Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 13 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

IOT: Detection of Keys, Controlling Machines and Wireless Sensing Via Mesh Networking Through Internet

By Md. Nasimuzzaman Chowdhury , MD. Mahbub Hossain Bhuiyan & Samiul Islam

American International University, Bangladesh

Abstract - Internet of things is getting developed rapidly. Each and every day new devices are getting connected with internet. This stream of IOT brings new experience in our daily life. Connecting our wearable devices, gadgets, keys etc can make our own home a new world to us. Every component of our house can communicate with us through IOT. But connecting each device with internet requires costly devices like Wi-Fi modems, GPRS modems etc. This makes connecting each component with internet quiet expensive. In this paper we have developed a cost effective way of connecting each component with internet quiet expensive. In internet. As most of the household components are stationary and close to each other they can be connected with each other through mesh networking. A central device will receive their information and transmit it to internet. The cheapest way to create a mesh network is to use NRF protocol and a WIFI modem does the rest of the work to upload each and every data of this network to internet. In this project there are several nodes regarding their purpose like sensor nodes to collect temperature, humidity, co2 gas quantity and monitor through internet. Control nodes turn on or off AC, fans, lights of house and detection node to find out keys, sun glasses, and small objects.

Keywords : internet of things (IOT), mesh network, Wi-Fi, home automation, sensor monitor.

GJRE-F Classification : FOR Code: 100510, 090905

Strictly as per the compliance and regulations of :

IOT: Detection of Keys, Controlling Machines and Wireless Sensing Via Mesh Networking Through Internet

Md. Nasimuzzaman Chowdhury [α] , MD. Mahbub Hossain Bhuiyan [σ] & Samiul Islam [ρ]

Abstract - Internet of things is getting developed rapidly. Each and every day new devices are getting connected with internet. This stream of IOT brings new experience in our daily life. Connecting our wearable devices, gadgets, keys etc can make our own home a new world to us. Every component of our house can communicate with us through IOT. But connecting each device with internet requires costly devices like Wi-Fi modems, GPRS modems etc. This makes connecting each component with internet quiet expensive. In this paper we have developed a cost effective way of connecting each component with internet quiet expensive. In internet. As most of the household components are stationary and close to each other they can be connected with each other through mesh networking. A central device will receive their information and transmit it to internet. The cheapest way to create a mesh network is to use NRF protocol and a WIFI modem does the rest of the work to upload each and every data of this network to internet. In this project there are several nodes regarding their purpose like sensor nodes to collect temperature, humidity, co_2 gas quantity and monitor through internet. Control nodes turn on or off AC, fans, lights of house and detection node to find out keys, sun glasses, and small objects.

Keywords : internet of things (IOT), mesh network, Wi-Fi, home automation, sensor monitor.

I. Introduction

For centuries researchers are trying to develop home automation systems. But most of the automation system depends on the presence of the user. Some solutions made through voice recognition, some are sound alert systems. Like "A zigbee-based home automation system" by Gill, K. Shuang-Hua Yang; Fang Yao; Xin Lu [1]. But IOT is a breakthrough in the world of home automation. The IOT has the potential to change the entire world into a smarter world. Where automated dictions like when things needs replacing, repairing or recalling can be made easily and efficiently by using IOT. Consequently it would greatly reduce waste, loss and cost of things that we cannot monitor properly. Although, the research into the IOT is quiet in its embryonic stage There are also several projects using IOT but the overall cost for each automation is not effective. Researches like An Internet of Things Approach for Managing Smart Services Provided by Wearable Devices [2], The Applications Of WiFi-based Wireless Sensor Network In Internet of Things And Smart Grid [3], Design of Intelligent Internet of Things for Equipment Maintenance [4]. These are controlling limited devices and costly solutions. To reduce the cost of internet connected things this project is implemented. It not only about controlling devices from internet, it also helps to monitor our home from internet, finding little daily needed things through internet. And as in present time internet is available in smart phones, anyone can access internet from anywhere anytime.

Author α : Dept. of Electrical & Electronic Engineering, AIUB, American International University, Bangladesh.
E-mail : mdnasimuzzaman.chowdhury.c@ieee.org
Author σ : Dept. of Electrical & Electronic Engineering, AIUB, American International University, Bangladesh.
E-mail : satubmh@gmail.com
Author ρ : Dept. of Electrical & Electronic Engineering, AIUB, American International University, Bangladesh.
E-mail : sami.aiub.edu@hotmail.com

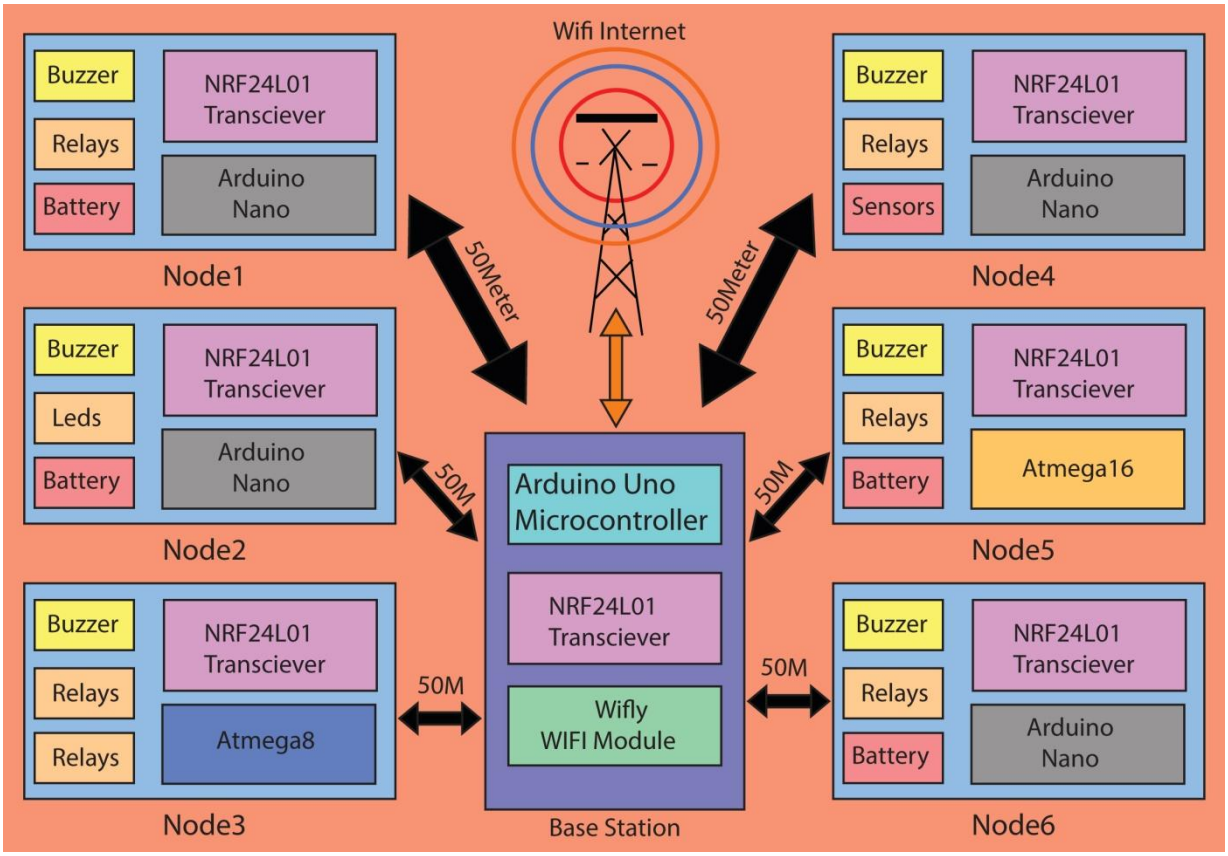

Figure 1 : Main Project Outline

II. Main Project Outline

In this project there are several nodes and one base station. Nodes are required to control, collect information and sense devices. Base station is used to transmit these data to internet. With one base station unlimited number of nodes can be connected. The communication between nodes and base station is through radio frequency. But each node has to be within a circle of around 50meter from the base station. Each node can communicate with each other if necessary. If two nodes communicate with each other then the distance between the nodes also have to be 50meter.

But if two nodes do not communicate with each other then they can be placed in any distance while maintaining specific distance from base station. Base station consists of a microcontroller, NRF transceiver, and an R171 wifly module. Nodes are largely categorized into three categories. Firstly controlling nodes (e.g Node 1, 3, 5, 6). Any node consists of relays to control ACs, fans, lights and NRF transceiver falls into this category. Secondly, sensing nodes like node 4 consists of temperature and humidity sensor. In this way this network can be used as wireless sensor network (WSN) also. Last but the most interesting node is called detection node. Lots of time we lost our important things like keys, sun glasses, small bags etc.

But we know that these things are somewhere near us. So these nodes contain leds, piezo buzzer and NRF transceiver. Whenever the important little thing is lost an alarm can be generated from internet and leds will start blinking, buzzer will start buzzing.

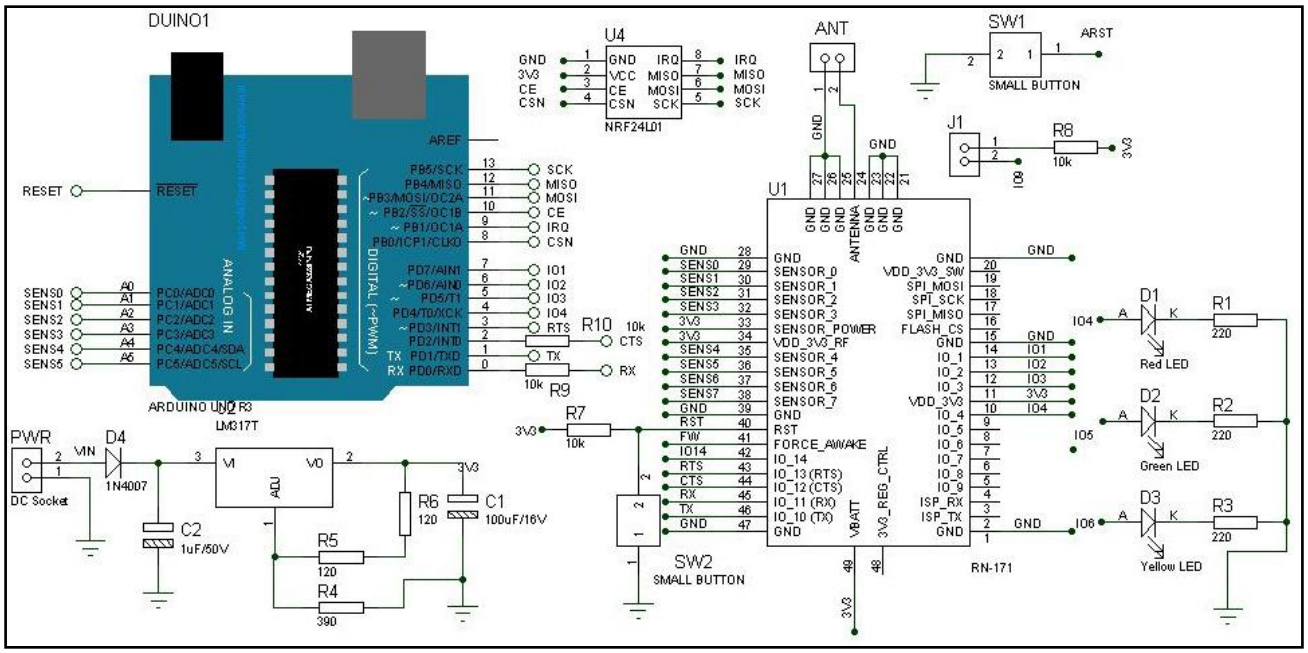

Figure 2 : Main Circuit Diagram

III. Main Circuit Description

The heart of the base station is arduino uno microcontroller. The Arduino Uno is a microcontroller board based on the ATmega328. Arduino Uno has serial peripheral communication pins also. With Arduino Uno NRF24L01 rf transceiver is connected. To connect the complete hardware with internet Wifly (Wifi module) has been used. In the simplest configuration the hardware only requires four connections (PWR, TX, RX and GND) to create a wireless data connection. Interface between arduino Uno and NRF transceiver is serial peripheral interface. MISO, MOSI, SCK & SS pins of arduino is connected with the same pins of NRF transceiver. Pin no 8, 9, 10, 11, 12, 13 of arduino uno is connected to 4,8,3,6,7,5 no pins of NRF transceiver. Here arduino is the master and NRF is the slave. NRF runs on 3.3v DC which collects from Vo pin of LM317T. Wifly module communicates through UART. And it also consumes 3.3v dc from Vo pin. For the purpose of UART communication Rx, Tx, RTS & CTS pins of wifly module connected with arduino uno. There are some other GPIO pins of wifly module which is also connected with arduino for different kind of gpio operations. The ability to go into deep sleep mode and automatically scan and associate to an AP when awake makes the RN-171 suitable for roaming applications. The RN-171 also includes a built in HTML client to automatically post serial uart data or sensor data to a web server. Both the device communicates at 9600 baud rate. Rx, Tx, RTS & CTS pins are connected with Tx, Rx, RTS & CTS pins of arduino respectively.

Different nodes consist of different hardware according to their purpose and application. Brain of node1 is arduino nano. The Arduino Nano is a small, complete board based on the ATmega328. The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the bootloader); the ATmega328 has 32 KB, (also with 2 KB used for the bootloader). The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM [7]. It has 14 digital pins, one uart, two external interrupt, 6 PWM channels, 8-channel 10-bit ADC, Master/Slave SPI Serial Interface, Byte-oriented 2-wire Serial Interface and Six Sleep Modes. SPI of NANO used to interface with NRF transceiver. In 14digital I/O pins 14 relays can be connected to control 14 electronics devices like AC, fan, light, door etc. But in this project we used a single relay to control. Another node consists of atmega8 microcontroller. It has similar capabilities like arduino NANO. ADC pins of atmega8 are used to collect data from sensors. Thus this node is called sensing node. In this project temperature & humidity sensor is used in sensing node.

But in available 5 ADC pins different types of sensors can be used. Another node is used to detect devices. That node consists of a microcontroller, leds & buzzer. In any GPIO pin of microcontroller leds, buzzer can be connected.

The Circuit diagram of this system consists the following equipments:

a) *Arduino Uno Microcontroller :*

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button [5]. It contains everything needed to support the microcontroller; simply need to connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. It operates at 5V voltage and DC current in I/O pin is 40mA. The DC current in 3.3V pin is 50mA. The figure is given below

Figure 3 : Arduino Uno microcontroller

b) *NRF24L01 Transceiver:*

The nRF24L01 is a highly integrated, ultra low power (ULP) 2Mbps RF transceiver IC for the 2.4GHz ISM (Industrial, Scientific and Medical) band. With peak RX/TX currents lower than 14mA, a sub μA power down mode, advanced power management, and a 1.9 to 3.6V supply range [6]. The nRF24L01 integrates a complete 2.4GHz RF transceiver, RF synthesizer, and baseband logic including the Enhanced Shock Burst hardware protocol accelerator supporting a high-speed SPI interface for the application controller.

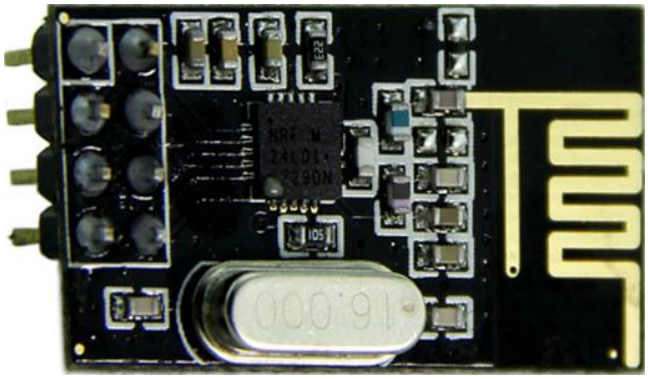

Figure 4 : NRF24L01 Transceiver

c) *Wifly Wi-Fi Shield:*

It"s a 2.4GHz IEEE 802.11b/g transceiver. High throughput - 921Kbps TX, 500Kbps RX data rate with TCP/IP and WPA2 over UART, up to 2Mbps over SPI slave. The RN-171 module is a standalone complete TCP/IP wireless networking module. [8]

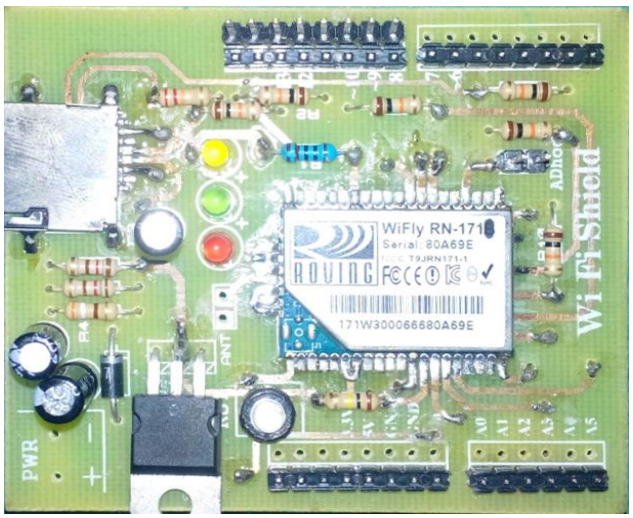

Figure 5 : Wifly Wi-Fi Shield

IV. Main Technology Used

Main purpose of this project is to reduce the overall cost to connect devices with internet. Here we used NRF transceiver to create a mesh network and connected the complete network with internet.

A NRF transceiver can communicate with 6 devices at a time as there are 6 different pipe lines each transceiver contains for communication. Each transceiver contains a Rx address and Tx address. But the Rx and Tx address are same. In order to send data to or receive data from the SPI port on the 24L01 the CSN pin on the 24L01 must be high to start out with. Then, bringing the CSN pin low to alert the 24L01 that it is about to receive SPI data. Once transmitted or read all of the bytes that needed, bringing CSN back high. To execute the R_REGISTER instruction on TX_ADDR register, which will read the contents of the TX address register out of the 24L01 and into micro. The TX_ADDR register is 5 bytes wide and 5-byte addresses is used. First, bringing CSN low and then send the command byte '00010000' to the 24L01. This instructs the 24L01 that needs to read register 0x10, which is the TX_ADDR register. Then five dummy data bytes is sent and the 24L01 will send back to you the contents of the TX_ADDR register. Finally, bringing the CSN pin back high.

The mesh network of nodes is shown below

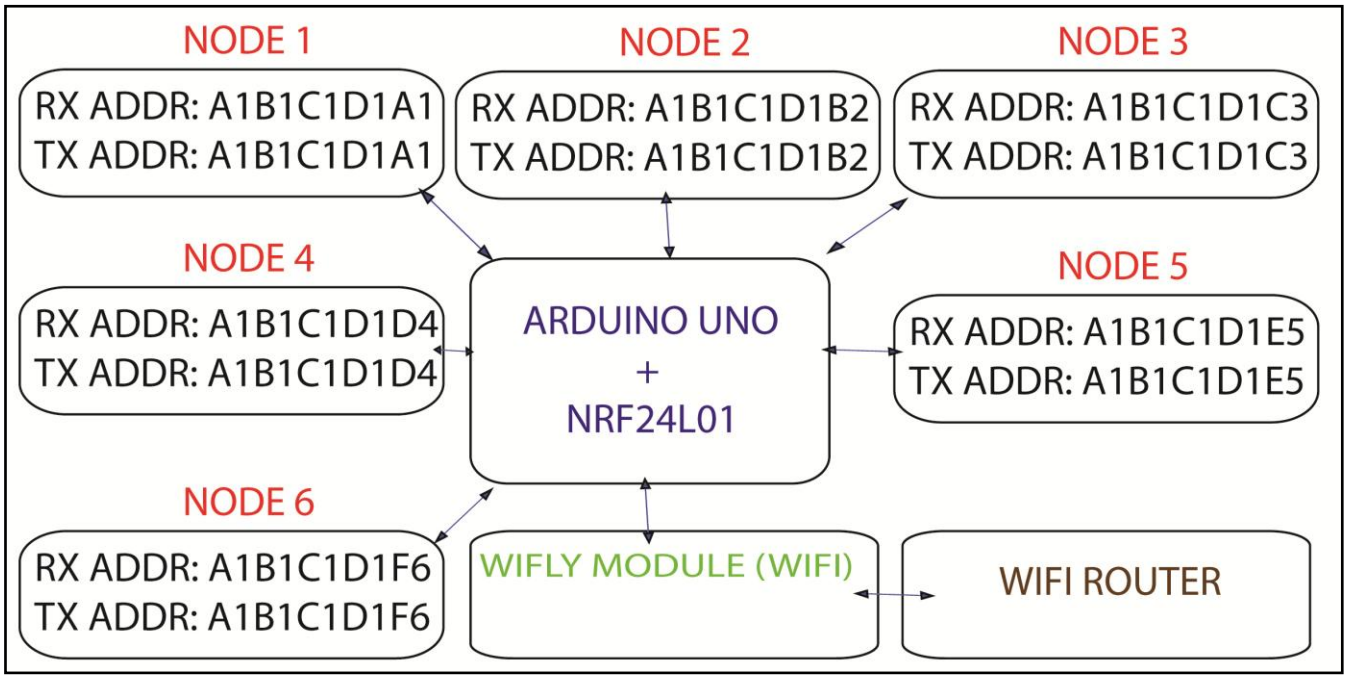

Figure 6 : Mesh networking of 6 nodes with base station

RN171 (Wifly) supports secure Wi-Fi authentication WEP-128, WPA-PSK (TKIP), WPA2-PSK (AES) [8]. To connect with Wi-Fi network WPA-PSK (TKIP) encryption is used.

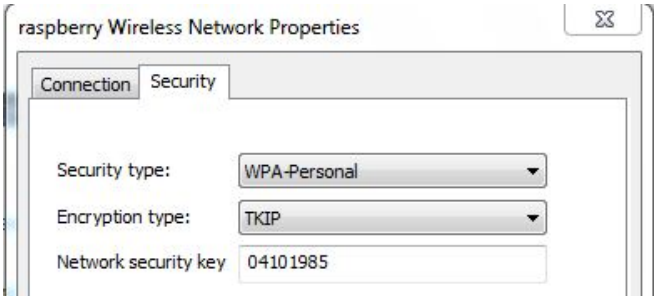

Figure 7: Encryption of wifi network.

For networks using WPA/WPA2 Personal encryption, the SSID and password is needed
SSID: Raspberry
Password: 04101985

At first the available network need to be searched. As the desired network found it is connected with arduino. Following few lines of codes used to search and connect with Wi-Fi network.

```
byte Networks = WiFi.scanNetworks();

char ssid[] = "Raspberry";

char pass[] = "04101985";

status = WiFi.begin(ssid, pass);
```

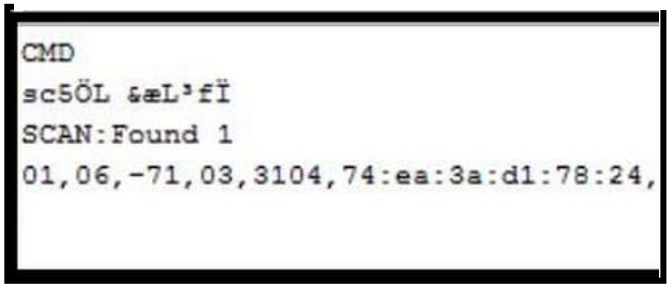

Figure 8: Network found to connect internet

Maximum length of 140 characters Tweet can be generated. To generate a tweet through arduino each account need to have a tweeter 'Token'. In this project

Tweeter account name: internetofkeys

Against this tweeter account an unique token is provided from twitter.com.

Figure 9: Token from Twitter

These are the few codes to setup twitter account with arduino

char msg[];

Twitter twitter("1867893906-rz9ZZWJvFCy8o6ciBRevQUqORBLycwGavEuaeKH");

twitter.post(msg)

Here different messages used for different tweet. User can control devices through re-tweeting also.

V. Hardware implementation

The base station is implemented in PCB design and Vero board. The figure is given below

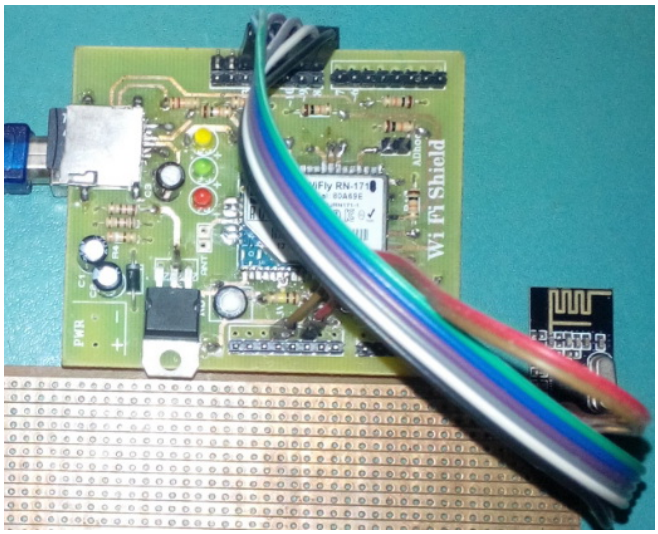

Figure 10. Hardware implementation of base station

There are three nodes implemented in the project. Those are shown bellow.

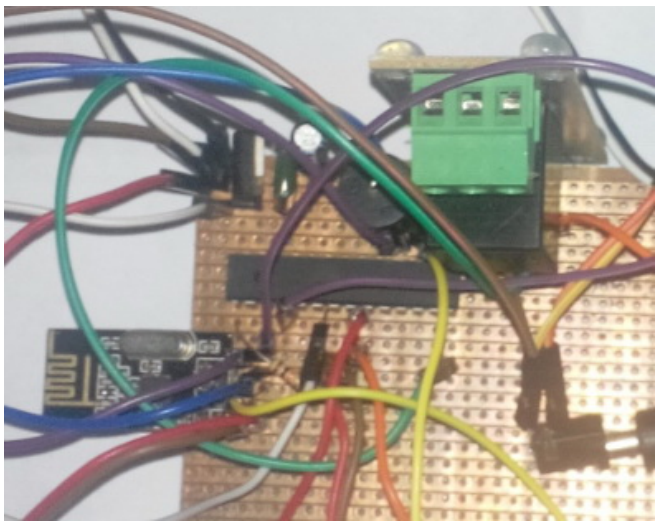

Figure 11: Control Node to control Machines

In this hardware atmega8 is connected with one relay, one buzzer and NRF24l01 transceiver. This node can be connected with machines and machines can be controlled from anywhere in this world through Internet.

In this node with an Arduino Nano, Led light , buzzer and NRF24l01 protocol is connected. This node PCB device can be connected with any necessary keys that helps to find the keys very quickly.

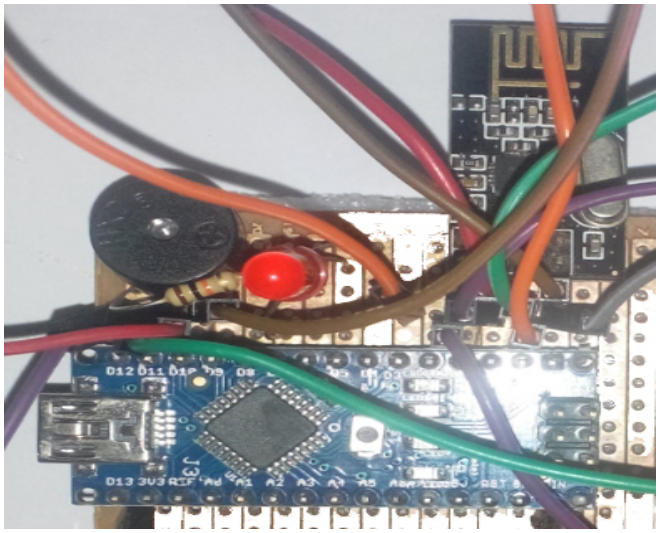

Figure 12 : Detection Node for Key detection

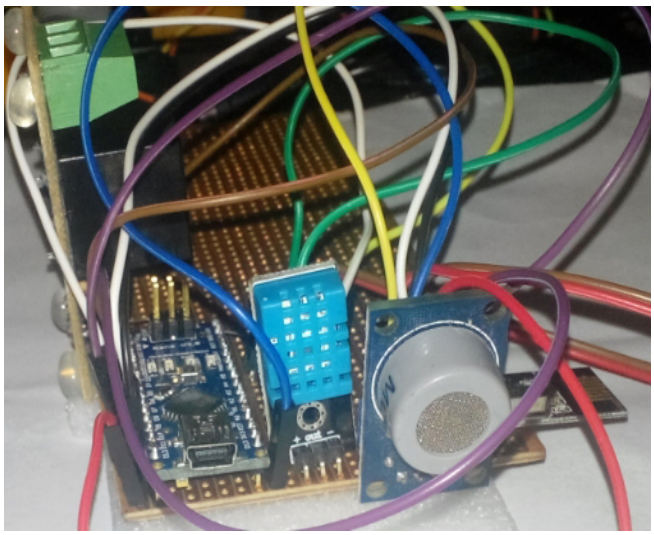

Figure 13: Sensing Node for sensing temperature and humidity

In this node with arduino nano temperature, humidity and gas sensor is connected. With this node device it's possible to sense any places temperature or humidity and the transmitted data can be viewed instantly via internet from anywhere.

VI. Output Results

All the outputs are shown in the tweeter. Here are some tweets transmitted from user account and re-tweet from base station. When connection establish base station tweet of connection establishment.

Figure 14 : Connection establishment confirmation

Here user is Md. Nasimuzzaman. So user can select a command to turn on or turn off lights, fans, Ac. This base station will accept tweets from @Md.Nasimuzzaman only.

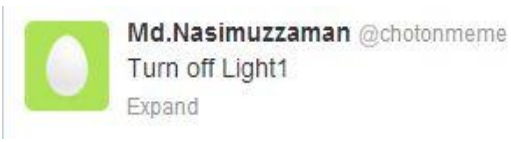

Figure 15 : Tweet from the user

If the operation completes successfully the base station execute the operation and re-tweet to user.

Figure 16 : Re-tweet and confirmation of task

The base station also tweet the temperature and humidity after an interval period of time. This time interval is selected by the user. By this node the system can give an update of temperature and humidity of anyplace this system is setup

Figure 17 : Output of Temperature and Humidity Sensor

VII. Further Application

a) Complete industry automation.
b) Wireless Control of any machine via Internet.
c) Wireless sensor networks.
d) Official Access & attendance systems.
e) Patient monitoring systems for doctors.
f) Internet of keys, moneybags, kids, toys etc.

VIII. Conclusion

For very small distance like 50meter NRF transceiver are reliable but if any movable object go beyond this distance its untraceable. There are other devices like Zigbee can be used for long networking. Here limited number nodes has been used but more than 6nodes are little complex through NRF24l01 transceiver. Overall we can say that through a mesh networking we connect the network with internet and our dream of connecting each component of this world with internet can be achieved very rapidly. It's a perfect present time solution until Wi-Fi modules comes in cheap with IPv6.

References Références Referencias

1. Gill, K, Shuang-Hua Yang; Fang Yao; Xin Lu, Consumer Electronics, IEEE Transactions on (Volume:55, Issue: 2), May 2009, pp.422 – 430.
2. Pedro Castillejo, José-Fernán Martínez, Lourdes López, and Gregorio Rubio, An Internet of Things Approach for Managing Smart Services Provided by Wearable Devices, International Journal of Distributed Sensor Networks Volume 2013, Article ID 190813, 9 pages.
3. Li Li , Hu Xiaoguang, Chen Ke, He Ketai, The Applications Of WiFi-based Wireless Sensor Network In Internet Of Things And Smart Grid, 2011 6th IEEE Conference on Industrial Electronics and Applications.
4. Xu Xiaoli, Zuo Yunbo,Wu Guoxin, Design of Intelligent Internet of Things for Equipment Maintenance, 2011 Fourth International Conference on Intelligent Computation Technology and Automation.
5. http://arduino.cc/en/Main/ArduinoBoardUno//
6. http://www.nordicsemi.com/eng/Products/2.4GHz-RF/nRF24L01#Overview
7. http://arduino.cc/en/Main/ArduinoBoardNano
8. WiFly- RN-171 datasheet.