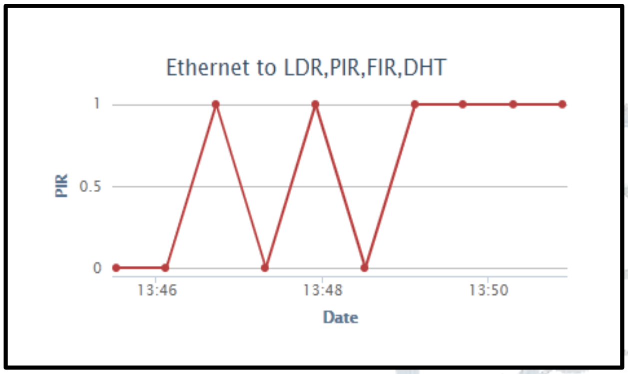

Figure 9: Plot of the PIR Sensor recorded data on the ThingSpeak Cloud

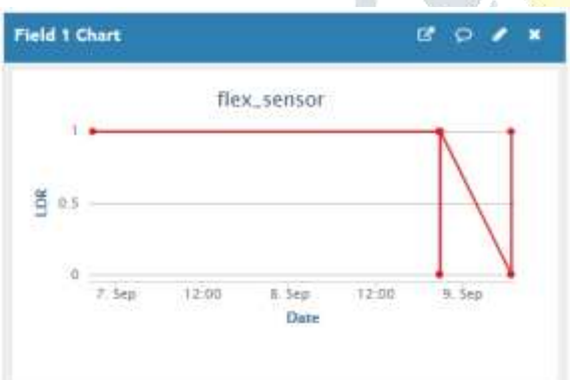

Figure 10: Plot of the LDR Sensor recorded data on the ThingSpeak Cloud

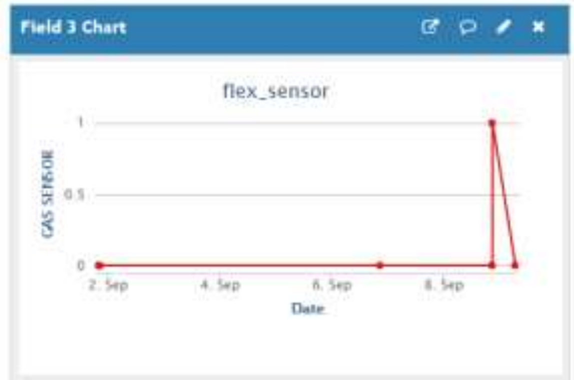

Figure 11: Plot of the Gas Sensor recorded data on the ThingSpeak Cloud

Conclusion:

The system worked very well as per the requirement. The only difficulties were the general-purpose pin availabilities. To increase the number of pins for input and output, the system was designed on the Ardunio Uno rather than Node MCU 8266, but as for the conclusion, the system must be designed on Arduino Mega 2560 or ArduinoYŭn. Graphs were drawn on the ThingSpeak website and which is accessible on any Android mobile with a simple app of Virtuino. With help of this app, we also able to provide emergency Emails and SMS to the particular group. Data has been displayed on three grounds; First, on serial monitor of computer, the second graph was drawn instantaneously on ThingSpeak website, third on Virtuino App. Still, the system needs the LCD or OLED display for further and fast access to data. IoT focuses on monitoring, automation, control, and spreading the information. IoT enables communication between devices. It is a Machine-to-Machine interaction. With the help of IoT, it is easier to get significant data to make the right decision.

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