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Smart Water Management using Internet Of Things and Wireless Sensor Network

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Abstract: This paper aims to present an Internet of Things based solution for smart and centralised monitoring and managing of water for smart residential/offices, smart cities, Industries etc. By using this Internet Of things-based solution we can regulate the usage of water, find out the leakage and blockage in pipelines, can detect overflow of drainage water. The information collected can be read by the users on the integrated websites using their smartphones/laptops device connected to the Internet. Basically, all the information is gathered from the sensor network which is set using NRF protocol.

Key Word: IOT, WSN, NRF24l01, Arduino.

1. Introduction

Internet of things (IOT) refers to connect things to Internet, things are an entity that has intelligence to sense data around its environment, and send it to the Internet, where it processes the data and make it useful for engineering purpose. The Internet Engineering Task Force, IETF, provides its own description of the Internet of Things, "The Internet of Things is the network of physical objects or "things" embedded with electronics, software, sensors, and connectivity to enable objects to exchange data with the manufacturer, operator and/or other connected devices." [1] All these definitions talk about the networking and data communications along with network services, which are realized by wireless sensor networks. These WSNs must be designed with sophisticated and extremely efficient communication protocols along with sensors with advanced sensing capabilities. This paper also attempts to do the same by implementing the wireless sensor network by using NRF protocol and send the sensor data on to the IOT framework by Wi-Fi module.

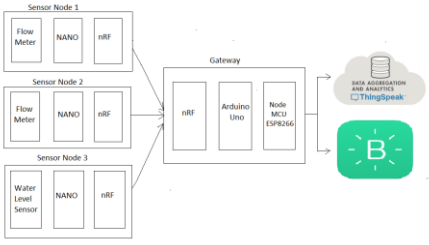
2. Objectives

Now a days drinking water utility are facing various challenges, due to improper water management system hence, there is a need for better methodology for real time water management. And also, the lack of proper waste water management leads to a major challenge and problem for cities. So the objectives of this paper is to provide clean, healthy and sufficient water supply for each society. To conserve and reduce the wastage of water by implementing technique of water metering i.e. Pay as per usage for each household. To provide cleaner cities and intelligent management of drainage in the cities by monitoring real

time the waste water level and blockage in drainages.

3. System Architecture

Basically, idea is to set a nrf24l01 wireless sensor network, where in a sensor network the master node will act as a gateway and will connect our network to internet the slave nodes will be interfaced with appropriate sensors to sense the required parameter. In our system we have configured Arduino UNO as a master node, to act it as a gateway I am connecting Arduino uno to NodeMCU board by UART connection, you can also directly interface a ESP-8266 Wi-Fi module directly with Arduino uno board. The reason I have done that is because I wanted my master, Arduino uno to just wirelessly take the sensor data from all the sensor slave nodes, with minimum data packet loss as possible. So now the data separation i.e. from which sensor node what sensor data is coming to master node is programmed at NodeMCU board such data separation is required because when the data will be send to IOT platform, or when the data will be analysed or integrated it will be easier and plus since, such data separation



programming is done on NodeMCU board which takes load off the Arduino master node that is advantageous for our system design.

4. Tools and Technologies

In this paper we try to make use of tools and technologies that gives reliability, simplicity, low power consumption, low cost etc. This work relies on open standard.

4.1 NRF24l01

nRF24L01 is a single chip radio transceiver for the world wide 2.4 - 2.5 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator, modulator and Enhanced ShockBurst™ protocol engine. Output power, frequency channels, and protocol setup are easily programmable through a SPI interface. Current consumption is very low, only 9.0mA at an output power of -6dBm and 12.3mA in RX mode. Built-in Power Down and Standby modes makes power saving easily realizable. If used in open space and with lower baud rate its range can reach up to 100 meters. Using this protocol use can set a network between 3125 sensor nodes.[2]

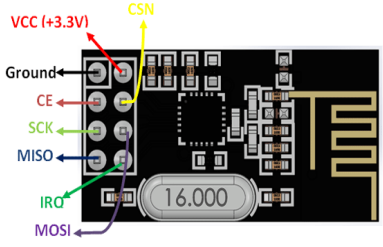


fig. 1: Nrf24l01 module

4.2 Arduino UNO

The Arduino UNO is an microcontroller board which has Microchip ATmega328p microcontroller embedded in it this board is developed by Arduino.cc and it is open source. The board has 14 Digital I/O pins (6 pins are capable of PWM output), 6 analog I/O pins and can be programmed with open source IDE called Arduino IDE using USB cable. It also supports various interfaces such as SPI (Serial Peripheral Interface) on MOSI – D11, MISO – D12, SCK – D13; UART serial communication on Pin D0 and D1 and also has software communication to replicate the functionality of hardwired Rx and Tx lines.

4.3 Arduino NANO

Arduino Nano is a small, compatible, flexible and breadboard friendly Microcontroller board, developed by Arduino.cc in Italy, based on ATmega328p (Arduino Nano V3.x) / Atmega168 (Arduino Nano V3.x). Arduino Nano pinout contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins. Supports SPI communication on pin 10, 11, 12, 13.

4.4 NodeMCU Esp8266

NodeMCU Esp8266 is an open source IOT platform, which comes with a firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. It can be interfaced with Arduino Uno board using several protocols like UART etc.

5. Experimentation scenario

For experimentation purpose we have made our sensor nodes and gateway node using Arduino Nano and Arduino UNO respectively. Each sensor node is interface with nrf24l01 radio communication module, as this is the protocol we are using for wireless communication and the needed sensor to sense the needed environmental parameters, thus we have use water flowmeter, to monitor real time flow of water through pipes and to check quantity of water that flows through pipe and water level sensor to check the level of water in stored tank or other water bodies. There is SPI interfacing between Arduino Nano and nrf24l01 module, and every radio module on sensor node is configured in transmitting mode. On other hand, for the gateway node we made use of Arduino UNO. Gateway node is also interfaced with nrf24l01 radio module, but here the radio module is configured in Receiving mode. So, it can be figured out the there is only one-way communication between each sensor node and gateway node. The Arduino Uno is programmed to exact all the data the incoming data from sensor node, and also to compare the sensor reading coming from sensor node, so if the difference between the two adjust sensor node increases then the buzzer which is also attached to Arduino UNO will turned on, indicating that there is the leakage between two adjacent node, this is the

ideology behind our real time leakage detection system.

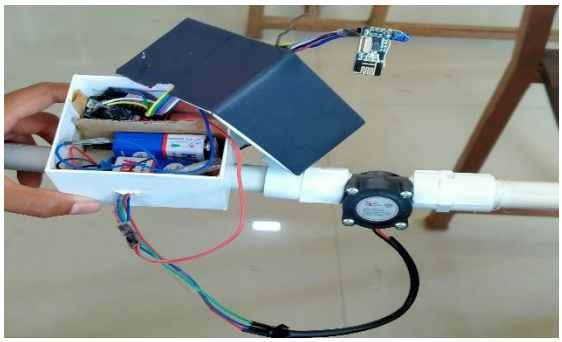


fig.2: One of our Sensor Node.

The fig. 2 shows the physical structure of our sensor node where the flow meter and nrf24l01 module is interfaced with Arduino nano.

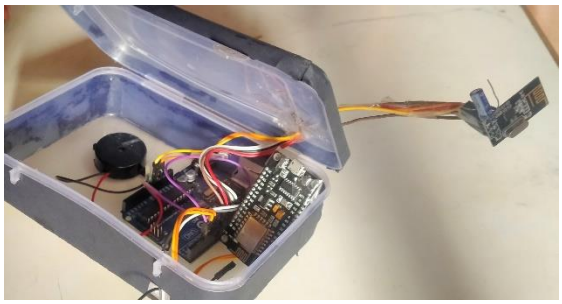


fig. 3: Receiver node / Gateway node

The fig. 3 shows the physical picture of our receiver node or gateway node. Here the nrf24l01 module is interfaced using SPI interface to Arduino UNO and serially communicating with NodeMCU esp8266 using UART interfacing protocol and a Buzzer is connected to digital pin of Arduino UNO for leakage Indication.

6. Experiment Result

Our system gives real time data of flow through each pipe, and post the data onto the IOT platform i.e. Thingspeak and also on client's mobile application i.e. Blynk application. Below figure shows the screenshot of our display panel on Thingspeak when NO Leakage is detected.

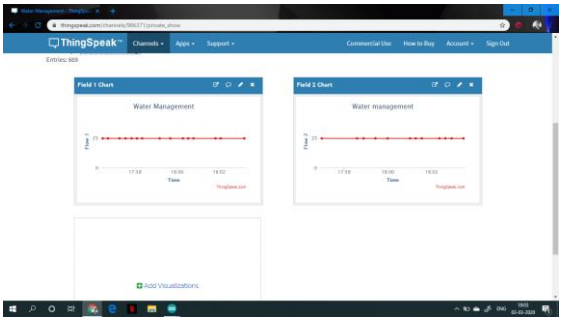


fig. 4: flow meter graph when No leakage occurs

If in case, leakage occurs the graph show difference in meter reading which is shown in the figure below.

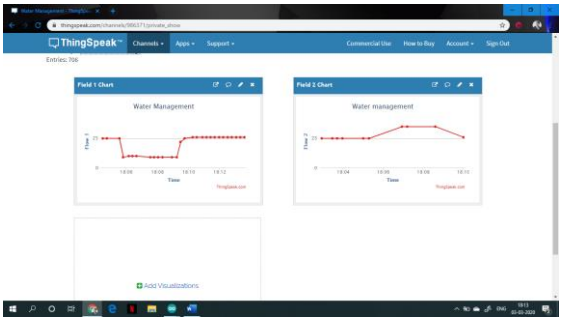


fig. 5: flow meter graph when leakage occurs.

Our system also posts all the data of how much total water is consumed i.e. it provide water metering and also gives real

time status of water level in storage tanks on the mobile application called Blynk application. Below figure is a screenshot of the blynk application interface that we have deigned according to our system needs.

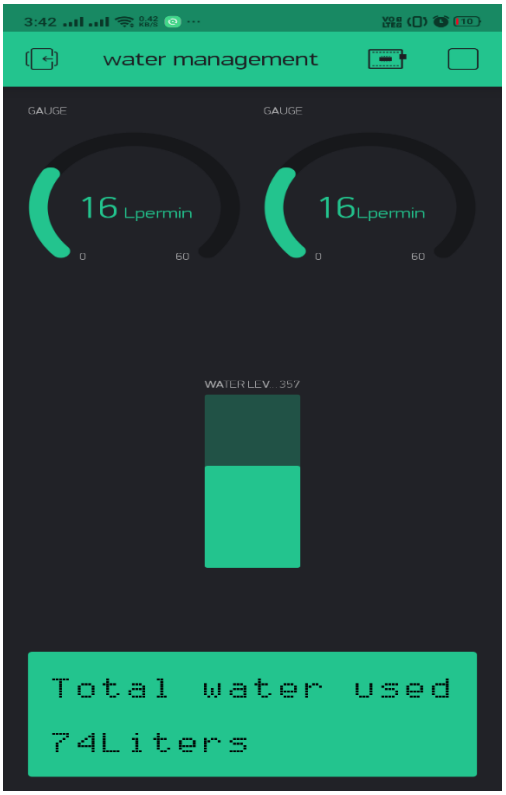


fig. 6: Blynk Application interface

6. Conclusion

The IOT and WSN will be an important technological advancement which will take the Internet and network in every domain like controlling, monitoring etc. So, we are using this technology for water management purpose. Thus it is seen in our paper that, we had set up a wireless sensor network using nrf24l01 transceiver module where all the sensor node sends the data to the base receiver module and, the base station acts as a gateway to connect this wireless sensor network to Internet using Nodemcu esp8266 module. So, as it is seen in result, the reading is visible on Thingspeak and Blynk application.

7. Reference

1. Internet Engineering Task Force (IETF), [Online], Available: http://www.ietf.org/topics/iot/
2. Nrf24l01, Nordic VLSI, [Online]. Available: https://www.digchip.com/datasheets/1106247-nrf24l01.html