AN OVERVIEW OF PLANT ENVIRONMENT MONITORING SYSTEM

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Abstract — Internet of Things (IoT) and cloud computing are increasingly used in many real time applications. Their usage makes nightmare scenarios possible and also greatly reduces human labour in many fields. IoT is transforming the agriculture industry and enabling farmers to contend with the enormous challenges they face. Data processing systems that handle massive data are less efficient when deployed in non-cloud systems. Hence when Wireless Sensor Networks are integrated with cloud, a more scalable processing system can be produced. This paper surveys such scenarios in detail. It compiles the latest trends and opportunities in IoT and cloud based processing.

***Keywords* --** Internet of Things (IoT), Wireless Sensor Networks (WSN), Sensor, Gateway, Network and Protocol.

I. INTRODUCTION

AS everything moved online now a day, billions of everyday products are connected to the wireless web for different purpose, where IoT plays vital role to drive digital transformation of the physical world. The touch of IoT is a bit sparse yet upcoming in the fields like medical, agriculture, chemical industries and many more. In modern communication world, new technological assistance may improve the profit in many ways. IoT is a new technology which enables things to communicate among them to carry out a required action without human intervention. When such IoT systems are integrated with cloud platforms the systems become more scalable for real time data and complex processing.

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Many researchers introduces the concept of data gathering through WSN [1,6,12,17] , combining data in cloud platform, performing analysis in cloud platform and generating control mechanisms or reports on the analysed data. They employ Wireless Device Network (WDN), Mobile Crowd Sensing (MCS), wearable sensors, gateways, and sensor kit modules for data gathering from real time environments. Protocols like ZigBee, Bluetooth and WIFI are used for communication of data and other controls. Several cloud services and platform like Hadoop, MapReduce, RESTful API, Bigtable and many more are used for cloud processing and control. Effective sensory data acquisition can be done using various hardware and communication techniques [7,8]. They also explain data cleaning and data handling mechanisms. [9] compares cloud and non-cloud systems based on two case studies and implies the importance of cloud in real time environments. As there are several techniques and knowledge framework for real time implementation of processing and monitoring system, it is necessary to monitor the environment efficiently for improving the cultivation [10,11]. This article provides a bird eye view on environment monitoring techniques and trends in real time agriculture. In agricultural farms, periodical checking of environmental parameters improves the cultivation, but it is difficult practically. The tremendous growth of telecommunication facilitates farmers to fulfill their requirements readily and increases the yield and profit too.

II. RESEARCH BACKGROUND

Muhammad et al. [1], proposed architecture for Environment Monitoring System using Wireless Sensor Networks. They apply it on vehicles to control pollution in cities. They use mesh network for data gathering from WSN nodes. They attach sensor nodes on the public transport vehicles. These mobile nodes pass through various locations of the city so as to monitor the varied concentration of air pollution in different areas. These sensor nodes also get the data of other parameters like the passenger's information, transportation information and much other information. Clusters are developed at different locations; they measure the concentration of air pollution in specific areas, so that necessary action will be taken on specific areas where air pollution is more. The sink node in each cluster makes analysis easy. The stations have zigbee wireless sensors, so when the bus stops at the station the LTE-M modules will collect data from zigbee wireless sensors and will send it to the cloud where it will be analyzed accordingly. Thus the concentration of air pollution is captured, analysed, and monitored by the government bodies across the city. The Necessary action can be taken easily on the specific areas that are adversely affected by pollution.

Ferreira et al. [2], proposed an environmental sensing and monitoring platform using a cloud and ubiquitous architecture. It takes Big Data processing capacity, towards an efficient and effective scenario. Its logical architecture components are Infrastructure, middleware, data processing, presentation, and social network. The infrastructure includes WSN having plug and work components like Wireless Devices Network (WDN) which includes sensors, cameras and other devices. The middleware acts as an integrator for data collection and configuration on remote sites. The data processing handles the analysis components with RESTful API to integrate new devices and services. The presentation is used for presenting analysed values in a effective dashboards for human analysis and decisions. The social network is used for communicating the analysed views with the outside world. So, by this architecture the environment and remote sensing variables are monitored and visualized for further decisions and communications.

Yunchuan and Antonio [3], promoted smart and connected communities (SCC) evolving from the concept of smart cities. They believe that internet of things provides a ubiquitous network of connected devices and smart sensors for SCC. They frame four layers, sensing layer, interconnecting layer, data layer and services layer to promote SCC. By these layers the data from various location are sensed, integrated and analysed to be given as an effective information to SCC enabled service holders. They talks mainly about two IoT concepts Mobile Crowd Sensing (MCS) and Cyber Physical Cloud Computing (CPCC). The MCS improves storage capacity and reduces cost on deployment and maintenance. The CPCC improves efficient use of resources in cloud platform. The major limitation in this practice is lack of privacy and cyber security. It doesn't support data heterogeneity and decision making at uncertain situation. As a case study, they present TreSight which integrates IoT and big data analytics for smart tourism and sustainable cultural heritage in the city of Trento, Italy. It uses data analytics in three levels; insight (understanding deep on data itself), outsight (understanding in social and external) and foresight (for predictions and preventions).

Robert, Abdul, Selase and Seth [4], proposed a fuzzy logic based multi sensor fire detection system and a web based notification system. For preserving the reliability of the fire detection mechanism they uses multiple sensors. But multiple sensor values must be fused together for further analysis and insights. For effective aggregation of multiple sensor data, they use fuzzy logic. It deals with uncertain data in an effective way and leads to right decisions.

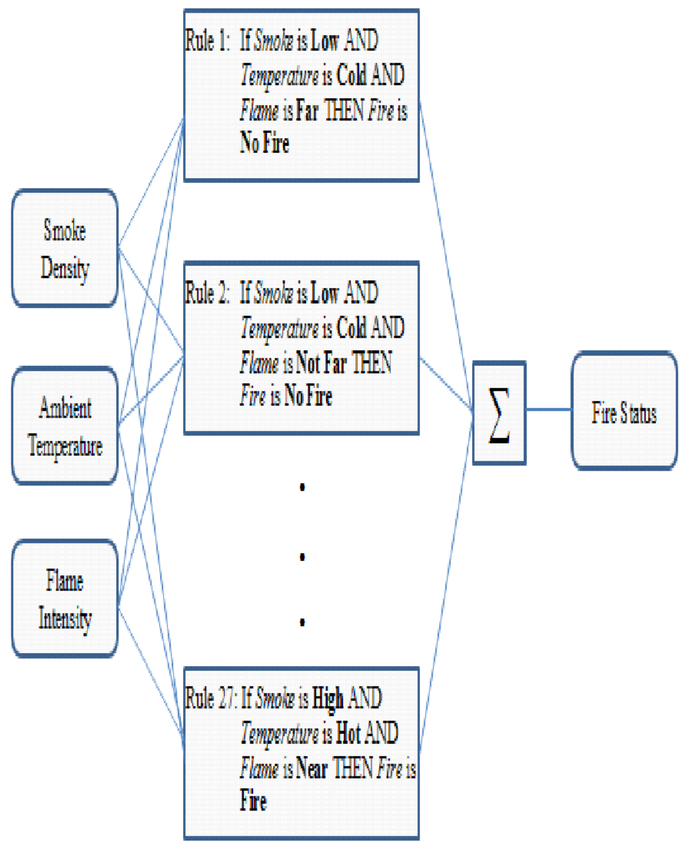

Fig 1. Explains the fuzzy logic used for fire detection.

They made to dispatch a notification on detection of fire from the output. They connected the fire detection system and the notification system using a SMS over GSM network. They implemented the fuzzy logic based fire detection system using arduino. The multi sensor environment includes, smoke sensor, flame sensor and temperature sensor. In the web based notification system they have two modules the user facing console for house owners and the super user administration console. Thus by this fire detection and notification framework false positive scenarios are avoided and alerts are given at right time to the users using SMS service.

Bing and yu [5], relates the interconnection of wireless sensor networks and cloud-based storage and computing infrastructure. They proposes the idea of distributed databases to store sensor data and MapReduce programming model for large-scale sensory data processing. They use HDFS and HBase for data storage and Hadoop MapReduce for data processing. They interconnect WSN with cloud using gateways. They make gateway to access remote cloud service through Java API interface for data writes. The gateway receives data from the Sink node and then writes data into local storage as a backup, and a daemon thread is in charge of periodically writing data to Cloud Data Center. The HBase and HDFS enables hosting of large tables and facilitates random, real-time read/write access. The MapReduce is a parallel programming language used for effective processing of large amounts of data. Thus the framework improves the data storage and processing capabilities of voluminous data.

Moeen et al.[6] analyses the opportunities and challenges in the implementation of a new IoT based wearable sensor technology in health monitoring field. In the architecture they defines a filter system running on the smartphones, which takes the patient's health records from the smart phone apps and compares with a lookup table, which contains the normal readings of the different health parameters. If the incoming health readings to the filter are found to be abnormal, then an alert message is sent to the doctors and a copy of the same record is also sent to cloud running EMR systems maintained by the hospital. The consolidated report that is sent to the doctor also contains the location (address) of the patient, sensed through the GPS sensor running on the smart phone. They provide a high level of integration, interoperability by using cloud which also permits a fast access and sharing by authenticated users. They apply a set of security constraints and access control to guarantee integrity, confidentiality, and privacy of medical data. Thus they introduce a new generation of Health Care system that are able to provide healthcare services of high quality and low cost to the patients using the combination of big data analytics, cloud computing and mobile computing technologies.

Chunsheng et al. [7] proposed a framework to process and transmit the sensory data collected by the sensors. It includes data traffic monitoring, filtering, prediction, compression, and decompression capabilities in the sensor gateway and the cloud gateway. The WSN–MCC integration framework can be described as; each WSN node that gathers sensor data is connected to a sensor gateway. The sensor gateway gathers the data collected by all the sensors and processes the data. The processing components are: data traffic monitoring unit, data filtering unit, data prediction unit, data compression unit, and data encryption unit. The data traffic monitoring unit checks the normal acceptable data traffic. If the data traffic go ahead of the normal limit, then some sensors are compromised. The data filtering unit removes all unacceptable sensor values. The data prediction unit uses Secondary Exponential Smoothing Model (SESM) for smoothing and forecast purpose. The data compression and encryption unit are employed for effective transition of data. The transformed data is send to the mobile users for further insights and usage. The capabilities and high performance of the proposed framework enable the mobile users to securely obtain their desired sensory data faster.

Sushabhan, Piyush, Rajesh and Anita [8], proposes a data acquisition for factories and industries, which will measure and gather the required parameters from the environment. They send the data gathered to control rooms through ZigBee protocol. So from the control room the users can use the data through their smart phone. The control room node contains ZigBee transceiver module to receive the information and Bluetooth modem send data to the smart phones, tabs and PCs. The system contains a transmitter section, a receiver section and a tablet/smart phone. The transmitter section collects data from the environment using various sensors like gas sensor, temperature sensor and sound sensor. The collected data is sent to receiver section through a ZigBee module in the arduino board. In the receiver section the zigbee receiver gets the data and sends required information to pc and smartphone through bluetooth. Thus this design will be useful for farmers for getting all information about the environment in a single piece of device which is easily operable by anyone.

Victor and Gary [9], compare cloud and non-cloud storage of big data. They use Organizational Sustainability Modelling (OSM) for experiments to ensure fair comparisons. OSM defines the actual and expected execution time, risk control rates and is mainly used to relate the key outputs of cloud and non-cloud experiments. They deployed cloud and non-cloud

Storage for biomedical scientists. They conducted experiments to compare the performance and efficiency in cloud and non-cloud systems. Forty experiments on both cloud and non-cloud systems were done on two case studies. The first study was on transferring and backing up 10,000 files (1 GB each) and comparing performance between cloud and non-cloud systems. The second case study was on transferring and backing up 1000 files (10GB each) and comparing performance between cloud and non-cloud systems. The results are summarized as 1) the actual execution time and the expected execution time on the cloud system was lower than that on the non-cloud system. 2) The cloud system had 99% consistency on expected and the actual execution time but the non-cloud system doesn't show any consistency on execution time. 3) The efficiency was higher on the cloud than the non-cloud. They sensed same risk-control rate for each experiment.

Hung, Kai and Tsung [10], presents a cloud-based system framework based on Bigtable and MapReduce. They propose a cloud-based system for providing a web-based service for managing BIMs in name as CloudBIM. They employ a private cloud model and SaaS. They makes use of Bigtable at the data layer and MapReduce at the processing layer. Bigtable is a compressed data storage system deployed over a distributed file system setting. MapReduce is a programming model for processing and generating large data sets stored in Bigtable with a parallel algorithm on a cluster. They let the users on the client side to view the 3Dmodel of a BIM via browsers using HTML5 and WebGL technologies. The information is provided by a cloud platform and a HBase database on the server side. Users can also upload BIMs and after processing by MapReduce, they are stored in HBase for other users on the client side to view and use.

They consider four analysis mode types based on the MapReduce computing frameworks.1) Quantity calculation on massive BIM data 2) Data mining pre-processing on massive BIMs 3) Data mining on the results of Mode 2 4) Exporting the data of massive BIMs in analysis software file formats. Thus this framework gives a cloud-based system framework for viewing, storing, and analyzing massive BIMs by combining Apache Hadoop cloud computing technology, WebGL 3D display technology, and HTML5 webpage technology.

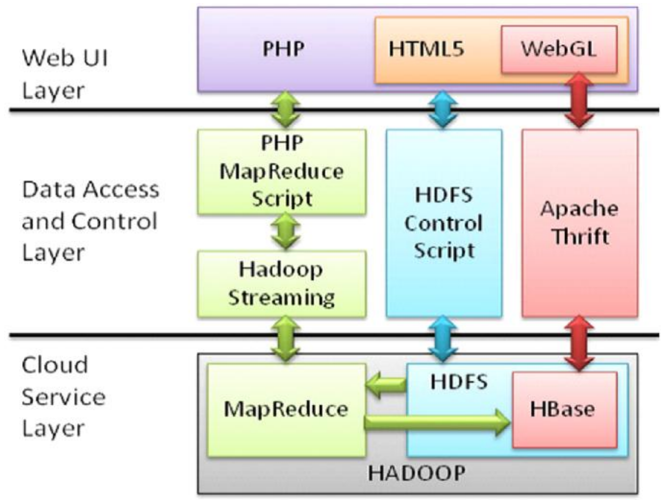

Fig 2. explains the process of cloud and web access.

Amelie, Pankesh, Amit and Martin [11], focuses on a knowledge framework for smart IoT systems. They strongly believe that smart IoT applications modify our physical world and our computations, like remotely controlling appliances at home. They see interoperability as a major issue in smart IoT trends, because each protocol and each device have unique characteristics. Hence smart IoT systems must be interoperable to support all technologies. They envision a framework for smart IoT systems with three layers in it. The layers are physical layer for accessing things, virtualization layer for deducing new knowledge and cyber layer for composing services. They use physical layer to enable a device such that an application can interact with. It is set to gather data using gateways, to interface with cloud services by using protocols like REST and to annotate domain specific data. Such annotations enable IoT services in implementing analysis and reasoning algorithms. In virtualization layer they include different processes and steps for combining data from heterogeneous sources and for building interoperable and innovative applications. In the cyber layer they get the services closer with the user by enabling the user to create intelligent applications on top of smart things. This knowledge framework makes development effort more easy and understanding.

Li, Hong, Cheng and Cheng [12], talks about the usage of zigbee protocol in monitoring and protecting electrical system in buildings. They compared various communication protocols like Zigbee, Bluetooth and Wifi for performance evaluation. And the choose Zigbee for their proposed work. They form two type of nodes base node and smart node. They form a star structure using their ndes and the way of connection between base and smart node is by polling. The smart node gathers parameters like current, power and voltage from the outlet. It then sends the gathered data to the base node through ZigBee. Now the base node is set to calculate required information for the protection function. They consider the transmission distance of ZigBee to be 100m under a barrier free condition. ZigBee uses direct sequence spread spectrum (DSSS) to reduce the environmental interference. Thus the usage of ZigBee helps to frame a remote monitoring system which could improve the functions lacking in traditional NFB systems, and enhance the electrical safety of buildings.

Hemlata, Sukheh and Dipali [13], talks about modernizing agriculture in countries like India by implementing real time monitoring system. They propose a multidisciplinary model with five modules: Sensor Kit Module, Mobile App Module, Agro Cloud Module, Big-Data Mining, Analysis and Knowledge Building Engine Module and Government & Agro Banks UI. Government and Agro Banks user interface is a web interface that gives information related to agricultural schemes and loans, based on the analysis done in Agro Cloud module. They uses Beagle black bone which is a reliable IoT device that can be interfaced to soil and other environmental sensors to collect soil properties and current environmental conditions respectively. Big data analysis on Agro Cloud data is done for fertilizer requirements, best crop sequences analysis, total production, and current stock and market requirements. This model is beneficial for increasing agricultural production and for cost control of Agro-products. The collected big-data will be analysed for the required actions for production.

Xin, Huamin and Supeng [14], proposes an concept for monitoring ginseng planting environment. They uses wireless sensors and transmitters to transmit environmental parameters using GPRS wireless transmission module and video monitor and alarm of ginseng land by using unattended machine. The system collects information about ginseng planting environment in real time and uploads to data warehouse. In monitoring process, the system has artificial operation, to avoid human intervention and ensures the authenticity and availability of data. By this they monitor the circumstance of ginseng lands, the system informs abnormal condition to the host computer , through 3G and its burglar alarm that makes a shrill sound to alarm once the values are beyond the threshold. Meanwhile it opens the camera and shoot immediately in order to get images of the scene, the images are transmitted and stored in the host computer.

Tong, Jing, Qing and Qunying [15], considers the time varying climatic data and frames a cloud based visualization tool to improve the usability of those data. The conceptual design contains a three tier architecture containing three levels cloud infrastructure management level, middleware level and client level. They developed visualization system based on Amazon Elastic Compute Cloud (EC2). Climatic data are stored on Amazon Elastic Block Store (EBS), and are attached to EC2 instances during visualization. The infrastructure management tools are developed on the Amazon Web Service (AWS) Software Development Kit (SDK) for Python. Python based infrastructure/AMI management tools were devised to communicate with EC2 platform, and facilitate the automated deployment and initialization of cloud instances. The Client communication management middleware, was done on a Django-based interface which is used to establish communications

between client-side JavaScript code and server-side Python programs. They implemented some 3D visualization algorithms for spatio-temporal climate data like raycasting and isosurface for volume

rendering, and streamflow for flow visualization. Thus using cloud principles they achieved a user scalable and a user friendly visualization tool for time varying climatic data.

Keerthi and Kodandaramaiah [16], proposes a greenhouse monitoring system based on IoT and cloud. They believe that, the materials used, energy, crop yield and quality can be influenced by operating the adjustable properties of greenhouse. In the system they monitor a variety of environmental parameters in greenhouse to meet the actual agricultural production requirements. It also monitors the window opening, drip irrigation, screening and CO_2 dosage. They use devices like temperature sensor, light sensor, relative humidity sensor and soil moisture sensor in the crop environment. The integrated information from the sensors allows the farmer to improve the cultivation in a way the plants needed. When the power supply is given either through a dc battery or through a solar charging circuit, the process starts. The GSM SIM starts to find the network and the sensors Start sensing the corresponding parameter values are displayed on the LCD. The temperature is displayed in centigrade, humidity in percentage, and light in terms of LUX. It is expected that the way the controls are operated, influences the final economic result.

Gaddam, Hrooby and Esmael [17], says the requirement to monitor basic information about the weather and soil condition in order to identify and predict drought conditions. This system integrates WSN and IoT, to report drought condition promptly and to achieve smart, precision agriculture. They frame a wireless system consisting five wireless sensor modules that are distributed over a farm. These modules continuously collect environmental parameters such as relative humidity, soil moisture content, sun light (luminance levels), and ambient temperature. The data collected by each sensor is sent to the base station through ZigBee protocol. The recorded data is displayed in the form of graphs on Google Apps via Raspberry pi which is connected to the internet. Thus by these parameters, droughts are predicted and relevant measures are taken in advance.

III. Conclusion

This article surveyed on various trends and use cases of IoT and cloud based processing in today's world. Various opportunities for application, forms of application and needs of improvement are discussed and identified. Perspectives of varied authors are captured and fruitful insights are gathered. The insights from the surveyed literature works motivates us to frame a plant environment monitoring system that periodically gathers data from the plant environment and sends the raw data to the processing unit which manages to visualize the data into useful format.

IV. Acknowledgment

We cordially thank our institution for their support and our lecturers for their constant insights and guidance for the survey.

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