An IoT Framework for Reconfigurable Smart Sensor Interface of WSN

Shopan Dey[1], Ayon Roy[2], Anil Kumar Chandravanshi[3], Prof. Sandip Das[4]

[1, 2, 3] *B.Tech Final Year, Department of Electronics and Communication Engineering, University of Engineering and Management, Jaipur, Rajasthan, India*
[4] *Associate Professor & Head, Department of Electronics and Communication Engineering, University of Engineering and Management, Jaipur, Rajasthan, India*

ABSTRACT

In today's world the Internet of Things (IOT) pairing up with Wireless Sensor Network (WSN) forms a key couple in the digital industry. The Internet of Things helps to peek into the virtual world of digitization where every smart device, every sensor is connected with the internet and therefore can be accessed wirelessly from anywhere around the world. This paper propose a secured IoT framework with multiple wireless sensor nodes that sends data to the web cloud server and allows users to access those data via a mobile application through a unique user id and password. The framework proposed is secured with end-to-end encryption. Among the numerous computer protocols present, TCP/IP protocol is used for data transfer in this framework. Due to the unique provision of adding multiple nodes the framework proposed seek its use in a number of fields such as commercial, meteorological, agriculture, medical etc. The cost effective design, long durability, minimal maintenance, ideal service makes the proposed framework a unique one. The home automation along with meteorological and agricultural automations has been successfully implemented with the help of the proposed framework providing much better efficiency.

Keyword: - *Internet of Things (IoT), Wireless Sensor Network (WSN), cloud server; sensor nodes, encryption*

1. INTRODUCTION

The rise of efficient IOT frameworks and Wireless Sensor Networks (WSN) had bought a significant change not only in the field of technology advancement but also had a positive impact on everyday life of human beings. The IoT system architecture consists of four layers: sensing, network, service resource, and application layers which harmonize various data processing techniques such as protocol conversion, data filtering, and data conversion [1][6][7][8]. The Internet of Things had an immense breakthrough in the field of communication as no hardware architecture is required for communication which might be handy in emergency situations [2]. A smart sensor interface is required for connecting number of sensors to a device which can be reconfigurable as desired by the user [3]. The use of STD services enables users to validate the actual source of the imaginary IoT service [4]. As the smart devices present now days can be accessed wirelessly with the help of IoT, it can be used in field of augmented reality (AR) where the real world environment can be manipulated [5]. The application of WSN through IoT needs a platform for providing efficient performance. The mobile ad hoc network (MANET) provides such platform where harvesting of monitored data in urban areas is processed [9]. The process of communication through image or through video exchange was not possible until the rise of IoT accompanied with WSN [10]. There is a lot of wireless communication possible due to the IoT and WSN. Therefore a lot of information is not secured which needs to be secured, that is, the security between a sensor node and internet host is an important aspect of IoT [11]. The exchange of information between a sensor node and internet host is carried out in super frames consisting of slots to carry information [12].

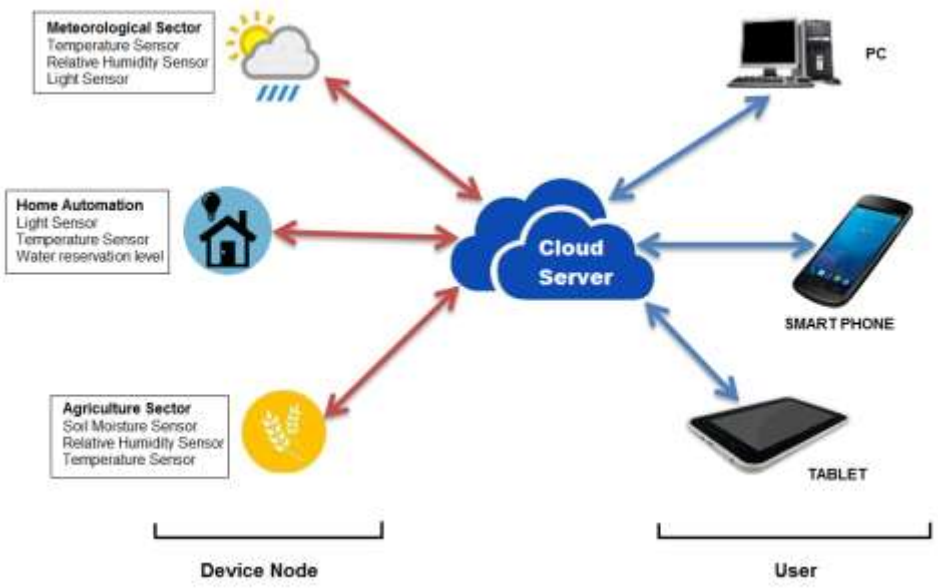


Fig -1: Proposed IoT framework for reconfigurable smart sensor interface.

This paper proposes a unique IoT framework along with the application of Wireless Sensor Network (WSN). The figure 1 alongside portrays entire proposed system. In the developed functional system an AWS server is created along with a database which stores all the information the server receives from the designed hardware. The hardware refers to the nodes to which three sensors are connected. The data of these sensors can be monitored by the registered user under whom the node is connected. PHP programming is used to develop a web page which will appear when a unique address is entered. Along with this an android application is also developed just in case if the registered user desires to monitor the sensor information connected to the node under the user itself. The developed system is very flexible as a registered user can add multiple numbers of nodes with zero limitation. The rest of the paper is organized as follows: the network architecture is presented in section 2, the system implementation is discussed in section 3, the result and discussion is presented in section 4 and finally concluded in section 5.

2. NETWORK ARCHITECTURE

The proposed network architecture is divided into three parts namely server side, hardware and client side. The server side forms the backbone of the whole frame work as it is the control house of the proposed frame work. The hardware section contains all the designed nodes. The client side holds the access to add, edit, or delete the nodes. The detailed overview of the network architecture is as follow.

2.1 Server Side

In the network architecture the server side holds the key to the proposed frame work. The server side contains the AWS server where all the data and other information such as number of users registered, number of nodes under each client etc. are stored in the database present in the server side. The database designed contains three tables namely-user info, node info and node data. The table user info holds the data of the registered users in the proposed frame work. The table under node info contains specific information about each node under each registered user. The table node data contains the entire log data of each sensor connected to each node under each registered user. Therefore the server side forms the control house of the proposed frame work.

2.2 The Hardware

The hardware present is an important part in the designed framework. The hardware section contains the different nodes to which sensors are attached. The proposed framework contains three distinct nodes, all for different purpose. The first node designed is used for home automation which contains three sensors. They are temperature sensor, light sensor, ultrasound sensor. The temperature sensor is to check the temperature, the light sensor is to check the light intensity and the ultrasound sensor is used to check the water level in the water tank. The second node designed

is used for meteorological purpose. The sensors connected to the second node are temperature sensor, humidity sensor and barometer sensor. The third node designed is used for agriculture. The sensors connected are temperature sensor, humidity sensor, soil moisture sensor. The exchange of data from the hardware to the server and vice versa is carried away with the help of an ESP8266-Wi-Fi module integrated with TCP/IP protocol.

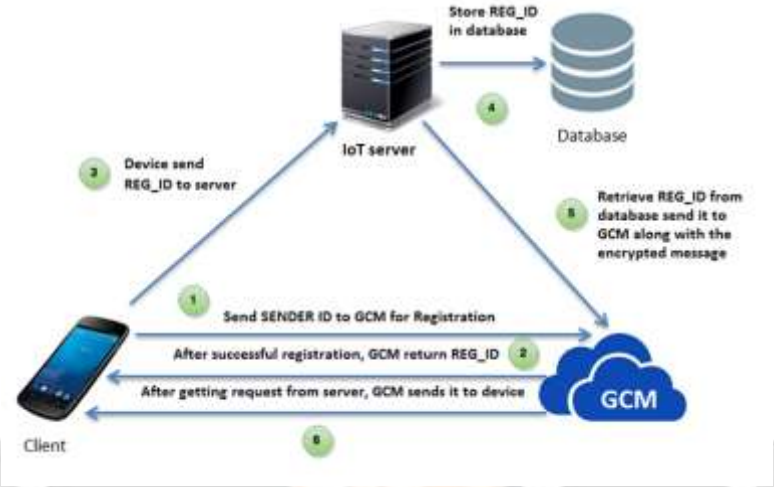


Fig -2: Functional block diagram of android application and IoT server.

2.3 Client End

The client side contains the browser and the designed android application through which a registered user access all the nodes under the user itself. The designed android application needs to be installed in the smart device of the user. Ones installed the application sends unique ID to Google cloud messaging (GCM). The GCM in turn sends a handshaking signal back to the smart device. The smart device sends the registered ID to the server. The server then stores the registered ID in the database under the table user info. The server then sends the obtained ID to GCM. After obtaining the request from the server GCM sends it back to the smart device shown as figure 2. The same process is carried out if the smart device is replaced by any browser.

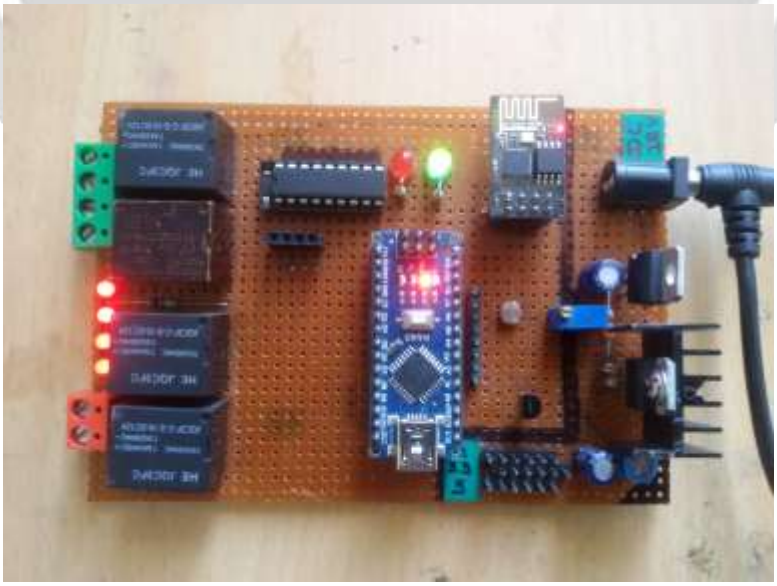


Fig -3: Prototype of sensor node.

3. SYSTEM IMPLEMENTATION

An AWS server is created at the very beginning in which by launching a Linux instance. As the instance is running the proposed system is online. Now a database is created using MySQL. The database created contains three tables for three different purposes. The table user info contains data of the entire registered user i.e. user id and password. The table node info stores information on each node such as the node number, the device id and serial key. It also stores the input parameters such as temperature, humidity etc. and the output parameters such as area1, area2, etc. The node data table stores the incoming sensor data values with their log time corresponding to the respective input parameters. After creation of the database the hardware implementation is carried out in this contains creation of nodes shown as figure 3. The node circuit consists of Arduino Nano which is an open-source .The Arduino Nano is programmed in C using Arduino IDE. It operates on 5V DC with a clock speed of 16MHz. The four electro-magnetic switch attached enables the Arduino to switch that loads attached to the node. The Esp8266 Wi-Fi module with integrated TCP/IP protocol provides internet connectivity via a local network. Each Esp8266 is programmed with AT command firmware that provides the necessary Wi-Fi facilities. The sensors connected to three nodes are temperature sensor, air humidity sensor, light sensor, soil moisture sensor, ultrasonic sensor and barometer. Under each node at most three sensors can be connected according to the need of the registered user. The exchange of data from the nodes to the server is carried out with the help of TCP/IP protocol. After successful registration through a web browser or designed android application, the Google Cloud Messaging (GCM) sends an acknowledgement signal to the web browser or smart device. Now the smart device or the web browser sends the registered ID to the server which the server stores in its database. The obtained registered ID is then sends back to GCM. Now after getting the request from the server, GCM sends it back to the web browser or to the smart device. This whole process is carried out in the same order for all users.

4. RESULT AND DISCUSSIONS

The developed frame work is implemented both by using a web browser and by installing the developed android application. To register using web browser an unique address is to be entered. After entering, a home page will appear which is created using PHP. The home page contains three bullets will appear starting with user report which the admin can only access, followed by Internet of Things and at the bottom a bullet to logout. Now when a registered user clicks on the Internet of Things a new page opens which reads Node Management. In this page a user can add, edit or delete node as desired by the user. In the very same page all the sensor values in each node under that user along with log time is accessible. The figure 4 shows the page of Node Management and the figure 5 shows sensor data along with log time.

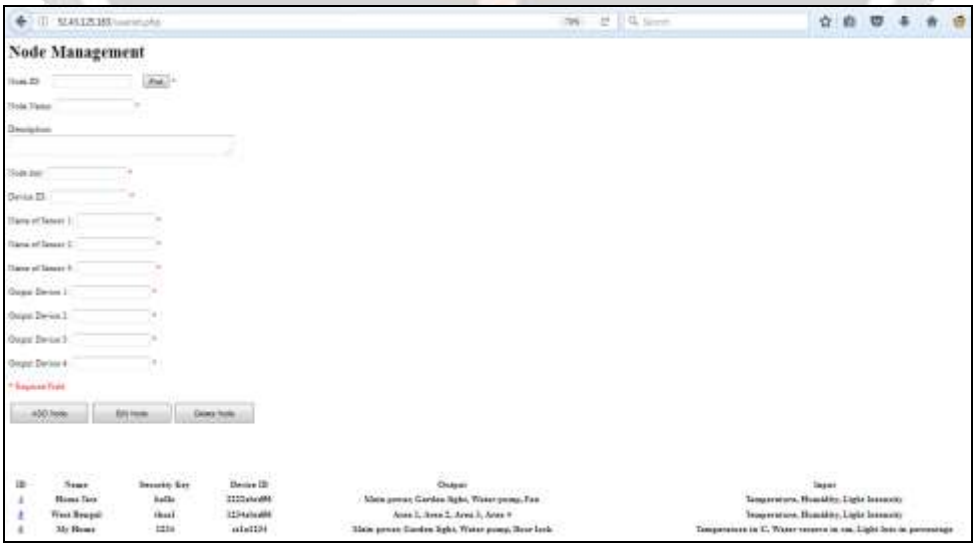


Fig -4: Accessing node management using web browser.

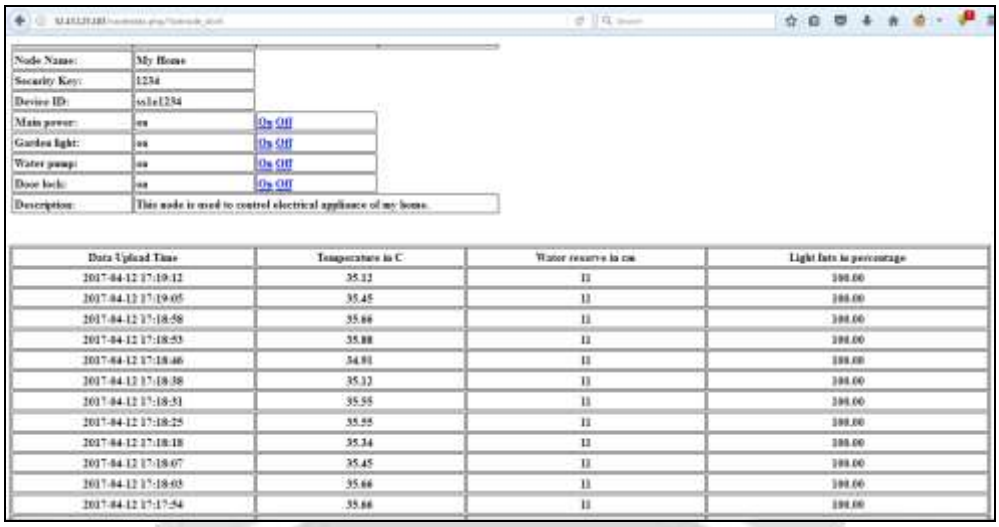
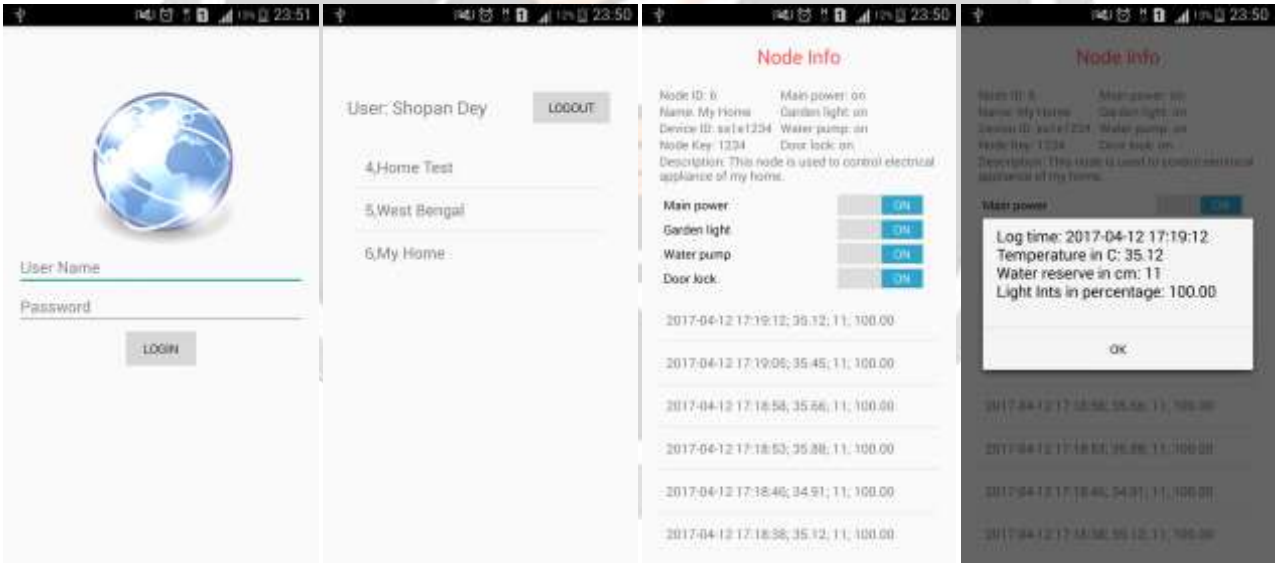


Fig -5: Data monitoring and hardware controlling page.

The android application developed needs to be installed to a smart device if the user desires to access through that smart device. After successful installation, when the user opens the application a home page will appear which reads username and password as shown in fig. . When the user provides the required username and password, the user will be directed to a new page where the user can monitor and can change the status of the load connected to a node under that user. No editing of node or node information is possible. The above figure 6 shows the node information along with sensor data and log time.



(a) (b) (c) (d)

Fig -6: Screenshot of android application (a) user login, (b) node list, (c) node management and (d) log data.

5. CONCLUSIONS

The IoT framework proposed in this paper for Wireless Sensor Network (WSN) contains a variety of sensors attached to three nodes. Multiple nodes can be added to the proposed IoT frame work but the only limitation is that only three sensor can be connected to each node. Other than this limitation the proposed IoT framework is economical with minimal maintenance cost, long durability and environment friendly providing good efficiency. For future work, the proposed IoT frame work can be further upgraded by making it secure using an encryption and the

developed android application can be upgraded by making a provision to edit a node through smart device along with monitoring.

6. REFERENCES

[1] Feng Zhang, Min Liu, Zhuo Zhou, Weiming Shen, "An IoT-Based Online Monitoring System for Continuous Steel Casting," IEEE Internet of Things Journal, Vol. 3, pp. 1355-1363, 2016.

[2] Minhyuk Kim, Sekchin Chang, "A consumer transceiver for long-range IoT communications in emergency environments," IEEE Transactions on Consumer Electronics, vol. 62, pp. 226-234, 2016.

[3] Qingping Chi, Hairong Yan, Chuan Zhang, Zhibo Pang, Li Da Xu, "A Reconfigurable Smart Sensor Interface for Industrial WSN in IoT Environment," IEEE Transactions On Industrial Informatics, vol. 10, no. 2, pp. 1417-1425, 2014.

[4] Hajoon Ko, Jiong Jin, Sye Loong Keoh, "Secure Service Virtualization in IoT by Dynamic Service Dependency Verification," IEEE Internet of Things Journal, Vol. 3, no. 6, pp. 1006-1014, 2016.

[5] Dongsik Jo, Gerard Jounghyun Kim, "ARIoT: Scalable Augmented Reality Framework for Interacting with Internet of Things Appliances Everywhere", IEEE Transactions on Consumer Electronics, vol. 62, no. 3, pp. 334-340, 2016.

[6] Romano Fantacci, Tommaso Pecorella, Roberto Viti, Camillo Carlini, "A network architecture solution for efficient IOT WSN backhauling: challenges and opportunities," IEEE Wireless Communications, vol. 21, no. 4, pp. 113 - 119, 2014.

[7] Jaime Lloret, Jesus Tomas, Alejandro Canovas, Lorena Parra, "An Integrated IoT Architecture for Smart Metering," IEEE Communications Magazine, vol. 54, no. 12, pp. 50-57, 2016.

[8] Luca Catarinucci, Danilo De Donno, Luca Mainetti, Luca Palano, Luigi Patrono, Maria Laura Stefanizzi, and Luciano Tarricone, "An IoT-Aware Architecture for Smart Healthcare Systems," IEEE Internet of Things Journal, pp. 1-12, 2015.

[9] Paolo Bellavista, Giuseppe Cardone, Antonio Corradi, Luca Foschini, "Convergence of MANET and WSN in IoT Urban Scenarios," IEEE Sensors Journal, vol. 13, no. 10, pp. 3558-3567, 2013.

[10] Elias Kougianos, Saraju P. Mohanty, Gavin Coelho, Umar Albalawi, Prabha Sundaravadivel, "Design of a High-Performance System for Secure Image Communication in the Internet of Things," IEEE Access, 2016.

[11] Fagen Li, Pan Xiong, "Practical Secure Communication for Integrating Wireless Sensor Networks Into the Internet of Things," IEEE Sensors Journal, vol. 13, no. 10, 2013.

[12] Hairong Yan, Yan Zhang, Zhibo Pang, Li Da Xu, "Superframe Planning and Access Latency of Slotted MAC for Industrial WSN in IoT Environment," IEEE Transactions on Industrial Informatics, vol. 10, no. 2, 2014.

[13] Shopan Dey, Ayon Roy, Sandip Das, "Home automation using Internet of Thing," Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON), IEEE Annual, 20-22 Oct. 2016.