International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol-6, Special Issue-3, Apr 2018 E-ISSN: 2347-2693

IoT based Monitoring System for Drought Prediction

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Available online at: www.ijcseonline.org

***Abstract*—** Drought is arguably the single biggest threat climate change. Its impacts are global. Therefore, there is a need for technological intervention to monitor basic information about the weather and soil condition, in order to identify and predict drought. The proposed wireless sensor drought monitoring system is capable of remote real-time monitoring for extended periods, identifying drought in the early stages. A combination of wireless sensor networks using TEEN (Threshold sensitive Energy Efficient sensor Network protocol) along with cloud technology would make data on humidity and salinity of the soil, temperature and light intensity on the surface that are accessible to end users. The data collected would then be transmitted to a public or hybrid cloud through satellite transmission protocols. Mobile cloud computing apps can be developed to raise an alarm when the drought conditions approach the critical stage. In this paper, we propose a novel IoT based monitoring system that assimilates data from real time weather and soil condition sensors. Thus providing a mobile client with which the user can monitor the drought conditions throughout the country, thereby indicating promptly when to take corrective measures.

***Keywords*—** Real-time monitoring, Wireless sensor network, Satellite transmission protocols, Alarm, Drought conditions, Internet of Things

I. Introduction

A **drought** is a period of below-average precipitation in a given region , resulting in prolonged shortages in the water supply, whether atmospheric, surface water or ground water. In India the history of droughts has been marked by periods of social tragedy and public health problems. The Great Bengal Famine of 1943 was a large famine in Bengal, a state in British-ruled India, claiming the lives of at least three and a half million people. The food crisis had begun as early as mid-1942.Deaths by starvation had peaked by November 1943. Food products could have been imported to reduce the adversities of drought. All the nations are trying out many ways to fight drought, yet there is no permanent solution.

But Prevention of droughts is the best solution. There is a need for technological intervention to identify and predict drought. The proposed wireless sensor drought monitoring system is capable of remote real-time monitoring for extended periods, identifying drought in the early stages. A combination of wireless sensor networks using TEEN (Threshold sensitive Energy Efficient sensor Network protocol) along with cloud technology would make data on humidity and salinity of the soil, temperature and light intensity on the surface that are accessible to end users.

II. Related Work

.Drought Prediction System for Improved Climate Change Mitigation was introduced to develop a new intelligent system concept for drought information extraction and predictions from satellite images. For the modeling experiment, this study used 24 years of data sets on selected attributes. By using these data sets, ten models were developed for predicting Drought Objects with a one- to four-month time lag for the growing season from June to October with an accuracy rate ranging from 0.71 to 0.95.

Drought Early Warning Systems in the Context of Drought Preparedness and Mitigation is an example of a new climate monitoring product, the Drought Monitor, is presented to illustrate how climate parameters and indices are being used in the United States to produce a weekly comprehensive assessment of drought conditions and severity levels.

III. Methodology

It has enhanced efficiency as it is using Threshold sensitive Energy Efficient sensor Network (TEEN) protocol.It is a distance adaptive system; it is accessible even in remote parts of the world. It uses hadoop to process complex data and presents the essential data to the end user. The monitoring committee's challenge is to coordinate and integrate the analysis so decision makers and the public receive early warning of emerging drought conditions. The proposed wireless sensor drought monitoring system is capable of remote real-time monitoring for extended periods. Intelligent sensors in a wireless network monitor the soil condition. These sensors collect various environmental; parameters and then send the pre-processed data wirelessly to a base station. From the base station this data uploads every two seconds to the cloud (internet) for further analysis. If a drought condition is identified by the monitoring system then an alert message is sent to the user via text message or email and the user is able to view .Once the data is captured it is recorded and displayed on Google Apps to be accessed by the user from anywhere.

IV. System Architecture

A. Block Diagram

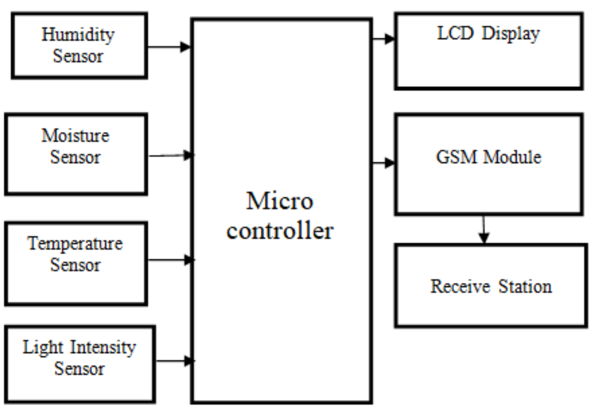


Figure1. System architecture of Sensors interfacing with microcontrollers

B. Description

1) Humidity Sensor

Humidity sensor takes the current humidity level of the environment and gives the output as an appropriate voltage to the microcontroller. The microcontroller contains an inbuilt Analog to Digital Converter (ADC) which converts the voltage given by the sensor to its appropriate digital value. The humidity sensor makes use of the resistive property to calculate the humidity.

2) Moisture Sensor

Moisture sensor consists of long copper probes which go into the ground. For our system, at a practical level, we are using a short probe. The probes measure the value of moisture content in the soil and give the appropriate voltage to the microcontroller.

3) Temperature Sensor

A simple temperature sensor is a device, to measure the temperature through an electrical signal it requires a thermocouple or RTD (Resistance Temperature Detectors). The thermocouple is prepared by two dissimilar metals which generate the electrical voltage indirectly proportional to change the temperature. The RTD is a variable resistor, it will change the electrical resistance indirectly proportional to changes in the temperature in a precise, and nearly linear manner.

4) Light Intensity Sensor

A light sensor is a device for measuring the intensity or brightness of light. One of the most common and least expensive detectors that can be used when building a light sensor is a photoresistor. Photoresistors, also called light detecting resistors (LDR) are made from cadmium sulfide (CdS) cells that are sensitive to visible and near infrared light. The resistance of a CdS cell varies inversely with the amount of light incident upon it – bright light causes a low resistance between the two leads of the cell while low light results in a higher resistance. When a photoresistor is placed in a voltage-divider circuit, proportional changes in light intensity can be measured with the Vernier Analog Breadboard Cable.

5) LCD Display

In this system we use a 16x2 display. The LCD displays the values of the sensor currently as well as the status of the micro-controller.

6) GSM Module:

The GSM module is responsible for sending the data from the sensors to the web server. The GSM module makes use of network connectivity in the form of GPRS data and sends the data to a specified IP address of the server.

7) Power Supply

Since each component requires some power to function, the power supply must be designed accordingly. The expected total power requirement is around 700-800mAh.

C. Working of Monitoring system

The level of drought occurrence is obtained by getting soil/atmospheric conditions through various sensors like temperature sensor, light intensity sensor, humidity sensor and soil moisture sensor. The information will be uploaded continuously from the WSN through Microcontroller and Wi-Fi [1]. We control and upload this data to cloud from where users can access it through a user interface (android application).The result values of different sensors depend on the area they are placed in. The result can be displayed on the PC or uploaded to the cloud.

V. Implementation Of TEEN Protocol

A. Working of TEEN

A Threshold Sensitive Energy Efficient Sensor Network has been depicted in fig.1.In this scheme, at every cluster change time, the Cluster Head (CH) broadcasts the following to its member in addition to the attributes [2]:

- **Hard Threshold (HT):** This is a threshold value for the sensed attribute. It is the absolute value of the attribute beyond which, the node sensing this value must switch on its transmitter and report to its CH.
- **Soft Threshold (ST):** It is a small change in the value of the sensed attribute which triggers the node to switch on its transmitter and transmit once the HT has been crossed.

In TEEN, nodes sense their environment continuously, thereby making it applicable for real-time applications.

The main features of this scheme are as follows:

1) Time basic information achieves the client promptly. Along these lines, this plan is prominently suited for time basic information detecting applications.
2) Message transmission expends considerably more vitality than information detecting. Along these lines, despite the fact that the nodes sense constantly, the vitality utilization in this plan can possibly be a great deal not exactly in the proactive system, since information transmission is done less much frequently.
3) The soft threshold can be varied, contingent upon the criticality of the detected trait and the objective application.
4) A smaller estimation of the soft threshold gives a more precise picture of the system, to the detriment of expanded vitality utilization. Consequently, the client can control the exchange off between energy productivity and accuracy.
5) At each cluster change time, the characteristics are showing once again thus the client can transform them as required.

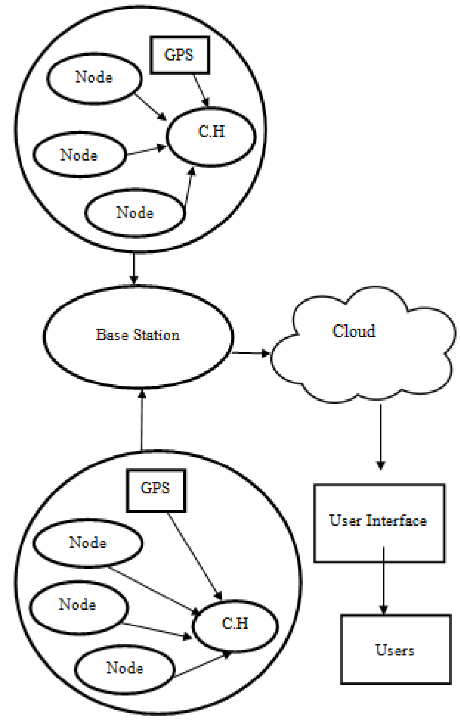


Figure 2. TEEN Structure

VI. Results And Discussions

A. Deployment

The sensors along with the microcontrollers are distributed along the field and using GPRS send the data to the cloud. In order to monitor the drought in different sites, we can upgrade our system with more wireless drought sensor units. By connecting to the internet, we can login to the system and get real time soil/atmospheric data remotely on any mobile device with internet connection [3].

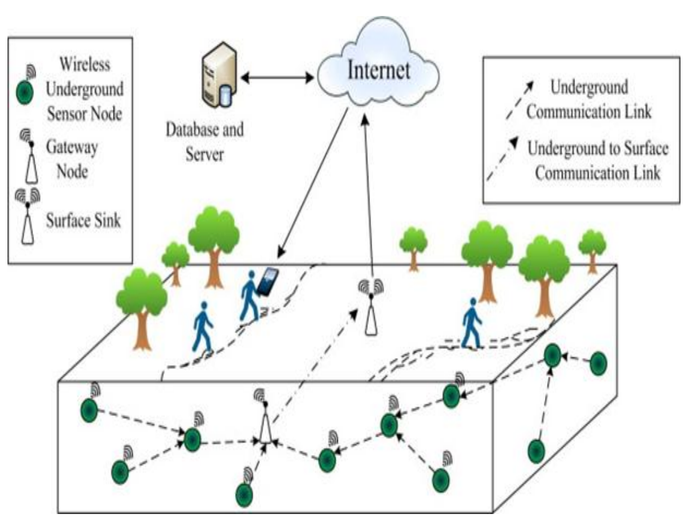


Figure 3. Communication between sensors

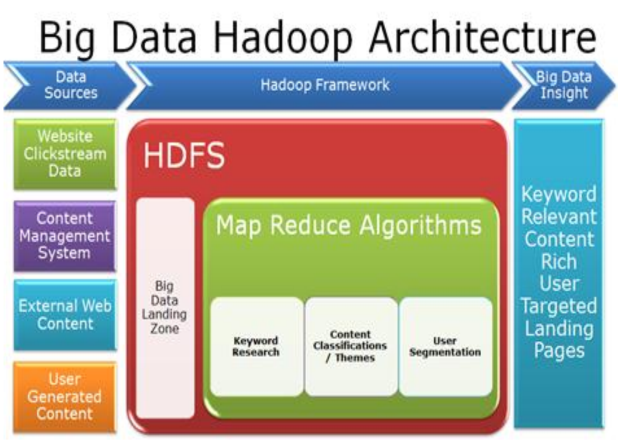
Two important aspects should be considered during the deployment of the sensors.

- **Connectivity**: the resulting network topology should allow information routing to take place.
- **Coverage**: the collaborative monitoring of the environment should allow a certain quality of collected information.

A possible methodology is to place the sink/gateway device(s) at a location (e.g. where a wired network connection or power supply is available). Place sensors in a prioritized manner where sensor measurements seem more necessary. If needed, add additional sensors to guarantee a certain desired connectivity level.

B. Data Processing In Cloud Computing

Data collected by the sensors are transferred to a public or private cloud for data processing. Cloud enables us to access anything at any time and any place in a user friendly manner using customized portals and in-built applications. Hence, cloud acts as a front end to access IoT. The data have to be stored and used intelligently for smart monitoring and actuation. Hadoop is an open-source platform designed for building reliable and scalable parallel systems [4]. One of the main benefits of HADOOP is its ability to work in a distributed environment. Due to the nature of the gathering process, which combines data from multiple locations, the geographical distribution of the database can be an advantage. In addition, given HADOOP's ability to automatically replicate data as well as it's security, reliability



and overall effectiveness can make it vastly beneficial as well structured ones.

Figure 4. Hadoop framework for Big data processing

C. Data Dissemination Using Mobile Applications

Applications are developed to disseminate the data to users wanting to access the sensor data from different OS platforms, such as mobile phone OS, Windows OS or Mac OS for a variety of applications. The users can select the desired location and the details in that area is delivered to the user. This structure allows users of different platforms to access and utilize sensor data without facing any problem because of the high availability of cloud infrastructure and storage.

D. Results Obtained

Successful deployment and testing of our drought monitoring wireless system that is capable of providing spatially distributed soil/atmospheric data relevant for plant growth. The coordinator software records, displays the data in real time and simultaneously uploads on to Google apps. It also embarks an alarm on reaching critical conditions.

VII. CONCLUSION AND FUTURE WORKS

This paper proposes a wireless sensor network based drought monitoring system. It can monitor four different soil/atmospheric parameters. Once the data is captured it is recorded along with the GPS locations and displayed on Google Apps to be accessed by the user from anywhere. Future scope includes providing detailed updates to the user, increasing the range of sensors and adapting measures to decrease the system size.

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