Simulation and Analysis of Various Parameters for IoT in WSN Environment Using SENSEnuts

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Abstract: Internet of Things (IoT) enables smart communication between the sensor devices via internet. It creates network of things that can sense, communicate, and interact with each other in precise manner. In this paper we use SENSEnuts platform for sensing various parameters like light, temperature, humidity and pressure. SENSEnuts is an advanced and compact platform for WSN and IoT senson, that gives various features as easy to use API’s, user friendly GUI, real time sensor data analysis, C based programming and easily modifiable source code. IEEE 802.15.4 MAC implementation helps in Wireless Personal Area Network deployment which is low rate that allows interconnection of wireless devices with low power consumption. SENSEnuts brings you affordable package with variety of sensors, communication modules and software toolchains that help us in developing the application. Sensed information from this device are transferred to the internet via SENSEnuts Wi-Fi module. Once they are send to the internet they are stored in the cloud, where we can monitor sensor data. ThingSpeak is an IoT analytics platform which is open source cloud that update the sensor information’s on near real time basis. Device send data via HTTP request which is aggregated, processed by ThingSpeak cloud where this data is being viewed, stored and analysed.

Keywords: Internet of Things, Senselive, SENSEnuts, ThingSpeak, WSN-Wireless Sensor Network.

I. INTRODUCTION

The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors, actuators and everyday items allowing these devices to generate, exchange and consume data with minimal human intervention [1]. In IoT objects are termed as “SMART”, as intelligence is inbuilt in this embedded sensor devices that they can perform accordingly. Wireless Sensor Network also allows us to deploy the network in remote and hazardous location where continuous sensing and monitoring is not possible, so as to provide the information from time to time as required. As an emerging technology brought rapid advances in modern wireless telecommunication, Internet of Things (IoT) has attracted a lot of attention and is expected to bring benefits to numerous application areas. The problem is that in today’s world people have limited time, attention and accuracy. This problem tells us that we are not that much good enough to capture things in the real world contest in a more accurate manner so as to do some predictions and decisions. If that is done precisely then we could do some better decisions, say when things are need to be replaced or whether it should be repaired , further controlling or maintenance has to be done. Accurate prediction could be taken as if temperature in room has shoot up , alert something has gone beyond any border , What to do next, whether some immediate attention or controlling has to be taken. SENSEnuts enables us to acquire sensor data in real time basis in more accurate manner. Thus, we can better understand the outside environment information. However for long term data acquisition, more accurate and diverse data has to be collected and monitored so as to do further analysis, predictions and decisions making in IoT paradigm. ThingSpeak acts as the cloud for collecting sensor data, storing, its visualization and analysis of our sensor nodes that collects the environmental parameters. We can also further do some statistical analysis from the data available, control the devices if needed, and predict how energy efficient sensing using low power consumption could be done.

II. RELATED WORK

In this section we are mainly focusing on how to setup a sensor network that communicates wirelessly, and how its data can be integrated with internet of things. Several proposals and approaches have been made in this scenario. Authors of [3] proposed which is based on IOT enabled healthcare monitoring. IT uses the SimIoT that is extended simulation toolkit to demonstrate various functions and the interactions occurring within the IoT-enabled devices. It allows experimentation on dynamic and real-time multi-user submissions within an IoT scenario. An overview of the IoT , its functionality and implementation of each layer of IoT architecture is in [4], that simply present IoT as a whole. Paper [5] involves interfacing the sensors on the BoosterPack and MSP430 that senses temperature, sound, potentiometer and accelerometer reading that refers to an IoT system that is connected to the cloud and is being monitored remotely. The sensor data was updated consistently with accuracy, some error was there due to issues like internet connectivity. It covers the basic needs of setup and communication via internet. A similar kind of IoT cloud assisted architecture is depicted in [6] that measure the thermal comfort. Paper [7] shows a similar work that uses an Arduino UNO board, ESP8266 Wi-Fi Module for processing and transferring the sensed data to the Thingspeak Cloud. In paper [8] they presented five scenarios focusing on various properties of IoT systems for sensors monitoring the environmental properties for weather forecasting scenario .This paper provides an idea about deployment of network , their
data collection and analysis. They also depict five scenarios which were examined like varied the amount of data produced by the sensors, varying sensor numbers and varying sensor data sizes per stations, random sensor data generation frequencies, station numbers dynamically change all these lead to the contribution for IoT Cloud simulation. These papers gives the idea of IoT as overall, how to built up a WSN and integrating the sensor data from the node to cloud via internet, what are the parameters that can be considered, what further we can extend like that. SENSEnut is a good platform for WSN and IoT application it is compact, easy to understand and can deployed fast. It can be used for environmental monitoring with its user friendly GUI. It is a very much advanced platform which is affordable and can be used for research purposes.

III. METHODOLOGY AND IMPLEMENTATION OF THE PROPOSED WORK

A. Overview:

Our proposed work can be quickly explained by the figure 1 given below, it contains the basic elements. The basic platform is our SENSEnut devices which contain different sensor modules and different communication gateway modules for sensor network setup and IoT applications. SENSEnut uses IEEE 802.15.4 which can be deployed based on parameters like low bandwidth requirement, low range, on-off behaviour and low battery consumption [9]. Further this sensor data are carried forward to internet where it is stored and reviewed using an open source cloud platform namely ThingSpeak. From the information retrieved from the cloud, we can further analyse and verify sensed data on any location.

B. Sensing and Accessing the Information:

Basic element here used is the sensor modules of SENSEnuts that include TL (Temperature, Light) sensor module and HTTP (Humidity, Temperature and Pressure) sensor module of the SENSEnuts package. Coordinator is set up by these two sensor module stacked over the radio module which is battery powered. PAN Coordinator is also set up it contains radio module for transmitting and receiving the signals and Wi-Fi module. Now this PAN Coordinator receive the signal from the coordinator. Once they get associated and this information is carried forward via Wi-Fi module, from there the data will be transferred and updated in the ThingSpeak open IoT analytics.

Above we had discussed the hardware components needed for network setup, PAN Coordinator and Coordinator are similar in their hardware aspects but their functionality differ whether the node is programmed for Coordinator or PAN Coordinator. For programming the modules we have to plug in the sensenuts gateway module and install the drivers. Once code is ready, compile the code to be built so as to generate bin file ready to be flashed on the device. Now open SENSEnuts GUI which is used for programming the radio module as well as displaying the data received from the network. Device programmer allows us to program the motes, when the device is accessed select the bin file for the microcontroller to be flashed. One node is programmed for PAN Coordinator and other for Coordinator. PAN Coordinator start their energy scan whereas parallely the Coordinator starts the active scan checking any PAN available for getting associated. Once associated, Coordinator broadcast the sensor data and starts communication between the PAN Coordinator wirelessly. Once our device start sensing our environment we can see various parameters on senselive which shows the updated sensor data on real time basis. These accessed information is passed to PAN Coordinator.

C. Sending Information to the Cloud and Its Analysis:

Further from the PAN Coordinator data is transferred to the internet via Wi-Fi gateway module of SENSEnuts which is also programmed accordingly so as to make an HTTP request to the ThingSpeak cloud for sending the sensor information to the cloud for future verification and analysis. IOT enabled SENSEnut module can be seamlessly sent data to various cloud service providers. Here ThingSpeak cloud will help us to monitor our sensor data. ThinkSpeak acts as the cloud for collecting sensor data, storing and its visualization. First we have to create a channel with various fields’ sets. Here four fields namely temperature, light, humidity and pressure has been set. Data is stored in this channel. For communication between Wi-Fi module and internet we have to use the write API key, using this we can publish
our data to ThingSpeak once our channel is setup. Our Thingspeak channel can be made as public or private as per the privacy requirement.

ThingSpeak is an open source platform with MATLAB analytics for IoT applications and has its API to store and retrieve data from things using the HTTP protocol over the Internet or via LAN. It also enables the sensor logging applications, location tracking applications etc. And they communicate that data in some form, such as a numerical value or electrical signal. It supports data analysis and data processing. Create a new channel to collect our information and to analyse the data. ThingSpeak contain various data fields, where we can add our fields like temperature, light, pressure, humidity etc. It also contains show location, show video and show status options that can be added if needed. we can also import and export our channel data. It contains API to create and update ThingSpeak channels and charts. Finally we can visualize the data that has been retrieved .It provide various apps as well for much more communication as SMS alerts using Twilo, Tweets, social network alerts etc[10][11].

IV. TECHNICAL DISCUSSIONS FOR DESIGN AND IMPLEMENTATION

In order to implement the work some hardware and software tool chain realizations are needed. This hardware and software requirement along with other technical specifications used for the work is shown in Table 1 [12].

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware Realization</td>
<td>SENSEnuts package, PC, USB cable.</td>
</tr>
<tr>
<td>Software Realization</td>
<td>Eclipse IDE , SENSEnuts toolchain.</td>
</tr>
<tr>
<td>IoT Analytics</td>
<td>ThingSpeak(open source cloud).</td>
</tr>
<tr>
<td>Sensing Modules</td>
<td>SENSEnuts TL-module and HTP module.</td>
</tr>
<tr>
<td>Basic Communications</td>
<td>IEEE 802.15.4 MAC Implementation , USB gateway, Wi-Fi gateway.</td>
</tr>
<tr>
<td>Microcontroller In Radio Module</td>
<td>32 bit RISC JN 5168</td>
</tr>
<tr>
<td>Memory</td>
<td>256KB flash , 32KB RAM, 4KB EPROM</td>
</tr>
<tr>
<td>TL-Module Specification</td>
<td>Temperature Range: -25 °C to 80°C</td>
</tr>
<tr>
<td></td>
<td>Light range : 3 to 64K</td>
</tr>
<tr>
<td>HTP-Module Specification</td>
<td>Humidity :Digital output with 14 bit resolution(0.04%Relative Humidity)</td>
</tr>
<tr>
<td></td>
<td>Pressure : Barometric pressure in 24 bit resolution.</td>
</tr>
<tr>
<td>Physical Medium Access</td>
<td>CSMA/CA</td>
</tr>
<tr>
<td>Protocols</td>
<td>MAC protocol, HTTP</td>
</tr>
<tr>
<td>Database</td>
<td>Create SQL(sqlite3)database , Senselive - Sensor_TL and Sensor_HTP</td>
</tr>
<tr>
<td>GUI</td>
<td>SENSEnuts GUI (senselive- live data visualization)</td>
</tr>
</tbody>
</table>

V. RESULTS AND DISCUSSIONS

A. Senselive Output Results:

From the figure 2 and figure 3 below we can see how the sensor data can be viewed as live data in senselive , all Data get updated in the database on real time basis. On senselive (Sensor_TL and Sensor_HTP record all the data received from the network) we can visualise the data simultaneously as they get updated on databases. Sensor_TL output is shown in figure 2 and Sensor_HTP is shown in figure 3. From both the figure Node Id (0CA9) remains same as both the modules are stacked on radio module that creates the coordinator node. Again variations in various parameters can also be verified by senselive that shows luminous intensity level fluctuations and temperature variations which can be easily notified in figure 2. Figure 3 shows the variations in humidity, temperature and pressure respectively, and all these variations are real time basis and are updated in the corresponding data base which can be retrieved.

Fig 2  Senselive Showing Temperature and Light Variations in Sensor_TL
B. Results on Thingspeak IoT Analytics:

From the below figure 4, we can clearly verify and analyse that all the sensor values are updated on Thingspeak. It allows user to display different sensor parameters in graphical format by setting its various field sets. Figure 4 shows these variations in parameters like temperature, light, humidity and pressure respectively. It senses in near real time basis as there is a few second delay for data getting updated on Thingspeak.

VI. CONCLUSION AND FUTURE WORK

In the proposed work we analysed the concept of integration of sensor data with respect to IoT domain. SENSEnuts provide a good platform for implementation with respect to WSN as well as IoT. Sensors sense on real time basis and data can be easily retrieved from the database, Senslive show real time sensing updations which can be realised from the outputs .A small change in the environmental parameters like a change in luminous intensity, temperature, humidity and pressure, were reflected in the result as well. As thingspeak is an open source platform it allow us to easily interpret the network conditions that can be collected and analysed, but with a few second delay in things getting updated. This completes the IoT definition anyone, anytime and anywhere, as we can view our sensor data by just login to your thingspeak account and select channel to view the sensor data. Further its apps can help us to control these devices as well.

Some future work can be ideated in order to improve the work. Though we deployed one coordinator and PAN coordinator it could be extended to more number of nodes. And to overcome the limited range of wireless communication among the nodes we can go for multi-
We didn’t deploy any circuitry for further controlling the devices, which can also be included further.

VII. REFERENCES


[10] https://thingspeak.com