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RESEARCH ARTICLE

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DESIGN AND IMPLEMENTATION OF SMART SENSOR INTERFACE FOR HERBAL MONITORING IN IoT ENVIRONMENT

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ABSTRACT

Almost from the ancient and medieval times, medicinal plants are viewed with utmost reverence. Medicinal herbs which have brawn to combat the terrible known and unknown diseases. At present, people moderate the fact of significance of herbal plants. But, obviously they have their genuine standard in medicinal field. In this paper, exploration prediction and geographical location of herbal plants in hilly areas are detected using WSN technology. In order to attain the main objective, some significant factors should interfere the process. The vital environmental factors that are responsible for the herbal plants sustainment in canopy are soil and weather conditions which includes the basic conditions like temperature, pH and humidity. Usage of intelligent wireless sensors over a spread of forest land results with various environmental conditions of the soil and weather which can possibly predict the sustainment of all herbs. A main server often called as "IOT" is also used to maintain a set of fixed database of certain herbal plants that can possibly dwell in a particular area. A comparison is made between the obtained real time sensor values and the database that is uploaded in the main server. Ultimately, this setup helps medicinal field by telling the existence of precious herb in places where man can hardly enter those places.

Keywords: Herbal, soil pH level, threshold/reference values, Environmental conditions, Wireless Sensor Networks (WSN's), IoT environment, Agriculture.

1. INTRODUCTION

The lifecycle of any human being is based on several factors like the surrounding and his environment around which he grows [6]. According to the U.N's annual report in the health analysis all over the world its estimated that the average human being life expectancy is only at 62 and there is a steady decline even though new breakthroughs are being made in the field of modern medicinal field. The real reason being the aftermath effect of the pollution from all the mediums via air, water and soil.

Though the scientific world of medicine has achieved many remarkable breakthroughs yet one reason why it's still largely debated cause of no of reasons where the patients have some allergic reactions. In stages where the artificial or man-made fails one often looks up to nature. The only

difference between the artificial and Ayurveda is that the manmade would give a quick relief but an artificial one would give perhaps a slow one but a complete relief which one would not accept form an artificial one. Even form the medieval times the use of herbal plants or nature gift for our well-being is one which everyone looks at. This has even been proved in our epic Vedas [5].Even today it's estimated that the still a large amount of herbs which are grown in wild are still yet to be discovered.

In India, the herbs have been of great significant. The proof of this is Ayurveda Society which is established and had its presence felt in India for many decades. But the presence of this type of herbs is mostly in the hilly areas and in the areas where the human population is a thin line. Hence the presence and the quantity of herbal plant are not known in approximate details. Taking in the case of India alone, taking alone an account of Tamil Nadu a large presence of herbs are found in the mountains of Kolli hills and also in the hills of Agasthyamalai[7]. The human expedition and also a constant study is not possible as the climatic condition of these places are not suitable, its reasons like this that the use of Ayurveda plants have become pretty less. Hence by the method of this proposed system not only the presence of the herbs but also the quantity of the plants is known and also their temperature and their distribution can also be estimated. The further studies also shows that there are other herbal plants which have not yet been identified for their herbal nature hence this proposed method would solve the case.

The method includes the measurement of environmental such as temperature, humidity and soil PH. The earlier methods if testing these parameters in earlier era were each done differently. For soil analysis it was basically done by either collecting the sample or by having an on the spot evaluation but these factors include a high cost rise in the terms if both labor and the procedure included. The earlier technology included had the use of cables which also increased the cost price. Hence the new prototype model puts the use of wireless network which are powered by solar batteries instead of using the conventional power lines and other type of cables complicating the whole procedure. By integrating the use of Wireless Sensory Network and Internet of Things (IoT), helps to bring this paper to life. The further applications if this type can also be in the field of crop growth, also in terms of irrigation and also a check to determine the drought regions in an area.

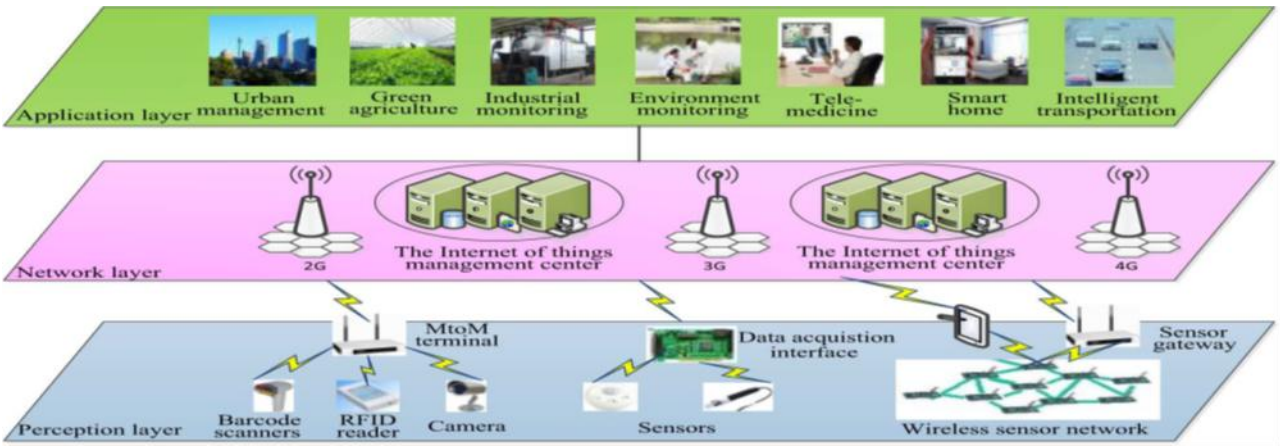

Fig.1 Architecture of IoT

2. HERBAL LOCATIONS IN INDIA (TAMILNADU)

In India the herbal location as said before are mostly in the Northern and the Southern part of the mountainous regions. There are many famous places in India where especially in Tamil Nadu hills. The atmospheric conditions along with the climatic changes in these places make the study and the human's interactions very difficult. Hence this proposed system is being implemented .This apparatus has basically nodes consisting of sensors which are implemented on it being kept in different location these sensors sense environment changes in atmospheric temperature, humidity, and in soil PH. A threshold value is kept in database regarding

the atmospheric temperature, soil PH and also on humidity. Any fluctuation in any of these would trigger directly to the plant in the database. Hence by this not only the plant will be known but also its favorable climate will be also learnt along with its distribution in the earth's surface.

A new technology in this used which is getting a good raise for its real-time application known as INTERNET OF THING (IoT) is a computing concept that describes a future where every day physical objects will be connected to the Internet and will be able to identify themselves to other devices. This is closely identified with RFID as the method of communication, although it includes some other sensor technologies, wireless technologies, QR codes, etc. In the term "Internet of Things" a "thing" could be described as a real/physical or digital/virtual entity that exists and move in time and space and is capable of being identified and the architecture of IoT is shown in Fig.1 [4]. Hence this makes the application if this device as no need of keeping a track of a separate network location as it has the ability of self-configuring ability thus making it to adjust itself to any network found around and also enabling it to run in a real time environment and also support in a large no of application like Telemedicine, Intelligent machine, Green agriculture.

3. DESIGN APPROACH

Herbals are most important and efficient for human's healthy life. It can cure most of the dangerous diseases. Most of them are used for the medical purposes. They are mostly found in hilly areas, mountains etc. But these medicinal plants which are found in hill or mountain areas are not used for any purposes and they become wasted one. In hilly areas of Tamil Nadu like Kolli hills, Agasthyamalai Hills etc. many herbals can be found in these locations but without knowing the types of herbals and their efficient use for human's healthy life, they become wasted and destroyed. To overcome this problem, by knowing all the types of herbals or the required medicinal plants which all are possible to grow in these areas or any other areas, this application can be used. Thus, it will helps us to find all the herbals in our required locations and their great use to the humans without letting them to destroy as a wasted one.

In dense forests, hills, mountains etc. we can find many herbals growing in these areas but the problem is to find its types and their location in these areas. This paper will helps to solve these problems. Initially we have to collect the database of all the herbals or useful/medicinal plants which we required, of their growth condition i.e., their temperature, humidity, pH level of soil and all their environmental conditions for their perfect growth. All these databases are stored in a main server. From this main server, we can monitor the sensor values and also control/reconfigure their threshold/reference values. Then different devices have to be placed in different locations. These devices will contain the set of required sensors which are used to measure the environmental condition of the herbals. The sensors which we connected to the devices, send their sensor values to the main server in IoT environment through a controller. In the receiving end, the controller will receive the sensors value and send it to the main server and this main server compares the received sensors value with previously stored database of all herbals as shown in Table 1which are referred from the reference [10]-[13]. If these sensor values matches with the stored database (threshold/reference values), it will display the list of all herbals which are growing in the particular area and also we can predict the types of herbals is possible to grow in that location. Because, each and every plants/herbals have their certain environmental conditions. An herbals can be grown with minimal adjustments if it is well matched with its environmental conditions [3]. This process is same for all the devices which are connected to the main server.

Table 1. Database of herbals

Herbal types	Temperature (°F)		Humidity (%)	Soil pH
	Day	Night		
Aloe Vera	70-80	50-60	60	6.5-8
Rosemary	60-65	46-52	83-88	5-6
Basil	65-75	55-60	65-70	6.0-7.0
Sage	62-70	50-60	60-70	5.5-6.5

4.SYSTEM ARCHITECTURE

The developed wireless system consists of many devices that are distributed over a different

WSN node in a hilly areas, each device monitors an environmental condition of the respective mote (Fig.2). These devices continuously collect the environmental parameters of each mote such as its temperature, relative humidity and soil ph. The data which are collected by each individual devices will be sent wirelessly through a Zig Bee communication module to the base station. From the base station, the received data are updated to the main server [1]. The recorded data is compared with the already updated database, and the list of growing herbal is displayed in the main server.

4.1 Interfacing Sensors

The Wireless sensor devices were built for the herbal monitoring system. Each device in the mote consists of sensor unit and ZigBee wireless module and also each sensor unit consists of three different sensor modules that can monitor three different parameters. These sensors are LM35 Temperature sensor, LM368 Humidity sensor and FC-28 Soil Moisture sensor. The RF module called ZigBee module which is used for data transmission and powered by 2.7 to 3.3V that can be connected to the microcontroller without providing any additional power-supply circuit. The XBee series-1 modules are configured as Coordinator and also Router, which covers up to 1.6 km line of sight. In the base station, the received data from different mote are transmitted to the server though GPRS module wirelessly. The three sensor modules are connected to the microcontroller as shown in Fig.2.

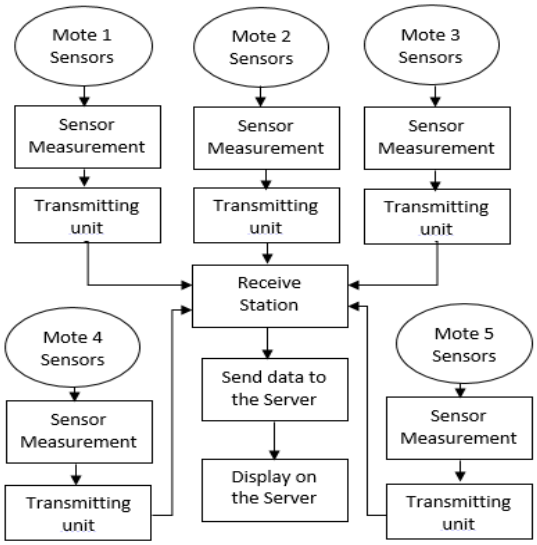

Fig.2 Functional block diagram of wireless herbal monitoring system

4.2 ZigBee Wireless Sensor Network

The ZigBee WSN comprises of XBee-S1 modules built by Digi which are configured as end devices (sensor nodes) and also communicate wirelessly to a coordinator [9] in the form of a mesh topology as shown in Fig. 3 [2]. If the end device is within the range of the coordinator device, the system runs like a star topology. Otherwise, hopping takes place and the outer most end device will send its data to the nearby router and consequently the data will reach to the coordinator as shown in Fig. 4.

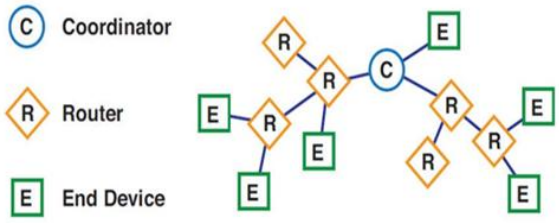

Fig. 3 ZigBee network

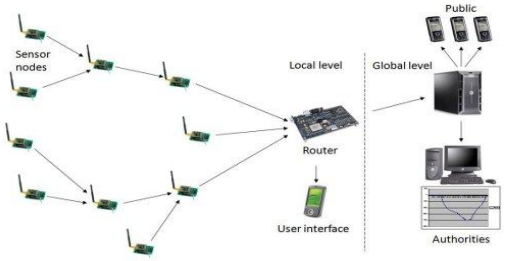

Fig.4Adhoc network

4.2 Sensing Units

We have used three different types of sensing units in each mote, for effective data management on the IoT networks.

The sensing unit type #1 measures the atmospheric temperature is measured by the LM35 sensor which is shown in Fig.5, primarily used for the measurement of atmospheric temperature. The main advantage is that

- You can make temperature reading more accurate than thermostat.
- The sensory circuit is sealed and not subject to oxidation
- The LM35 generates a higher voltage than thermocouples and may not require that the output voltage be amplified
- Can be fixed into any circuit with much less complexity.

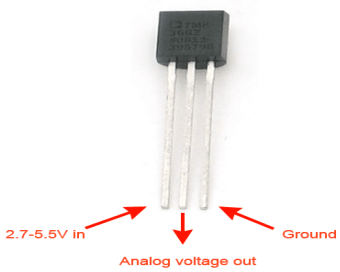

Fig. 5 LM-35 Temperature Sensor

The sensing unit type #2 Relative humidity is a measure of the amount of water vapour contained within the air. Humidity is a very important environmental element in terms of plant growth. It controls the rate of transpiration and how the nutrients are received by the plant. LM368 sensor was chosen to monitor ambient temperature and humidity. This sensor proved to be reliable and stable [8].The output from LM368 is a calibrated digital signal which can be interfaced directly to any network. It utilizes the latest development in digital-signal-collecting-technique and humidity sensing technology that calibrates automatically. With its small size, low power consumption, and ability to function in all kinds of harsh application occasions, which makes the LM368 a onetime wing sensor in the field of humidity.

The sensing unit type #3 one of key parameters of soil, water and even food is pH level. It denotes the activity of hydrogen ion. In simple terms if pH level is less than 7 it is said that solution is acidic if greater than 7 – alkaline. Around 7 it is somewhat neutral.7029 Soil pH sensor consists of pair of electrodes that can be inserted in the soil which is shown in Fig.6.

Fig. 6 7029 Soil pH sensor

A small current flow through the probes and the level of pH is measured also the level of moisture can be measured if required. The output from the sensor is an analogue output that can be connected to one of the analogue to digital port (ADC) available on the microcontroller board (Table 2).

Table.2 Calibration Results for 7029 Soil pH Sensor

Sensor reading (ADC value)	Soil Condition
0 ~300	Dry soil
300~700	Humid soil
700~950	Saturated with water

5. IMPLEMENTATION AND RESULTS

5.1 System setup

On setting up the sensing unit, the coordinate make an automatic connection to the routers and creates a wireless mesh network. The coordinator sends information to the router and vice-versa. The received data is reviewed for its accuracy. A unique identifier is sent by sensor unit to each type of sensor as shown in Table 3. This enables the software to identify the type of sensors it communicating with.

Table. 3 Data Packet from Sensors Send to the Coordinator

Mote ID	Temperature (°C)	Relative Humidity (%)	Soil pH	Soil Moisture (ADC value)
A	28	57	6	721
B	30	55	5	681

The serial port monitoring software is required for the setup of herbal monitoring system. The ZigBee module acts as coordinator is associated with WSN to collect the data and monitor the sensor Text.

5.2System Deployment

For implementation purpose, two hardware prototype for herbal monitoring wireless units were deployed. The data is sent to Coordinator from these units. Two prototype hardware have been developed and shown in Fig.4 and Fig.5.A prototype hardware board for monitoring the environmental conditions of respective mote has been implemented .In this prototype, the hardware board 1 which gets the temperature, humidity and soil pH data of mote 1 from their corresponding sensor as

shown in the Fig.4 and also the hardware board 2 gets the temperature, humidity and soil pH data of mote 2 from their corresponding sensors as shown in Fig.5. Then, both the hardware sends all the information to the Coordinator using the ZigBee transceivers.

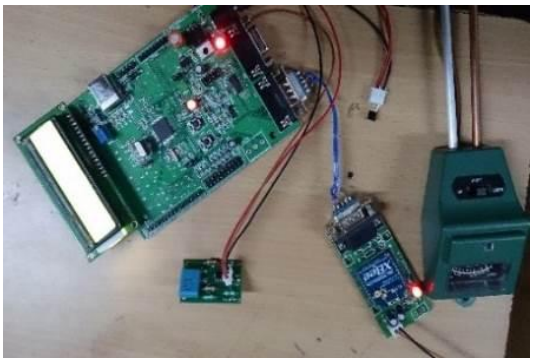

Fig. 4 Prototype Hardware Boards 1 for monitoring environmental conditions in mote 1

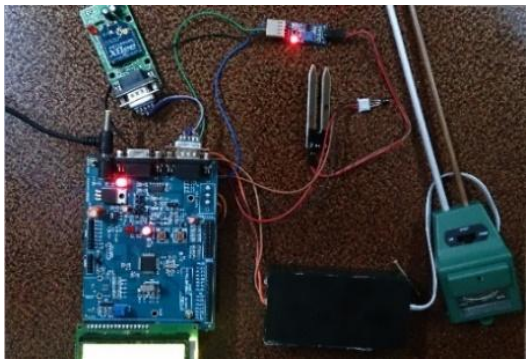

Fig .5 Prototype Hardware Boards 2 for monitoring environmental conditions in mote 2

The hardware circuits in the different nodes measure the environmental parameters such as temperature, humidity and soil pH using the sensors Temperature Sensor, Humidity sensor and Soil pH sensor respectively. This information is collected by the each hardware controller and transmitted using ZigBee transceiver to the Coordinator which is also called Base Station.

In this Base Station, all this information are received by the ZigBee transceiver. These information are further transmit to the main serveries shown in Fig.6. The collected raw data from each WSN node which represents the current environmental conditions of each node respectively is shown in Fig.7.The communication between the Base Station and the Server takes place either by wired or wireless communication through LAN or GPRS module. By using either one of these method, the received information are updated in Server

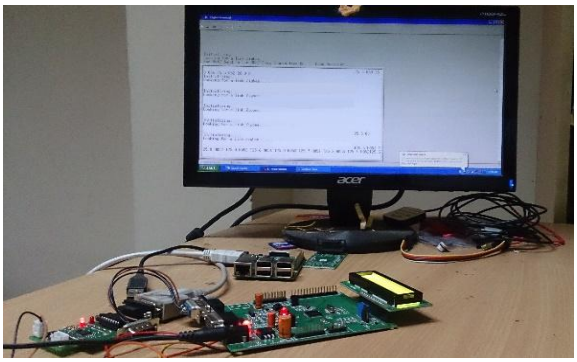

Fig.6 Coordinator updating its received motes data to Main server via Ethernet

Once all the system hardware is connected, the serial port is opened on the software program. The program initially records and displays the number of sensors in the network as shown in Fig. 7. This feature enables us to verify whether all the sensor nodes are communicating with the coordinator and working properly. Any kind of sensor node failure are detected and rectified at this stage.

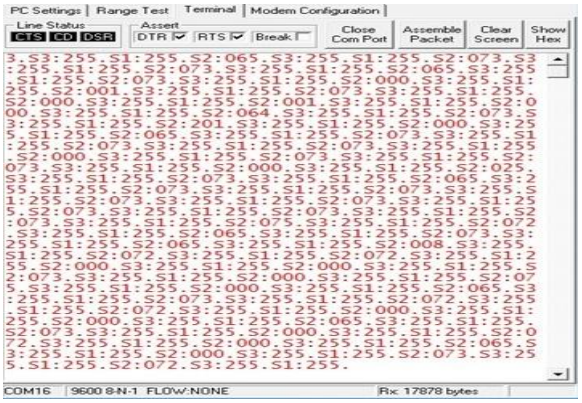

Fig.7 Data Packets from Sensor Units

The developed hardware device is successfully implemented and tested on Herbal monitoring wireless system that is capable of providing spatially distributed soil/atmospheric data relevant for herbal growth. The coordinator software records, displays the data in real time and simultaneously uploads on to the server.

In the main server, the updated data which are from different motes are compared with the already updated database of each herbals. From this, we can get the information based on the types of herbal is growing in that mote and also the prediction of herbals is possible to grow in that mote.

4. CONCLUSIONS AND FUTURE WORK

This paper reports of a working model of calibrated sensors which are in equilibrium and provide the data in an approximate manner maintaining the

integrity of the instruments. The sensors mentioned here can record the temperature, soil PH and humidity in an approximate value which can also be as a raw data in various other applications such as Drought management and Irrigation. Since the use of IoT (Internet of Things) rather than relying on any specified network to report back the data or the use of cable making the reporting system to use any available network thereby reducing the cost in price in setting a private internet address and setting up the apparatus.

Further report also concludes that by integrating the sensor with a GPS will enable the approx. distribution of these herbal along countryside or hilly areas. By gathering the data, a pattern could be formatted whereby we can not only find the distribution but can also help us to cultivate in other area.

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