Integrating Wireless Sensor Network with Open Source Cloud for application of Smart Home

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Abstract— Integration of wireless sensor network for home automation will connect the houses with the internet. This paper focuses on following strategies (1) Developing a low cost solution for integrating the internet of things with the cloud service (2) Developing a maintenance free and economic sensor network which consumes less power (3) Approach towards designing a more secured type of network for the home automation.

Keywords—Wireless Sensor Network, Cloud computing, Open source computing

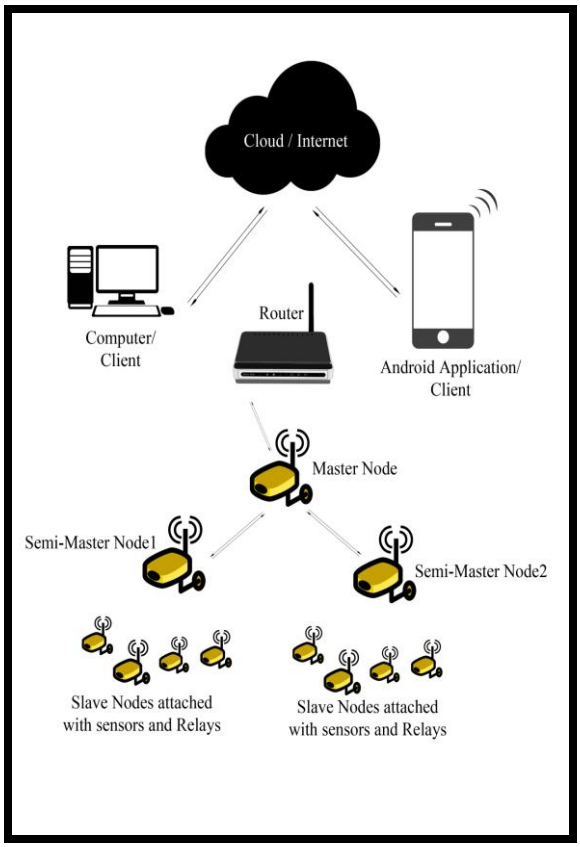
I. INTRODUCTION

In the modern era, we always want to be connected to each other. This is same with our house or there are certain things to which we are attached to. You always want to be near or connected to that thing. For example a garden lover will always wonder how the health of plants in his garden is. An animal lover will always wonder how his/ her pet animal is when he/she is away from home. This problem is resolved using a thing called Internet of Things. Which will connect each and every thing with the internet. The problems can be easily overcome by just combining the present things with the internet. For example, if there are sensors which are constantly monitoring the health of the plants in the garden and updating it on the cloud through internet, it becomes easy for the garden owner to see and monitor the garden. And also he/she can also see and monitor the history and get decisive on the future actions related to it. In the same way there is a central system in the house which keeps the track of when your pet needs food will dispense the food on the exact time. This whole thing will be connected to internet which will help you to monitor the status. Another good example is of security and protection. Suppose if you are away from your home and somebody tries to break in or any kind of LPG leakage or short circuit is detected, then there will be a system which will detect the emergency and will alert you through twitter, WhatsApp or any kind of ping based service. This would surely put the loss down. The whole ideology of connecting the small things with internet is called Internet of Things which will help to make the world a better place. Here we are integrating and developing a system which will ease the Internet of Things such that it can be applied at any field and in any domain without making any major changes in the current system. Since, Sensors and wireless systems are known to increase the cost of the whole system, we have found and alternative solution which is quite simple, cheap and easy to implement. And that too without compromising with the quality system. Our system uses a very low cost sensor network which is attached to a wireless device whose cost is comparatively low compared to other present systems in the market. The wireless sensor network holds an Arduino Nano which is open source and ultimately makes it cheap to use, along with nrf240l which is a very low cost but high range transceiver which works on pipelined addressing architecture based system for data transfer. The system is not only cheap but maintenance free and consumes less power. The fact that internet is a vulnerable place would surely make this system vulnerable. But we have used much secured protocol to transfer the data with certain verification and validation parameters. As mentioned above, the system uses Arduino Nano and NRF240l transceiver as a sensor node. These nodes are not only capable of handling the sensor data but also they can be used to control the appliances by just connecting the node with a relay. Here the system breaks into certain parts including locally connected and globally connected. For globally exchanging the data we would need a medium or physical storage device to store the live feed of the data coming from the sensors. We are using open source cloud storage which is free to use and can handle the desired amount of data easily. The data routing is done through various complex and secured protocols which will prevent the system from getting hacked or sniffed.

II. SYSTEM ARCHITECHTURE

The system architecture is broken down into multiple parts or stages which integrates as modules to form a super system. The base level of the system are nodes which are independent structure with a sensor, microcontroller and a transceiver which is discussed in the paper earlier. The NRF240l works on a pipelined addressing based structure where each node has

unique ID in the network. The nodes are connected in a star network based structure and that to in a ratio of 5:1 which forms semi master node and its slaves. These semi master nodes will send or collect the data from the nodes which are acting as slave node for that semi master node. This semi master node is again connected to a master node which is connected to a internet medium say router. And the router is connected to the internet cloud. In this way, the slaves send or receive data from the semi master node, the semi master node sends or receive data from a master node and the master node is responsible for logging and exchanging data on the cloud through the internet. Many semi master nodes can be connected together to form a final tree like structure. The NRF240L is capable enough for providing addressing for a bigger kind of structure.



As Shown above in the figure, we have slave nodes which are transmitting and receiving the data for sending the sensor data or receiving the data for operating the relays and appliances. The clients are the user who are constantly monitoring or controlling the sensor network. The Cloud is the data center where the data is stored securely.

III. METHODOLOGIES

A. *Using Arduino as tiny nodes*

Most of the researches will Use the arduino platform for developing the tiny nodes. Since arduino is low cost and open source, we are also implementing the arduino to form nodes. There are currently various existing controllers on arduino platform each having a different version of flash memory and IO pins. According to our demand in the project the Arduino UNO is the best suited for making the nodes of the sensor since it is low cost and easily available. Also the SMD version of the node will consume less power which can last up to 6 Months depending upon the type of battery power supply given. Also the Analog pins which are available on the controller are enough for the need of the project making it best suited to make tiny nodes.

B. *Using NRF24l01*

The nRF24L01 is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced Shock Burs), designed for ultra-low power wireless applications. The nRF24L01 is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz. An MCU (microcontroller) and very few external passive components are needed to design a radio system with the nRF24L01. The nRF24L01 is configured and operated through a Serial Peripheral Interface (SPI.) Through this interface the register map is available. The register map contains all configuration registers in the nRF24L01 and is accessible in all operation modes of the chip. The embedded baseband protocol engine (Enhanced Shock Burst) is based on packet communication
And supports various modes from manual operation to advanced autonomous protocol operation. Internal FIFOs ensure a smooth data flow between the radio front end and the system's MCU. Enhanced Shock- Burst reduces system cost by handling all the high-speed link layer operations. The radio front end uses GFSK modulation. It has user configurable parameters like frequency channel, output power and air data rate. The air data rate supported by the nRF24L01 is configurable to 2Mbps. The high air data rate combined with two power saving modes makes the nRF24L01 very suitable for ultra-low power designs. Internal voltage regulators ensure a high Power Supply Rejection Ratio (PSRR) and a wide power supply range. This ultra-Low power consumption and low cost makes the NRF very suitable for using in the WSN technology, since it will make the whole structure more cheaper and fast to implement.

C. *MIT App Inventor*

A mobile app has been developed for the application using MIT's App Inverter. It provides a block based technique for creating android apps. This application is also secured and specific to a particular user as it uses the secured key that the user has on the cloud account. The app has the capability to

access the data and to send any control signal to home from anywhere around the world.

D. Cloud

All the data collected by the master is continuously send to the cloud. The cloud has been created on www.thingspeak.com. A user can have his own private account so that nobody else can view the data send to the cloud. The private account is provided with a security key which is required by any other API that wants to get the information. The information is kept and stored on the cloud and can be viewed by the user as and when required.

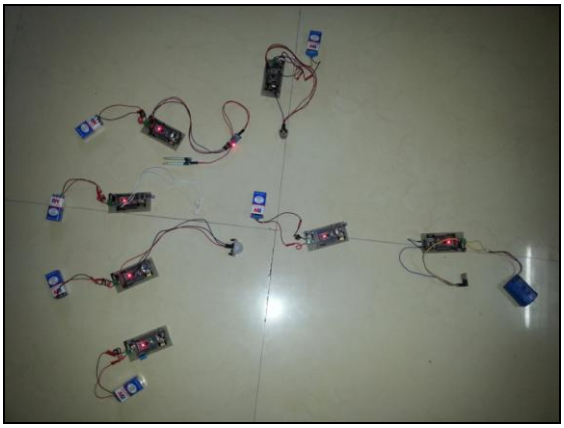
E. ESP8266

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

IV. Use Case Studies

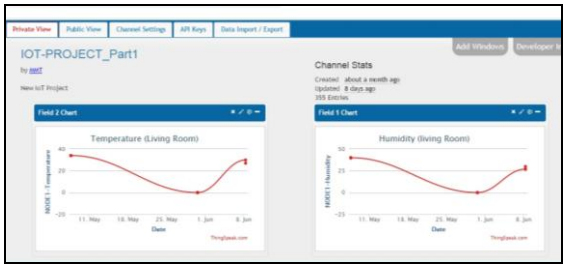
A. Sensor Node

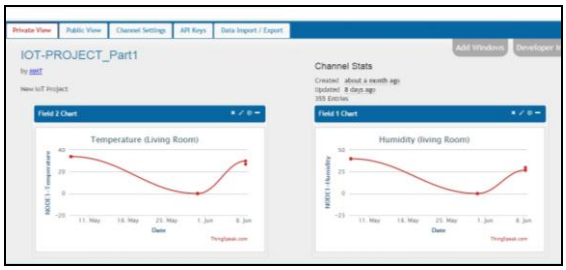
The sensor node is specified nodes which are connected to the sensors and relays which are used to connect and interact with the devices which are connected to the nodes. Following figure shows the implementation of the earlier specified proposed structure.



In the above figure we can see a system where five slave nodes are connected to a semi master node and the semi master node is connected to the master node which is directly connected to the internet cloud through a router.

B. Thingspeak Cloud





Above figure shows the graphical representation of the data which is coming indirectly from the slave nodes. This graphical data is formed from the continuous stream of data which is store on the Thing speak cloud. This data can be parsed into any format and is easily available for viewing on website as well as hand held devices platform.

C. Android Application

As discussed earlier in the paper we want the interface to be available on the hand held devices. We have already listed the methods through which we are developing the android application. The above figure shows the UI of the android application. Which is being used to control and monitor the data coming from the slave nodes.

V. Conclusion

Initial testing proved very fruitful, with speeds maxing out the configured data-rate of the chip, and reliability was improved over previous iterations of the library. Over the course of the following year, the library has been further optimized and

extended, with many new features, bug-fixes, and improved reliability and performance.

By using this methodology there are some key features achieved which are mentioned as below:

- The cost of the complete project reduced due to the use of the low cost NRF24L01 Transceiver instead of ZigBee.
- The Throughput of the NRF24L01 is remains same as that of the ZigBee.
- The size of the sensor node reduced.
- The star topology is perfectly achieved.

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