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Cloud Integrated Temperature Sensor Using Restful Web Services

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ABSTRACT: In today's scenario, the Cloud environments are mainly used for storage and processing of data. It is a flexible, powerful and cost-effective framework in providing real-time data to users at any time with vast coverage and quality. Wireless Sensor Network is an very important technology in which sensors are placed in a distributed manner to monitor the physical and environment changes such as temperature, pressure etc. Combining these two technologies deals with the easy management of remotely connected sensor nodes and the data generated by these sensor nodes. By connecting, evaluating and linking these sensor networks, several data conclusions can be made from the real time data .The integration of Wireless Sensor Network and Cloud computing is used to continuously monitor the temperature of an environment and simultaneously store this data in cloud. The sensor is set to send a Push notification to the client regardless of his location in case of any changes in that environment and thereby intimating him about the necessary actions to be take**n.**

Keywords: *Statistical approach , intelligent decision support system , cloud computing , wireless sensor , Arduino-uno.*

INTRODUCTION:

The Internet of Things (IoTs) is described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the World Wide Web where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves. According to a survey in 2008, the number of connected devices surpassed connected people and it has been estimated by Cisco that by 2020 there will be 50 billion connected devices which is seven times the world population. One of the most important elements in the Internet of Things paradigm is wireless sensor networks (WSNs). WSNs consist of elements such as smart sensing nodes with an embedded CPU, and sensors which are used to monitor the environmental conditions such as temperature and collect the sensed data. In short, the actual purpose of the WSN is to provide sensing services to the users. Since, the number of Internet users are increasing, it is in need to provide WSN services to this ever growing community.

RELATED WORKS:

A. *Management of Wireless sensor networks using cloud technology*

As per Dipankar Mishra and Geeta Bhatia Sensor networks are widely used to monitor real time parameters. These networks play a vital role in providing critical data in any field of application. The Advancement of technology in the field of sensors, wireless networks has resulted in the interfacing of sensors to the Information Technology sector. Data from the sensor networks is analysed at the base station and depending upon the situation, sensor nodes are manipulated manually to provide an optimized performance. This paper presents a concept of remote and automated monitoring of wireless sensor networks with least amount of human intervention.

B. *Integration of Wireless Sensor Networks to Cloud services for data collection and sharing*

According to Swathi B S and Dr. H S Guruprasad Cloud environments are mainly used for storage and processing of data. Cloud computing is a known for enabling convenient and on demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with a minimal management effort. Wireless Sensor Networks have been seen as one of the most recent technology, where distributed and connected

sensor nodes automatically form a network for data communication. A sensor network is known as the group of specialized transducers with communications infrastructure intended to monitor and record conditions at diverse locations. Commonly monitored parameters include the temperature, humidity, pressure, wind speed, illumination, etc. The real-time sensor data must be processed and the action must be taken regularly so as to handle the situation in a right manner.

C. *A Survey on Cloud Sensor Integration*

According to Chandrani Ray Chowdhury, Wireless Sensor Network (WSN) has become an important entity in human life. It succeeds in reaching those areas where humans could not. The advancement of these networks has become an invincible trend in various industrial, environmental and commercial areas. However it has certain resource and design constraints. This can be overcome by integrating cloud computing with the WSN. The main areas involved in sensor cloud integration are Sensor Cloud Database, cloud based sensor data sharing platform and cloud based sensor data processing platform.

D. *Towards Internet Of Things* (IOT) : *Integration of wireless sensor networks to cloud services for data collection and data sharing.*

As per Seong Ro Lee, Cloud computing provides enhanced benefits for applications hosted on the Web that also have special computational and storage requirements. This paper uses an extensible and flexible architecture for integrating Wireless Sensor Networks with the Cloud. The REST based Web service is used as an interoperable application layer that can be directly integrated into other application domains for remote monitoring such as health care services, smart homes. The REST based Web services enables data access from anywhere. The alerting feature has also been included to notify users via email or tweets for monitoring the data when they exceed certain target values and events of interest. This ensures that the client is aware of the environmental condition so that he can take necessary actions.

ARDUINO – UNO

Arduino is an open-source platform used as a part of electronics projects. An Arduino consists of both a physical programmable circuit board and a piece of software, that runs on PC , used to write and upload code to the physical board. It does not need a separate piece of hardware (called a programmer) in order to load new code onto the board . The user can simply use a USB cable to integrate the board to the PC. Additionally, the Arduino IDE uses a simplified version of C++, thereby making it much easier to learn and program.

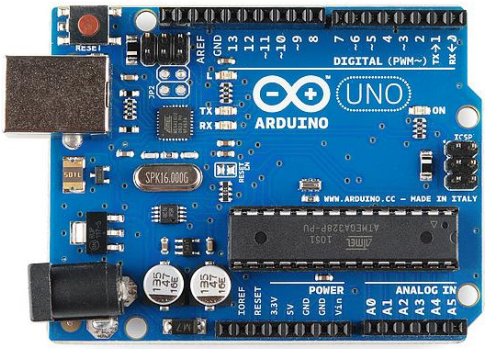

Figure 1. IC picture

Using simple code, the Arduino can control and interact with a wide variety of sensor devices.

WARNING, ERROR AND STATUS CODES:

//status
#define MSG-METHOD_SUCCESS 0
Terminated successfully
//warnings
#define WRG_NO SERIAL_DATA AVAILABLE 250
Available at the serial input buffer
//errors
#define ERR_SERIAL_IN_COMMAND_NOT TERMINATED -1
Last char is not a '#'

PSEUDOCODE:

n=0 ; number of measurements taken in current day loop {
if n==0 then {
max = temp
min = temp
avg = temp
} else
{
if temp > max then max = temp
if temp < min then min = temp
}
avg = (avg*n + temp) / (n + 1) ; moving average
display current temp, min, max, average
pause until next measurement time
increment n
If time==midnight then {
n =0
print / save to file, max, min average }
}

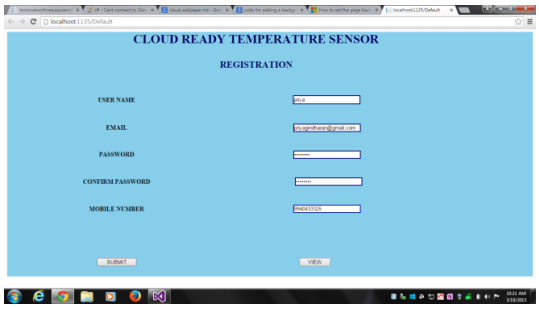

Figure 2. Login page

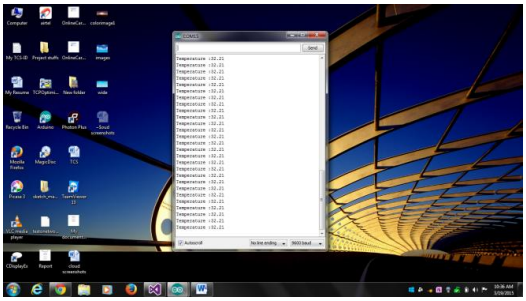

Figure 3. Server page

SYSTEM ARCHITECTURE

The intelligent and adaptive decision making system architecture for alarm generation system has three subsystems viz.
(1) *Data Acquisition system* that is responsible for acquiring the monitored environment's information with the help of its sensor nodes and sending them to the central server via a gateway node.
(2) *Intelligent information processing system* that maintains a log of the collected data in an on-line database, continuously monitors the data, and hence analyzes the events to take decisions and send alerts to notification system.
(3) *Alert notification system* that processes the alerts and proceeds to send the formatted and structured SMS to the concerned authenticated user using a GSM Modem. However it also encompasses sending e-mails as an alert notification.

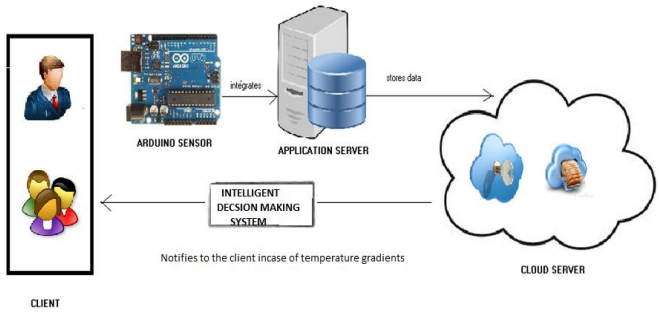

Figure 4. System Architecture

EXPERIMENTAL WORK:

Data Acquisition:

The wireless sensor network consists of a coordinator called base station. It is responsible for starting the network and managing it to a certain extent. The Base station is connected to a normal power supply through central server (PC), since it generates and receives lots of radio packets. It therefore remains active to maintain and log all ongoing operations of the network. The routers, known as aggregators are responsible for relaying data across multiple hops of the network, extending coverage and flexibility of network. End-devices i.e. the sensor nodes are responsible for performing data collection at regular intervals and/or on-demand.

Each sensor node senses the data according to certain predefined sensing frequency that depends on the type of data to be sensed and also the configuration of the node. The external sensors sense the physical parameters and generates signals in accordance to the design and specification of the sensing device. Whenever the sensor node senses data which is beyond a predefined tolerance level it notifies the client regarding this environmental condition. Different tolerance level is chosen for different sensing devices based on their purpose.

Intelligent Information Processing:

The data obtained from the base station are collected and stored in an online cloud database. These Logged data are used to calculate the temporal gradient over a period of time for every individual sensor node. Information Processing system deals with an interaction of the system with the user through the Graphical User Interface (GUI). Log files are maintained for all alarm notifications in the database.

Through this interface, we can also authenticate the user by receiving his/her mobile number for receiving the alert notifications. All the logged data records together with their corresponding decisions i.e. alarm or not alarm, are fed to an artificial neural network (ANN) for training. On the other hand, the system uses the Hidden Markov's Process to evaluate the probability of any temperature gradient even before it prevails in the target environment. This is used to have an intelligent and supervised learning of the mechanism used in the decision support system for generating alarms in future.

Alert Notification:

The detection of an abnormal event is done by the processing system. This system will invoke an alert notification system to send the message to the concerned authenticated user. Alert notification system defines the different kinds of alerts and is responsible for authenticating various users and their mobile numbers as well as their email-id. Different users are specified for different type of alerts and for different locations. If any kind of alertness is detected by the processing system, then an alert message is composed in a predetermined format is sent as SMS through GSM modem to the concerned user or client. This alert message is also sent as an email for record purpose.

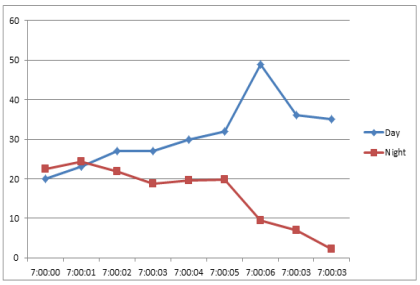

Figure 5. Temperature vs time (s) graph

Thus as shown in the figure, when there is any hike or fall in the temperature value, then the decision support system functions accordingly and sends an immediate PUSH notification to the client thus establishing an asynchronous way of data transmission.

CONCLUSIONS AND FUTURE WORK

An intelligent and adaptive alarming system in a wireless sensor network zone is being proposed.The system is designed to be interactive for sensor network management system and generating notifying alerts through SMS using GSM modem to concerned authenticated user(s). The system is scalable as it allows the sensed data to be stored at the cloud server that can be accessed by the client without having any impact on the application and regardless of his location. The alarm detection system uses both spatial and temporal gradients of received signal, along with the acceptance range of threshold values to constantly monitor the target environment. It aims at generating alarms for abnormality in light condition, fire detection, movement of objects,etc that affects the temperature conditions in that environment. In future, it is proposed to use the fuzzy logic and machine learning techniques for more accurate prediction of alarm. The same system can also be used for monitoring health condition of different sensitive equipment in laboratories.

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