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oneM2M Compliant Sensor Network for Smart farming & Cellular Radiation Monitoring

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***Abstract*— Agriculture is the worldwide prime occupation of human being. The increase in the pollution and other environmental problems such as global warming and radiation from the base stations have harmful impact on the farming practices as well as threats to health of human beings. So, the modern technology is necessary to resolve these problems and support better irrigation management. This paper presents a system with a oneM2M compliant sensing network that senses the soil moisture, temperature & humidity, light content and the electromagnetic field (EMF) radiation in the environment and send the collected data over Wi-Fi to the Thing Speak server. Raspberry Pi is the controlling unit for this system that collects all the data and send over Wi-Fi. The present work focuses on developing a Smart Farming System for helping the farmers in increasing their productivity. Additionally, this system also monitors hazardous radiation from cellular towers.**

***Keywords*—** *EMF, IoT, Things Speak, oneM2M, Sensor Network Wi- Fi, Wireless, WSN, LDR*

I. INTRODUCTION

The worldwide prime occupation of human being is agriculture, which occupies 64% of total available land and it consumes 85 % of fresh water [4]. With the increase in pollution level, environmental problems and mobile phones electromagnetic (EMF) field radiations from the cellular towers, the health of human beings is being affected .There is a challenge in front of every country to have a systems for good farming as well as to monitor the environmental parameters and harmful radiations from towers. Since last decade, some system are working to improve irrigation practices and hazards monitoring, but these systems have some limitations.

The proposed wireless sensor networks (WSN), is a self-configuring network of a sensing node and various sensors communicating among themselves based on oneM2M standard.

The paper is organized as follows, first a brief description of Wireless Sensor Technology, followed by the oneM2M overview, then related work in this area and finally the proposed hardware model is explained with implementations and conclusions. The paper emphasis on a oneM2M compliant Wireless Sensor Network that has a sensing node that sense the data from various sensors and send it over the server using Wi-Fi at 2.4GHz with raspberry-pi as the controlling unit.

II. WIRELESS SENSOR TECHNOLOGY

The Wireless Sensor Network(WSN) is an inter related system of devices, mechanical and digital machines with a unique identifier and the capacity to transfer data over a network with requiring human to human or human to processor communication. Applications of Wireless Sensor Network (WSN) can be found in various sectors such as health, education, agriculture cultivation, environment pollution control etc. Cloud Computing enables to devour a compute property, such an effective machine, storage or an application as a utility to improve the betterment of living.

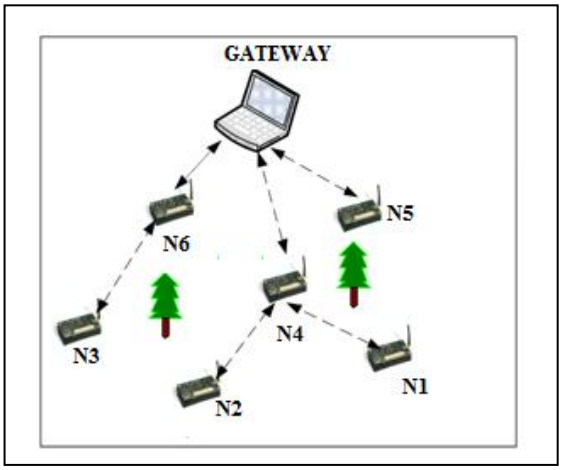

Fig. 1. Elements of Wireless Sensor Network

III. OVERVIEW OF ONEM2M

M2M communication refers to the technologies that allow wireless and wired systems to communicate with their devices

of the same ability. oneM2M is a global standard initiative for machine to machine communication.

oneM2M is producing specifications and reports for M2M communications and IOT applications .It aims to provide a common set of service layer capabilities, an access – independent view of end to end service, open / standard interfaces ,APIs and protocols, security, privacy and charging ;reachability and discovery of applications; identification and naming of documents and management aspects.

The oneM2M functional architecture comprises the following functions:

A. Application Entity (AE):

Application Entity is an entity in the application layer that implements an M2M application service logic. Each execution instance of an application service logic is termed an "Application Entity" (AE) and is identified with a unique AE-ID . Examples of the AEs include an instance of a fleet tracking application, a remote blood sugar monitoring application, a power Metering application, or a controlling application.

B. Common Services Entity (CSE):

A Common Services Entity represents an instantiation of a set of "common service functions" of the M2M environments. Examples of service functions offered by CSE include: Data Management, Device Management, M2M Service Subscription Management, and Location Services.

C. Underlying Network Services Entity (NSE):

A Network Services Entity provides services from the Underlying network to the CSEs. Examples of such services include device management, location services and device triggering.

oneM2M NODES:

Nodes are logical entities that are individually identifiable in the oneM2M System. Nodes are either CSE-Capable or Non-CSE-Capable:

•A CSE-Capable Node is a logical entity that contains at least one oneM2M CSE and contains zero or more oneM2M AEs. The ASN, IN and MN are examples of CSE-Capable Nodes.

•A Non-CSE-Capable Node is a logical entity that does not contain a oneM2M CSE and contains zero or more oneM2M AEs. The ADN and Non-oneM2M Node are examples of Non-CSE-Capable Nodes.

A. Application Service Node (ASN):

An ASN is a Node that contains one CSE and contains at least one Application Entity (AE). There may be zero or more ASNs in the Field Domain of the oneM2M System. Example of physical mapping: an ASN could reside in an M2M Device.

B. Application Dedicated Node (ADN):

An ADN is a Node that contains at least one AE and does not contain a CSE. There may be zero or more ADNs in the Field Domain of the oneM2M System.
Example of physical mapping: an Application Dedicated Node could reside in a constrained M2M Device.

C. Middle Node (MN):

A MN is a Node that contains one CSE and contains zero or more AEs. There may be zero or more MNs in the Field Domain of the oneM2M System. Example of physical mapping: a MN could reside in an M2M Gateway.

D. Infrastructure Node (IN):

An IN is a Node that contains one CSE and contains zero or more AEs. There is exactly one IN in the Infrastructure Domain per oneM2M Service Provider. A CSE in an IN may contain CSE functions not applicable to other node types. Example of physical mapping: an IN could reside in an M2M Service Infrastructure.

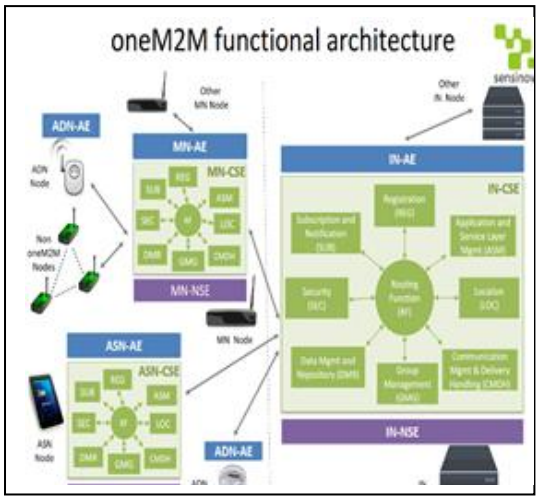

Fig. 2. oneM2M functional architecture

IV. RELATED WORK

A. Agriculture Field Monitoring

This paper proposes the design to monitor the same attributes using wireless sensor network. Moreover, when a critical change in one of the measurements occurs, then the farmer will be acknowledged via SMS and e-mail by an agriculture expert [4].

B. Environment Monitoring System

This system collects various climatic parameters like temperature, humidity etc. The system includes a web application which is using Google Maps to show the greenhouse status and provide regular voice and SMS alarm service. Since, it requires lots of power so it is powered by solar and storage batteries.

C. Development of Precision Agriculture System

In this scheme temperature and humidity sensors are deployed at suitable location to examine the yield. Sensing system uses response control device with manage component which wheel stream of water depending on temperature and moisture value. Control unit collects data from sensor analyze it and take feat [7].

D. Drip Irrigation System And Monitoring of Soil Wirelessly

In precedent various lifetime the farming technology has abrupt expansion. In this method the test of soil for chemical constituent, salinity, manure & irrigate stuffing and all these information is collect wireless nodes and further processed for the development instream irrigation plan [6].

V. PROPOSED MODEL ARCHITECTURE

The proposed model consists of a microprocessor (Raspberry-Pi) as a main processing unit that controls the entire system from the sensor interfacing to the collection of data and sending the data over the Wi-Fi to the server. The collected data from various sensors is processed and analyzed and updated to the cloud through Wi-Fi module by the microprocessor connected to it. Here we are using Raspberry – Pi to meet the oneM2M requirements. All data communication is based on oneM2M standard, C-DOT developed software stack (AE) has been used for the implementation.

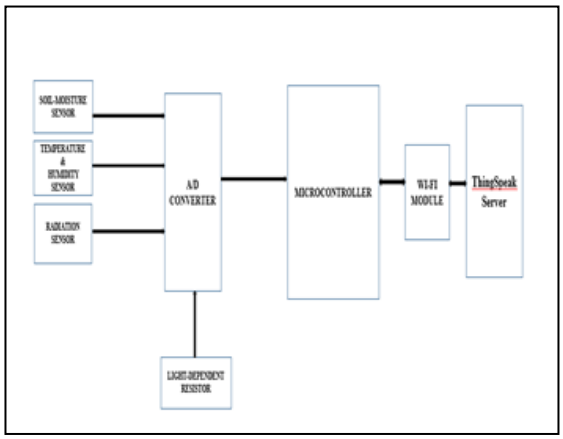

Fig. 3. Block Diagram for System

The ADN hardware architecture consists of following modules:

A. Sensors

The sensor node consist of soil moisture sensor, temperature and humidity sensor, light dependent resistor for light sensitivity, radiation sensor for measuring the radiation strength.

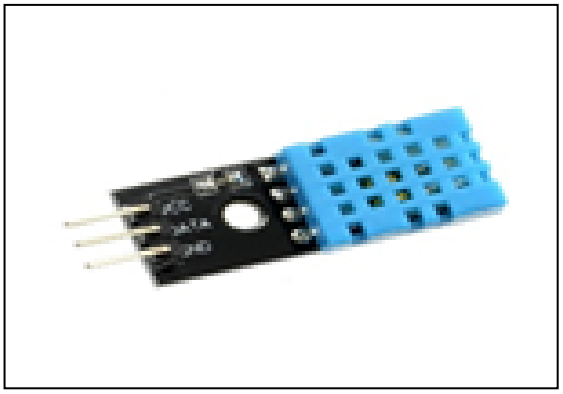

Fig. 4. Temperature and humidity sensor

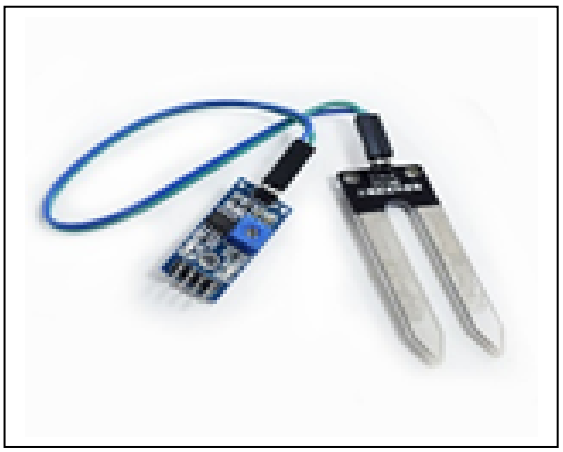

Fig. 5. Soil moisture sensor

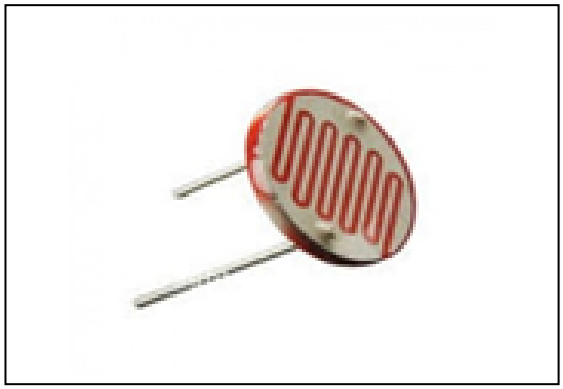

Fig. 6. Light dependent resistor

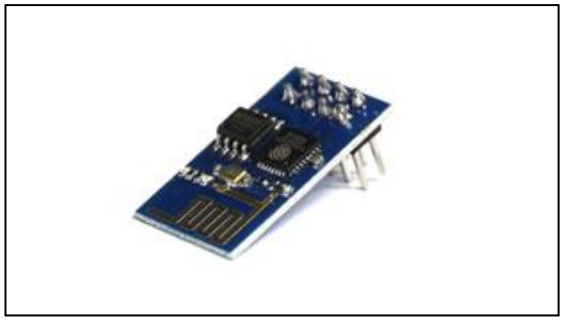

Fig. 7. Wi-Fi module

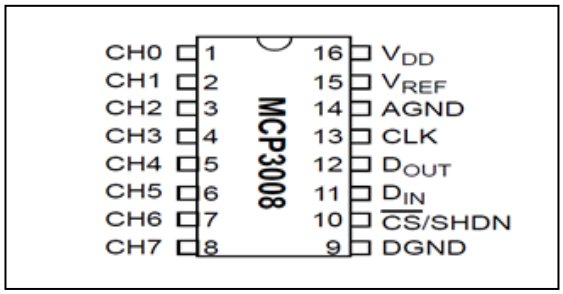

Fig. 8. Analog to digital converter

B. Wi-Fi Module

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

C. Thing Speak and Raspberry Pi

Thing Speak is an Internet of Things (IoT) platform that lets you collect and store sensor data in the cloud and develop IoT applications. The Thing Speak IoT platform provides apps that let you analyze and visualize your data in MATLAB, and then act on the data. Sensor data can be sent to Thing Speak from Arduino, Raspberry Pi, Beagle Bone Black, and other hardware. Raspberry-Pi
The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside of its target market for uses such as robotics.

D. Analog to Digital Converter
MCP 3008 is a 10-bit Analog-to-Digital (A/D) converters with on-board sample and hold circuitry. The MCP 3008 is programmable to provide four pseudo-differential input pairs or eight single-ended inputs.

VI. COMPUTATIONAL ANALYSIS

Calculation of sensors parameters, like Temperature, Humidity, and Light Intensity and EMF strength is done using some basic analytical methods.

A. Temperature and humidity calculation

For calculating the temperature and humidity we connect the sensor to the analog to digital converter analog pin and is processed through the controller and install the library, which contains all of the functions we will need to get the humidity and temperature readings from the sensor.
Temp = read_adc (CH0);
Humidity= read_adc (CH1);

B. Light intensity calculation

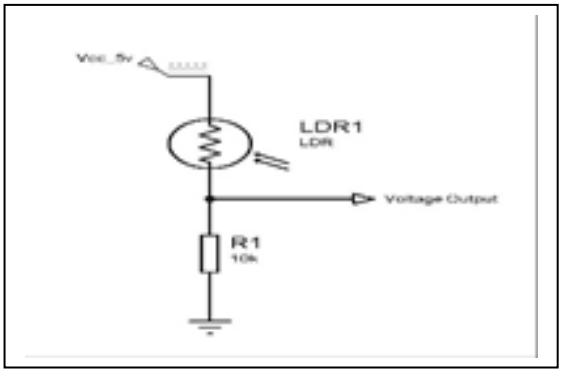

Fig. 9. LDR Circuit

Output across LDR is given to any analog pin of ADC .When light is falling on LDR its resistance decreases, then voltage across it decreases, ADC reading decreases. When no light is falling on LDR its resistance increases, then voltage across it increases, ADC reading also increases.
ADC_reading= read_adc (CH2);
Voltage = (ADC_reading x 5)/ 1023;
ADC_reading = 400 to 650 when brightness.
ADC_reading = 700 to 1023 when darkness.

C. Soil moisture calculation

The output pin of the moisture sensor is interfaced to the analog pin of the ADC and then the moisture value is sent and corresponding threshold results in blinking of LEDs.
Moist = read_adc (CH3);

D. EMF Calculation

For calculations of EMF value the voltage corresponding to the RF power is measured using sensor and then the corresponding analog value is sent to the ADC pin and then processed by the controller for the threshold monitoring of health hazardous limits.
A_data= read_adc(CH4);

Now depending upon the output voltage an electric field strength is calculated and this value is compared to the threshold values depending upon the RF frequency band.

VII. IMPLEMENTATION

In this model, we used Raspberry-Pi, Sensors, Analog to Digital Converter and ESP-8266 Wi-Fi module as an embedded system for sensing and storing the data in the Thing Speak server.
After sensing the data from sensors, the data is processed and stored in the cloud of Thing Speak for analysis on data for the monitoring purpose.

Fig. 10. Results

VIII. CONCLUSION

With this embedded wireless sensor network device, we can monitor the soil moisture level, temperature and humidity in the environment and the light intensity essential for photosynthesis process that enables us for better irrigation practices. Also with this system we can monitor the harmful radiation from the tower and hence helps in prevention from hazardous effect of the radiation.
Thus , this system is not only a solution for smart farming that can help the farmers to improve their irrigation practices but also helps to monitor harmful radiation. The data collected will be helpful for future analysis and it can be easily shared to other end users.

IX. FUTURE SCOPE

With the Wireless senor network, a new area of Internet of Things has emerged that is really developing value in farming manufacture, accuracy irrigation, environment control and many more. This paper provides a solution for smart farming and environment monitoring that helps to improve the farming activities as well as protect the human being from hazardous impact of radiation from towers.
This system have future scope with the increase in the sensors interfaced with the controller so as to control more parameters. Along with this improvement, the technology for sending data can be enhance to NB-IoT for improving the coverage.

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