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Smart Sensing with MQTT Mesh Network

S.Sarvanan [1] ,Pooja Shree.D [2] ThalabeethaAgnes.A[3], Yogeswari.N[4]

Assistant Professor[1],Student[2,3,4]

Department of Computer Science and Engineering

PERI INSTITUTE OF TECHNOLOGY

ABSTRACT

A wireless mesh network (WMN) is a mesh network created through the connection of wireless access point (WAP) nodes installed at each network user's locale. The networking infrastructure is decentralized and simplified because each node need only transmit as far as the next node. WMNs may or may not be connected to the internet. Wireless mesh networks, which can also be a form of wireless ad hoc network (WANET), are often used for the following: connecting internet of things (IoT) devices, such as sensors, security systems, smart appliances and monitoring systems; building networks in developing communities that lack internet wiring infrastructure; and providing consistent wireless access to hospitals, educational campuses and warehouses. Wi-Fi and networking in temporary locations, such as construction Network Security Can be defined as measures taken to protect data during their transmission along the media. Whereas securing the internet means taking measures to protect data during their transmission over a collection of Interconnected networks. Network security is the most important issue in the vast field of wireless networks. In order to improve network security, there are number of products that are available in the market that use packet filtering. For a network administrator, packet filtering is an effective tool for security purposes but he/she has to have an in depth knowledge of the capability of this tool. Our firewall software contains a set of protocol for which the filters will be applied. We have devised a packet filtering firewall called Net app for Microsoft windows operating systems.

INTRODUCTION

In this project the WiFi - based mesh network that will transmit the data to each nodes and finally the data will be published in the MQTT based web server, So there is no need of wired connections between sensors and clouds. In this, the nodes don't need to connect to a central node. Nodes are responsible for relaying each others transmissions. This allows multiple devices to spread over a large physical area. The nodes can self-organize and dynamically talk to each other to ensure that the packet reaches its final node destination. If any node is removed from the network, it is able to self-organize to make sure that the

packets reach their destination. ESP-MESH network has much greater coverage area as nodes can achieve inter-connectivity without needing to be in range of the central node. Here, stations are Node MCU's WIRELESS mesh networks is an emerging technology and may bring the dream of a seamlessly connected world into reality. Mesh networks can easily and effectively connect a significantly large area e.g. a city. In a wireless mesh network, the network connection is spread out among dozens or even hundreds of wireless mesh nodes that talk to each other to share the network connection across a large area. Mesh nodes are small radio transmitters that function in the same way as a wireless router. They use Wi-Fi standards known as 802.11a, b and g in order to communicate with users and with each other. They are programmed to tell them how to interact with each other. Only a fraction of nodes have direct access to the internet. That wired node shares the internet connection wirelessly with the nearest cluster of nodes, which then shares it with the nearest cluster of nodes and so on. In this case, the nodes done need to be wired to anything but a power supply. WMNs are has two types of nodes: mesh routers and mesh clients. Other than the routing capability for gateway/bridge functions as in a conventional wireless router, a mesh router contains additional routing functions to support mesh networking . Through multi-hop communications, the same coverage can be achieved by a mesh router with much lower transmission power.

To further improve the flexibility of mesh networking, a mesh router is usually equipped with multiple wireless interfaces built on either the same or different wireless access technologies Mesh routers have minimal mobility and form the mesh backbone for mesh clients. Thus, although mesh clients can also work as a router for mesh networking, the hardware platform and software for them can be much simpler than those for mesh routers .To date, several companies have already realized the potential of this technology and offer wireless mesh networking products.

Wireless mesh networks are preferable to existing cable based networks or wireless LANs , due to the following potential advantages: (a) it is more cost effective, as service providers do not have to install a wired connection to each subscriber; (b) it is more reliable, as each node has redundant paths to reach the Internet; (c) the throughput got by a user can be increased through routing via multiple, bandwidth-abundant paths and (d) the wireless network can readily extend their coverage by installing additional ad-hoc hops. Wireless mesh networks technology is flexible and has low budget which is now growing in the market due to its advantages or benefits both in developed and developing countries. According to a report by MuniWireless.com in March 2007, 81 U.S. cities have already installed citywide or region wide municipal wireless networks and 164 more are actively building such networks. The report also says that 38 U.S. cities already have municipal wireless networks for the exclusive use of public safety and city employees .In this project, I will discuss what wireless mesh network is, how it functions, its advantages, the network architecture, applications, problems the new technology is facing and possible ways of solving them while using a better protocol.

HARDWARE REQUIREMENTS

RASPBERRY PI

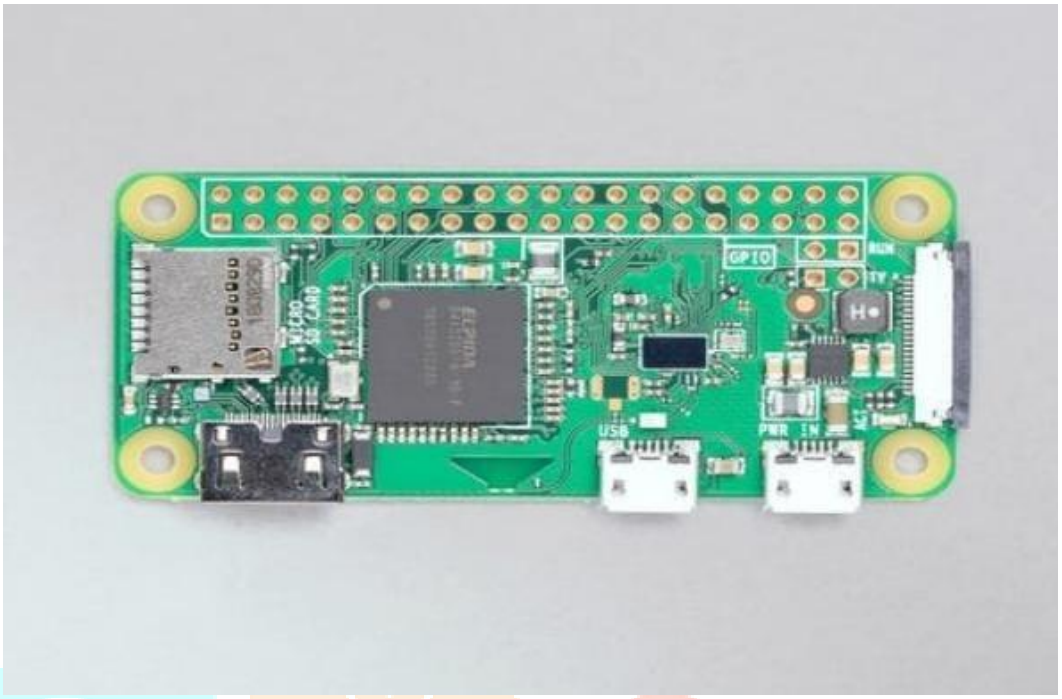

Fig 1: Raspberry pi kit

Raspberry Pi is a series of small single-board computers (SBCs) developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. The Raspberry Pi project originally leaned towards the promotion of teaching basic computer science in schools and in developing countries. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices. The Raspberry Pi uses the ARM processor architecture, which is also used by many modern mobile phones. An operating system can be installed using the Raspberry Pi Imager, or by copying operating system 'images' to an SD card.

FEATURES

1. 1GHz single-core ARMv6 CPU (BCM2835)
2. Video Core IV GPU, 512MB RAM
3. Mini HDMI and USB on-the-go ports
4. Micro USB power
5. HAT-compatible 40-pin header
6. Composite video and reset headers

NODEMCU ESP8266

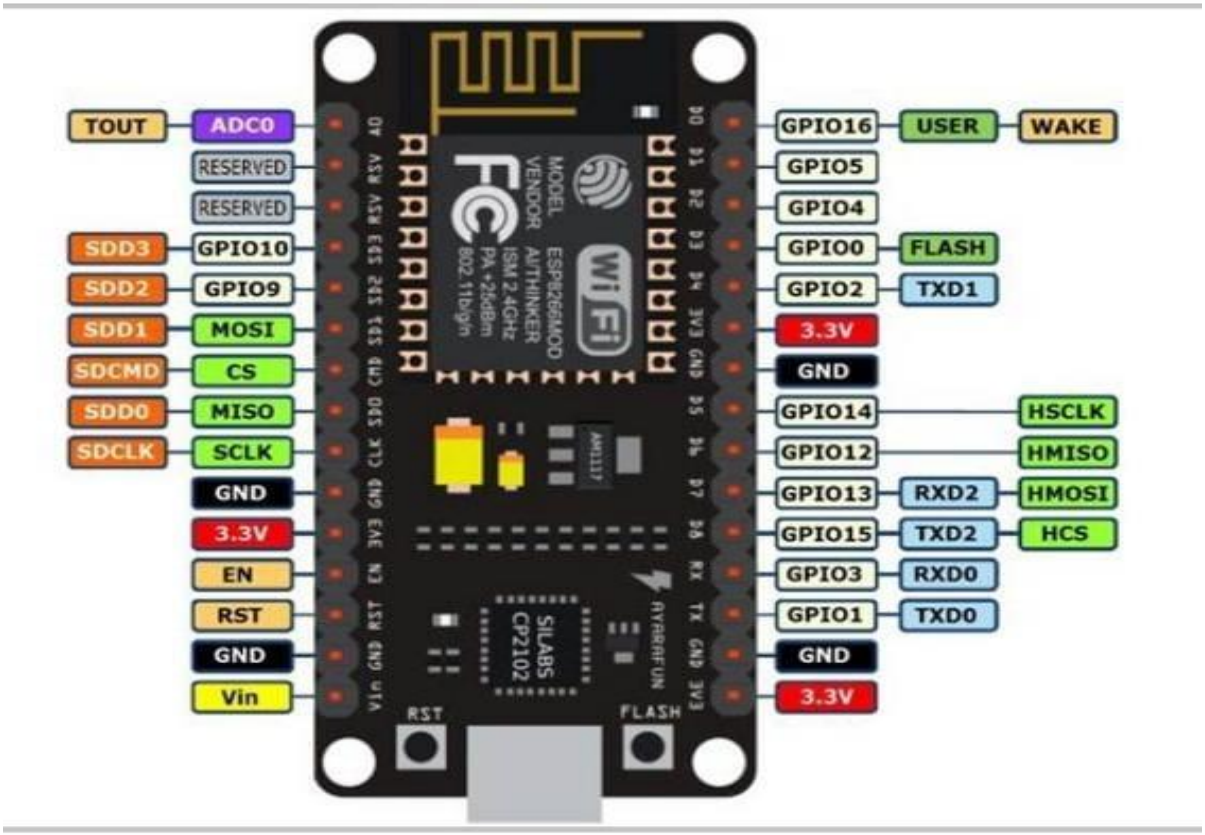

Fig 2: NODEMCU ESP8266

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit).Both the firmware and prototyping board designs are open source. The firmware uses the Lua scripting language. The firmware is based on the project, and built on the Expressive Non-OS SDK for ESP8266. The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards.

The Node MCU ESP32 board (in some cases also known as ESP32-DevkitC) is fully supported by ESP Home. Simply select ESP32 when the ESP Home wizard asks you for your platform and nodemcu-32s as the board type. Note that in certain conditions you can use the pins marked as INTERNAL in the above image.

GPIO0 is used to determine the boot mode on start up. It should therefore not be pulled LOW on start up to avoid booting into flash mode. You can, however, still use this as an output pin.

GPIO34-GPIO39 cannot be used as outputs (even though GPIO stands for “general purpose input output).

GPIO32-GPIO39: These pins can be used with the Analog To Digital Sensor to measure voltages.

SOFTWARE REQUIREMENTS

QUBITRO

5Qubitro is a brand and model agnostic IoT platform that makes devices able to connect via all major IoT communication protocols, including MQTT v5.0, CoAP/LwM2M 1.1, and LoraWAN over the WiFi, 3G/4G/5G, and NB-IoT networks ensuring security via TLS/DTLS, and built-in custom token-authentication mechanism.

Qubitro is a SaaS IoT Cloud platform. To its users; Qubitro enables real-time monitoring, storage, and rule sets of data coming from internet-enabled devices on a single platform, enabling it to trigger its own, 3td party services or other devices. For special scenarios, with Qubitro services (API), users can develop their own mobile or web applications and provide data flow to analytics platforms.

ARDUINO IDE

IDE stands for “Integrated Development Environment” :it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device.

1. Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.

2. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.

3. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

4. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.

5. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.

6. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.

7. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.

PYTHON

python is interpreted language, when you run python program an interpreter will parse python program line by line basis, as compared to compiled languages like C or C++, where compiler first compiles the program and then start running.

THONNY IDE

Thonny is an integrated development environment specifically intended for beginners Its user interface is characterized by simplicity. However, it is not as simple as those found in text editors. Nor is it as complex as those of other IDEs, generally used by professionals. Thus, Thonny has a panel where the code is edited, another one to visualize the assigned variables, and finally, a space to execute the code. It is also very convenient to have a debugger to detect possible errors in the code.

OTHER TECHNOLOGIES

- Wi-Fi name (SSID) and one channel for the whole system
- Plug and play and self-configuration of the two systems: Gateway which connects to LAN cables and relay which does not connect to the LAN/Internet cable when supplied with electricity.
- Smart routing the best gateway among many other gateways. • Automatically connect to other gateways.
- Seamless roaming beyond traditional WLAN boundaries allows users to move their devices such as laptops, smart phones freely from one place to another.
- Limits the number of the users accessing to a Hybrid Wi-Fi mesh station. Each station manages its own bandwidth.
- Automatically and unlimitedly connects Hybrid Wi-Fi mesh stations to each other to create a complete mesh Wi-Fi system.
- The whole Hybrid Wicell system uses IP LAN.
- Most stable and strongest signal coverage in the market with MIMO standard. Data transmission speed reaches 300xMbps. The technology applies to any scale of project and supports all IP based services.
- Hybrid Wi-Fi network controller. Free software which controls all activities of hybrid Wicell

SYSTEM ARCHITECTURE

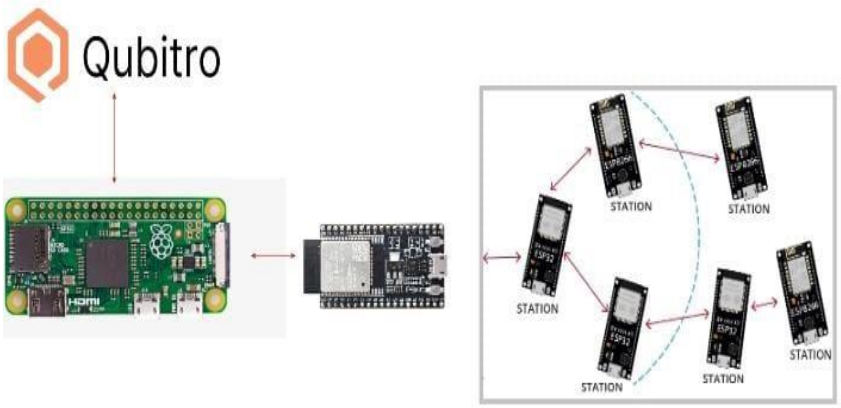

Fig 3: system architecture

WORKING PRINCIPLE

The working principle of wireless mesh network is the same as that of the packets that travel around the wired internet data transfer between one node and another toward the destination. This is implemented with the help of dynamic routing algorithm. It is possible by making each node communicate its routing information to other nodes within the network. With the received information, each node will decide whether to forward or to keep the data for itself. It is based on the functionality of the routing protocol. It is necessary for any routing algorithm to ensure that routing is done by predicting the shortest path between the source and destination.

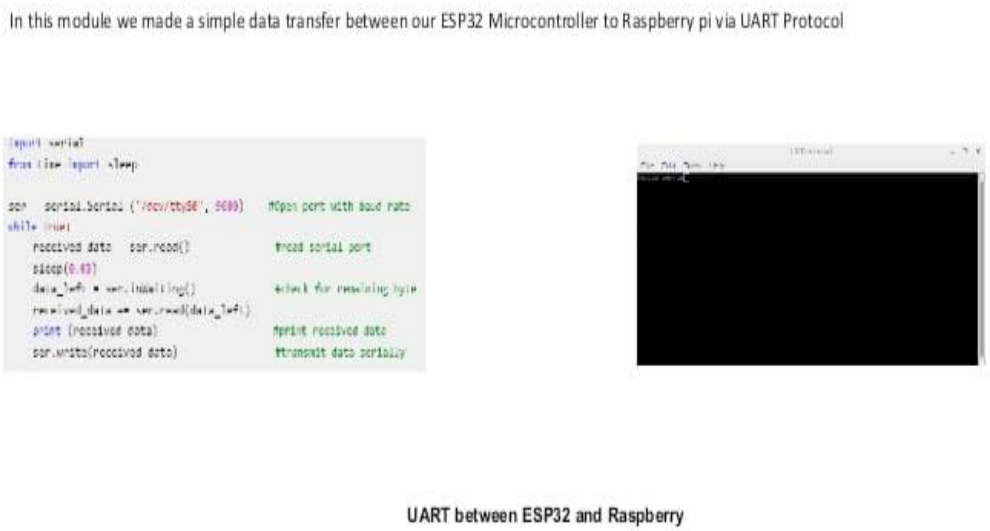

Fig 4: working process

OUTCOME

Fig 5: outcome result

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