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Design of Environmental Data Sharing Center using WSNs Based on IoT Protocols

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Abstract:- Monitoring of the environmental parameters is commonly the main issue of Scientifics, Researchers, international organizations and countries as results of the changes of climate. Exchange the information about the environments is very important topic to upgrade the awareness of minimizing the uses of environmental contaminated sources. This paper introduces the design of environmental data share center using wireless sensors network based on IoT protocols. The data share center used to monitor and exchange the environment information collected by sensors nodes and gateways. The sensors nodes detect measure and monitor the environment parameters at distributed different area locations. The wireless sensors network designed using temperature and humidity sensors (DH11), gas sensors and air quality sensors connected to open source hardware platforms supported to MQTT publish/subscribe messaging protocol. The nodes publish the results of the measurements and location of the node to the main station. In the main station, the raspberry pi used as a subscriber to receive the data from the transmission nodes through the broker and present these data at a graphical user interface to display the exact data reading of nodes station.

Keywords:- *WSNs; Internet of Things Protocol MQTT Publish/Subscribe*.

I. RELATED WORK

A wireless radiation detector network for environmental monitoring was designed using A pin diode silicon semiconductor detector, which is well suited for X-rays, Alfa particles, Bita radiation, and High energy charged particles.

The proposed network topology enables densely sensor-populated regions with short-range communication capabilities for low-energy consumption (and consequently long lifetime). The regions are connected by a global to a global communication infrastructure (GSM network) through gateways. SIM900 GSM\GPRS module is used to send SMS to an administrator phone when a wasted radiation is detected by the sensor tag. It is used for global communication. For short range applications the wireless communication is achieved by using RF technology [1].

A typical sensor node in a WSN consists of a wireless communication unit, a microprocessor, a data acquisition unit, memory unit, and sensor boards. The microprocessor and the memory unit control how often the sensor measurements are taken or transmitted. The measurements can be taken in fixed time intervals or based on an event driven model [2].

II. INTRODUCTION

Monitoring of the environmental parameters was commonly the concern of Scientifics, Researchers, international organizations and countries. More studies to monitor these parameters has been done as results of the changes in climate. Monitoring and exchange the information about the environments is very important topic to upgrade the awareness of minimizing the uses of environmental contaminated sources. The monitoring process can be done by establishing fixed monitoring station at reference location using deferent technologies and methods.

The environmental WSNs is a group of devices and sensors connected with each other through communication protocol. These WSNs has computing and processing capabilities to continuously sense and transmit data to a main station to monitor the real time measurement of environmental conditions at distributed location. The main station where data can be processed the data and observed in real time [3].

The proposed work is to design the environmental data-sharing center based on IoT technology. The WSNs used to monitor and exchange the environment information collected by sensors nodes and gateways at deferent location.

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III. METHODOLOGY

A. Design Hardware

The wireless sensors network designed using sensors, embedded system, internet of things protocol for communication, open source broker and dashboard. The general block diagram of network topology is shown in fig.1.

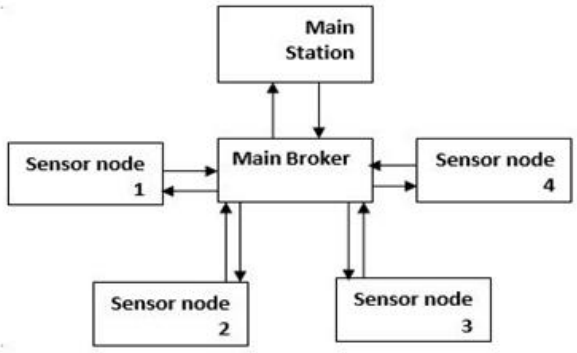

Fig 1:- The main topology of the data sharing center wireless sensors network.

➢ *Sensor Node:-*

Sensor nodes are small-embedded devices, which are mainly able to perform simple computations and to send/receive data. Their typical usage is to gather information about their environment via sensors, to potentially pre-process these data, and to finally transmit them [4].

For data publishing and data subscribing on all clients stations, ARDUINO UNO microcontroller board is used as publishing / subscribing node. The board is suitable because it has a built-in ADC used to receive data from sensors in analog form. More than one sensor can be connected the microcontroller. The microcontroller then sends the sensors reading data as a frame of data in the form of characters to main broker using topic for each sensors reading. This topic can be used from other clients node to subscribe for the published data as sharing method of data exchanging.

Arduino on its own has no networking capability; it was connected to an Ethernet shield, allowing it to connect to the internet. Using the Ethernet and MQTT library, Arduino can talking to MQTT servers to submit and retrieve data.

In sensor nodes, there are three deferent sensors sensor used to monitors the temperature and relative humidity, air quality sensor to get information about the quality of the air, gas sensor to monitor chemical leakage gases and temperature / humidity sensor to monitor the temperature and relative humidity.

The technical information of the sensors as shown at the below

- The Groove gas sensor MQ5 module used for monitoring leakage of gas. It can detect H2, LPG, CH4, CO, Alcohol. The output voltage from the Gas sensor increases when the concentration of gas increases with technical information as shown below:-
- The Groove air quality sensor module used to monitor the quality of the air and used in applications that require only qualitative results. The sensor responsive to a wide scope of harmful gases. The main gas detected is carbon monoxide, alcohol, acetone, thinner, formaldehyde and other slightly toxic gases.
- The DHT-11 used to monitor the relative humidity and temperature sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin.

B. Raspberry Pi Processor:

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation. It has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU. Its GPU provides Open GL ES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high profile decode which is capable of 1Gpixel/s, .5Gtexel/s or 24GFLOPs with texture filtering with 512 MB RAM [7]. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage. It can be connected to a network using an external user-supplied USB Ethernet or Wi-Fi adapter. Generic USB keyboards and mice are compatible with the Raspberry Pi. The Raspberry Pi primarily uses Linux-kernel-based operating systems [5].

C. MQTT protocol

MQTT was developed by Andy Stanford-Clark (IBM) and Arlen Nipper (Eurotech; now Cirrus Link) in 1999 for the monitoring of an oil pipeline through the desert. The goals were to have a protocol, which is bandwidth-efficient and uses little battery power, because the devices were connected via satellite link and this was extremely expensive at that time.

The protocol uses a publish/subscribe architecture in contrast to HTTP with its request/response paradigm. Publish/Subscribe is event-driven and enables messages to be pushed to clients. The central communication point is the MQTT broker; it is in charge of dispatching all messages between the senders and the rightful receivers. Each client that publishes a message to the broker includes a topic into the message. The topic is the routing information for the broker. Each client that wants to receive messages subscribes to a certain topic and the broker delivers all messages with the matching topic to the client. Therefore the clients don't have to know each other, they only communicate over the topic. This architecture enables highly scalable solutions without dependencies between the data producers and the data consumers [6].

D. M2M Communication

When most people think of the Internet, they think of individuals using a web browser to gather information from search engines, to communicate with others using social media, or to connect to viewing devices, such as web cameras. Yet as technology evolves, it is increasingly common for devices to be connected to each other. This type of connection has created a need for efficient, machine-to-machine (M2M) communication protocols. The MQTT

protocol is ideal for use in M2M communication. It enables connectivity that extends beyond smart devices to some of the smallest remote devices and sensors, including devices with limited processing or network abilities. This extension makes MQTT a critical component in self-managing M2M networks and a key part of realizing the Smarter Planet vision. In addition, because MQTT is highly scalable, it is possible to create systems that involve hundreds or even thousands of remote sensors or devices. The MQTT for Sensors (MQTT-S) protocol enables the inclusion of machines that typically would not be able to use MQTT due to a lack of TCP/IP network abilities. MQTT-S extends the MQTT protocol to low-cost, battery-operated sensor and actuator devices existing on non-TCP/IP networks. It can function on any network that allows bidirectional data transfer. MQTT-S is ideal for wireless sensor networks (WSN) of spatially distributed autonomous sensors. WSNs are attractive due to their simplicity, low cost and ease of deployment. MQTT-S clients connect to a gateway that performs the protocol translation between MQTT and MSTT-S. The MQTT-S clients are often used to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, or motion [7].

IV. RESULTS AND DISCUSSION

The arduino Uno with Ethernet shield with attaching sensors used to capture the environment physical parameters reading. Fig.2 shows the image of the client node. This node programmed with arduino IDE software using MQTT and Ethernet libraries to publish the data of sensors reading to the main broker and to subscribe from the broker the other clients reading using the topics of publishing data. The topics used to subscribe for specific sensors parameters reading. Fig.3 shows the pub/sub data from the Ethernet node presenting the topic name and the data sensors reading of the topic.

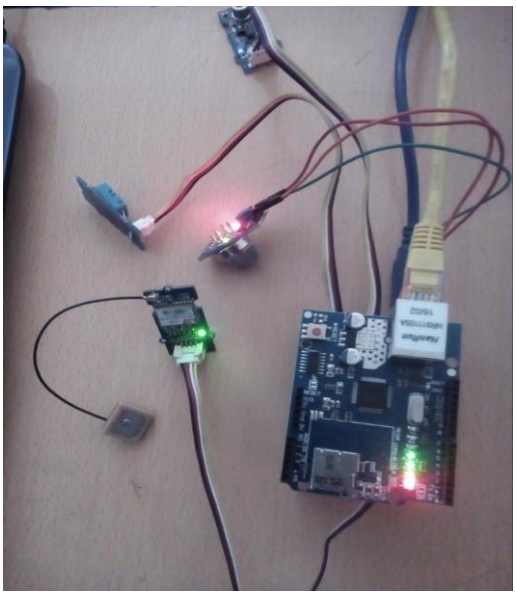

Fig 2:- the image of the client node for publish and subscribe sensors data

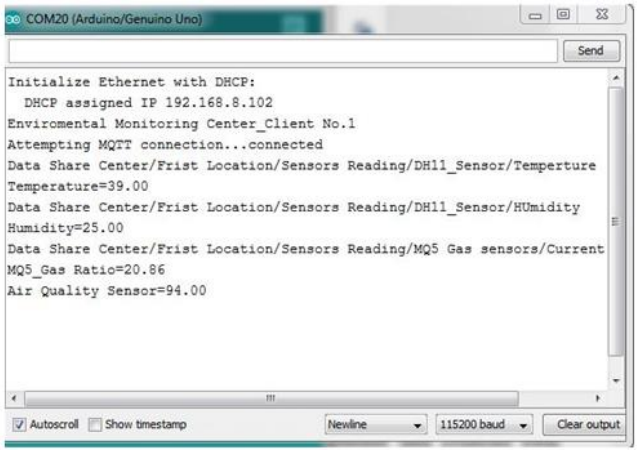

Fig 3:- Shows the subscribing data from main broker according to specific topic

The collected data from sensors published to open source dashboard. The" DemoThingsspeak.com" dashboard is used to present and visualizing the sensors reading. Fig.4 show demo.Thingsspeak.com dashboard design for data sharing center.

Thingsspeak is an open-source server-side platform that allows to monitor and control IoT devices. Fig.4-A_Bshowing the designing of the public sensor reading dashboard fig.5 showing the current reading of the public environmental data sharing WSN data sharing channel of Demo.Thingsspeak.com dashboard.

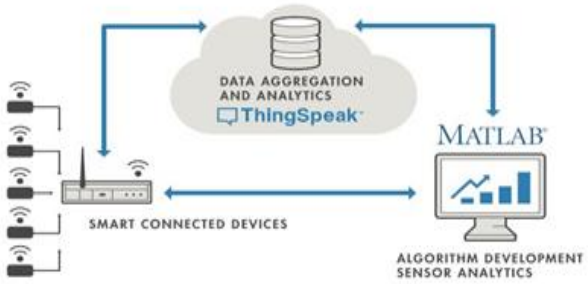

Fig 4-A:- Designing the dashboard for the environmental data sharing WSN

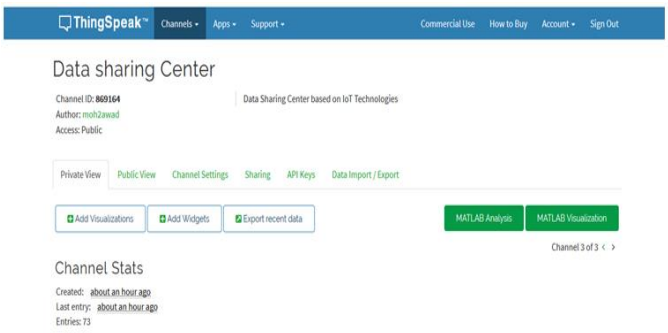

Fig 4-B:- Designing the dashboard for the environmental data sharing WSN

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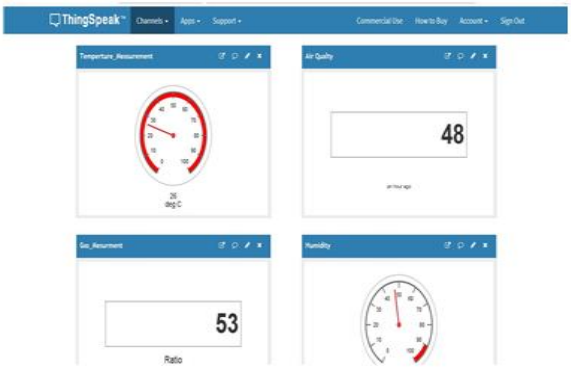

Fig 5:- the current reading of the public environmental data sharing WSN

V. CONCLUSION AND RECOMMENDATION

The targeted work proposes to design an environmental monitoring solution that involves installing open and extended network to share the environment data collected from sensors nodes. Subscribing to topic nodes and the public channels in dashboard gives the ability to monitor several parameters at the same time with connected client nodes with free access and sharing data between distributed client's nodes.

The design has been tested and the results of the measurements for environments sensors reading from clients node based on Arduino Uno working in publishing / subscribing mode has been registered and storage in local data base using MySQL data base system at the main center station with capability of monitoring and visualizing the subscribing data at each client node.

The open source mosquito broker has been used and configured in raspberry pi B+3 working as broker and subscriber for the published data.

The subscribing data from sensors topics visualized and storage on the open source dashboard "Thingspeak.com" server after registration and designing the custom dashboard for sensors reading.

Arduino UNO pushes these data to Thingsspeak server via MQTT protocol by using PubSubClient library for Arduino. Data is visualized using built-in customizable dashboard.

This network can be extended using nodes publishing and subscribing using the topics of the data sharing center to implement the open sharing data for environment monitoring.

ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g.” Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B.

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