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IOT based Environmental Monitoring System

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***Abstract*— Today environment monitoring becomes important for humans to ensure a safe and wealthy life. Monitoring requirements are extremely different depending on the environment, leading to specially appointed usage that needs adaptability. The proposed system describes an implementation of Wireless Sensor Network that can be adjusted to various applications. And it also inserts the adaptability required to be conveyed and updated without necessity of arranging complex infrastructures. The solution is based on small autonomous wireless sensor nodes, small wireless receivers connected to the Internet, and a cloud architecture which provides data storage and delivery to remote clients. The solution permits supervisors on-site not only to monitor the current situation by using their smart-phones but also to monitor remote sites through the Internet. The proposed system is useful in predicting environmental condition like rain, also, to measure the temperature, humidity, and presence of CO gas.**

***Keywords*— IOT, Wireless Sensor Network, Node MCU, android application, cloud server**

I. INTRODUCTION

The environmental care has become one of the biggest concerns for almost every country in the last few years. Even though the industrialization level has been increasing without any control in the last decades, the current situation is clearly changing towards more environmentally friendly solutions. Water and air quality are essential to maintain the equilibrium between human development and a healthy environment. It is also important to notice that by means of looking for a more efficient production in factories both pollution and consumption of natural resources can be decreased. Processes, such as boiling, drying, binding, and so forth, are being carried out by almost every kind of the current factories. Those processes are responsible of a great amount of gas emissions and polluted water discharges. Although the majority of the factories have their own sewage plants, it is crucial to measure the quality of the waste water that is being poured in to the public sewer.

In reality, clean air is a basic requirement for daily life. Air pollution affects human health and considered as a major serious problem globally, especially in countries where gas and oil industries are ubiquitous. According to the United States Environmental Protection Agency (USEPA), the air quality is characterized by measuring certain gases that affect the human health, which are: carbon monoxide (CO), ground level ozone (O3), and hydrogen sulfide (H2S).

The main intention of environmental monitoring is not only to gather data from a number of locations, but also to provide the information required by scientists, planners, and policy makers, to enable those making decisions on managing and improving the environment, in addition to presenting helpful information to end-users. There are huge efforts are carried out to improve the air quality in both environments: indoors and outdoors. Habitat and environmental monitoring represent an important class of sensor network applications. Recent advances in low power wireless network technology have created the technical conditions to build multifunctional tiny sensor devices, which can be used to sense and observe physical phenomena. Wireless Sensor Networks (WSNs) are currently an active research area due to their wide range applications including military, medical, environmental monitoring, safety, and civilian. Many environmental monitoring examples of WSNs are already presented in the literature and developed for different purposes.

II. RELATED WORK

When the concept of DSNs was first introduced more than two decades ago,[1] it was more a vision than a technology ready to be exploited. The early researchers in DSN were severely handicapped by the state of the art in sensors, computers, and communication networks. In work proposed in [2], the design and deployment of the real time water quality monitoring system for drinking water using wireless sensor network has been presented.

Recent advancement in wireless communications and electronics has enabled the development of low-cost sensor networks. The sensor networks can be used for various application areas (e.g. health, military, home). For different application areas, there are different technical issues that researchers are currently resolving. The current state of the art of sensor networks is captured in this article, where solutions are discussed under their related protocol stack layer sections. The article presented in [3] also points out the open research issues and intends to spark new interests and developments in this field.

The survey presented in [4] is an overview of Wireless Sensor Networks. The survey described the generations, architecture, Routing and storage management of wireless sensor Networks. Applications areas and characteristics of WSNs are also described in this paper. There are still many challenges and constraints in the sensor networks including limited bandwidth and network lifetime of a node. The paper has also highlighted research challenges in WSN and identifies the future research directions.

III. THE PROPOSEDMETHODOLOGY

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For determining temperature and humidity of atmosphere we are using temperature and humidity sensor (DHT11) which will help in predicting weather condition. CO sensor is used for detecting Carbon Monoxide in environment, where as rain sensor is used for detection of rain.

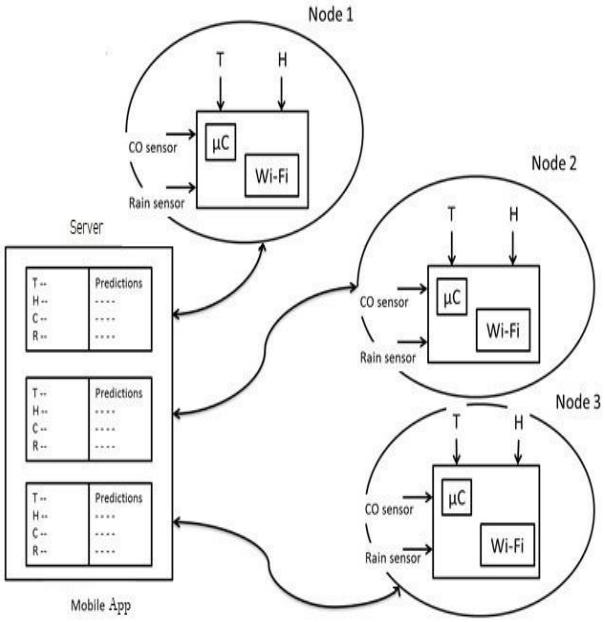


Fig. 1 Schematic diagram of proposed system

The system is placed in 3 different locations and data from each location is collected by the server as shown in figure. The server stores and displays the current values of all 4 parameters. A look up table is generated which contains the values of temperature and humidity and is used for predicting the current environmental conditions like if humidity is more and temperature is less then there is a chance of rain. Data from all 3 nodes is updated on servers as well as in Android App. User can access this data using authorized login ID and password.

IV. WIRELESS SENSOR NETWORKS(WSN)

In recent years an efficient design of a Wireless Sensor Network has become a leading area of research. A Sensor is a device that responds and detects some type of input from both the physical or environmental conditions, such as pressure, heat, light, etc. The output of the sensor is generally an electrical signal that is transmitted to a controller for further processing.

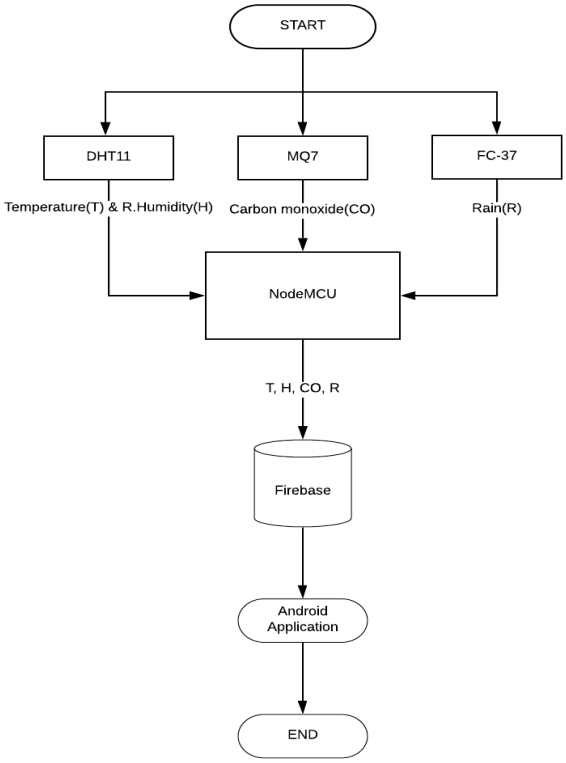
A Wireless sensor network can be defined as a network of devices that can communicate the information gathered from a monitored field through wireless links. The data is forwarded through multiple nodes, and with a gateway, the data is connected to other networks like wireless Ethernet.

WSN is a wireless network that consists of base stations and numbers of nodes (wireless sensors).These networks are used to monitor physical or environmental conditions like sound, pressure, temperature and cooperatively pass data through the network to a main location as shown in the figure.

V. FLOW CHART

The below flow chart shows the graphical representation of the work flow of the proposed system. The proposed system uses 3 nodes which are identical to one another. The below flow chart shows the work flow for any one node and the work flow for other 2 nodes will be the same.

Fig. 2 Flow Chart



A. *HARDWARE & SOFTWARE*

DHT11 (Sensor)

The DHT11 humidity and temperature sensor makes it really easy to add humidity and temperature data to your DIY electronics projects. It's perfect for remote weather stations, home environmental control systems, and farm or garden monitoring systems. DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the digital signal acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long term stability.

Working Principle of DHT11

The temperature is measured with the help of a NTC thermistor or negative temperature coefficient thermistor. These thermistors are usually made with semiconductors, ceramic and polymers. The resistance of the device is inversely proportional with temperature. The humidity is sensed using a moisture dependent resistor. It has two electrodes and in between them there exist a moisture holding substrate which holds moisture. The relative humidity is calculated by measuring the electrical resistance between two electrodes. When moisture is absorbed by the substrate, the

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resistance decreases. The change in resistance between the two electrodes is proportional to the relative humidity. Both these temperatures and relative humidity changes are processed by an IC placed on the other side of the board. It calculates the values of both and can transmit those values to a microcontroller using only a single data line.

NodeMCU (MicroController with Buit-in Wifi)

The NodeMCU (Node Micro Controller Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip. It is an open-source firmware and development kit that helps you to prototype or build IOT product. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which is based on the ESP-12 module.

There have been many different ESP modules over the years, each with their own advantages and drawbacks. There have been just two types of NodeMCU boards, however: versions 0.9 and 1.0. The 0.9 version is blue and comes loaded with the ESP-12 chip, while the 1.0 is black, and comes with the ESP-12E (which stands for 'enhanced').

Given that the ESP8266 is a more recent release than the Arduino, it's not surprising that it has stronger specs. There's a 32-bit RISC processor clocked at 80MHz, along with a generous RAM complement and support for up to 16mb of external flash storage. The device is especially useful for IOT applications, thanks to its tiny footprint and built-in WiFi support.

VI. CLOUD SERVERS

Cloud server is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. If the connection to the user is relatively close, it may be designated an edge server. It is hosted, and typically virtual, compute server that is accessed by users over a network. Cloud servers are intended to provide the same functions, support the same operating systems (OSes) and applications, and offer performance characteristics similar to traditional physical servers that run in a local data center.

A. Firebase

Fire base is a technology that allows you to make web applications with no server-side programming so that development turns out to be quicker and easier. It supports the web, iOS, OSX and Android clients. Applications using Fire base can just utilize and control information, with out thinking about how information would be put away and synchronized crosswise over different examples of the application in real time. With Firebase, you don't need to stress over-provisioning servers or building RESTAPIs with just a little bit of configuration; you can allow Firebase to make a chanceto take every necessary step: storing data, verifying users, and implementing access rules.

B. MIT App Inventor2

MIT App Inventor 2 lets you develop applications for Android phones using a web browser.

Goto MITAppInventor2homepagehttp://ai2.appinventor.mit.edu/

C. App Inventor Designer window

The "Designer" is where you create the Graphical User Interface (GUI) or the look and feel of your app. You choose components like Buttons, Images, and Text boxes and functionalities like Text-to-Speech, Sensors and GPS.

D. Connect to android phone

While you're building an appon your computer, you can test it on a connected Android phone or tablet. Be sure your computer and mobile device are connected to the same WiFi network. Return to the Designer Window on your computer.

E. AI2 Companion app

Open the AI2 Companion app on your device by clicking on the app icon. A screen (like the one shown below) will appear with the option to scan the QR code or type in the six character code. If you choose to scan the code, press the blue "scanQRcode" but to n forth escanner to launch. Scan the QR code. Wait a few seconds for your app to open on your mobile device. If you choose to use the code, type it in to the white text box, click the orange button after words.

Fig. 3 AI2 Companion app

VII. RESULTS

A. Designed 3 WSN nodes

Successfully designed 3 WSN nodes. Each node comprises of a NodeMCU, a DHT11 sensor, a MQ-7 sensor, a FC-37 sensor and a battery.

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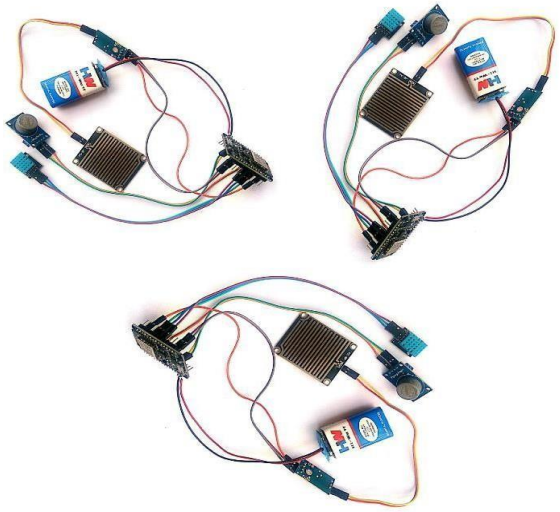

Fig. 4 3 WSN Nodes

B. *Developed an Android Application*

Successfully developed an android application named "eWeather" which is integrated to the firebase server. When user opens this app, the very first thing he sees is a login screen. To monitor the environmental conditions of the 3 nodes, the user must have to login with authorized email ID and password. To be able to login successfully, the entered email ID and password should match with the email ID and password stored on the firebase server. If it is not matched, the app shows an error. Once successfully logged in, the home screen is appeared showing the environmental conditions.

Fig. 5 Login Screen and Home Screen of Android Application

CONCLUSION

Environmental monitoring is a tricky activity as the environmental conditions can easily change from point to point even at small distances. This is especially true inside buildings where temperature, humidity, and pollutants can be different not only in different rooms but also within the same room especially when showcases and closed furniture are used. While several architectures have been proposed that can manage many sensing nodes, often there is low attention given to its flexibility and also they are quite costly. Therefore, the components developed within the framework described in this work is designed flexible enough to adapt to the change in different environmental parameters. It is a simpler system with minimal cost which uses battery-operated sensors equipped with a wireless transmission protocol, which ensures real time monitoring. The system is user- friendly as it has support of Google Assistant and an android application is developed which acts as a Graphical User Interface (GUI) which is able to prevent unauthorized access.

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