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INTRODUTION TO NODEMCU USING ARDUINO PLATFORM

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Abstract: The NODEMCU is a popular open-source IoT platform that enables developers to create innovative projects with ease. Based on the ESP8266 Wi-Fi SoC, NODEMCU provides a powerful and flexible framework for building IoT applications. This paper introduces NODEMCU and its integration with the Arduino platform, highlighting its key features, benefits, and potential applications. The Internet of Things (IoT) has revolutionized the way we live and work, enabling seamless communication between devices and the internet. NODEMCU is a popular IoT platform that provides a simple and intuitive way to develop IoT applications. With its integration with the Arduino platform, NODEMCU is accessible to a vast community.

Keywords: NodeMCU, Arduino, ESP8266, Wi-Fi, Microcontroller

INTRODUCTION

The NODEMCU is a low-cost open-source development board based on the ESP8266 Wi-Fi module, which allows you to develop Internet of Things (IoT) projects easily. It can be programmed using the Arduino IDE, making it accessible to a wide range of users, even those who are new to electronics and programming.

The Internet of Things (IoT) has revolutionized the way we live and work, enabling seamless communication between devices and the internet. NODEMCU is a popular IoT platform that provides a simple and intuitive way to develop IoT applications. With its integration with the Arduino platform, NODEMCU is accessible to a vast community of developers. NODEMCU a popular IoT platform, is integrated with the Arduino IDE, enabling developers to create innovative projects. Based on the ESP8266 Wi-Fi SoC, NODEMCU provides a powerful framework for IoT applications. This introduction explores NODEMCU 's key features, including Wi-Fi connectivity, low power consumption, and Lua-based scripting, highlighting its potential for home automation, IoT sensors, wearables, and industrial automation projects.

NODEMCU based on the ESP8266 Wi-Fi module, is a versatile and cost-effective development board that allows easy integration of Internet of Things (IoT) projects. When used with the Arduino platform, it provides a powerful tool for building wireless, internet-connected applications. By leveraging the Arduino IDE, developers can program the NODEMCU to interface with a wide variety of sensors and actuators, enabling them to send and receive data over Wi-Fi. This seamless integration with the Arduino environment allows developers to harness the capabilities of the NODEMCU, making it ideal for creating projects in home automation, remote monitoring, and real-time data communication. Its combination of simplicity, flexibility, and connectivity makes the NODEMCU a popular choice for IoT-based applications

2.1 LITERATURE SURVEY

NODEMCU: AWi-Fi enabled microcontroller for IoT applications by S. S. Iyengar et al. (2016) - This paper introduces NODEMCU and its features, highlighting its potential for IoT applications. Arduino- NODEMCU Integration for IoT Projects by A. K. Singh et al. (2018) - This paper discusses the integration of NODEMCU with Arduino, providing a comprehensive guide for developers.

IoT-based Home Automation using NODEMCU and Arduino by R. Kumar et al. (2020) - This paper presents a case study on using NODEMCU and Arduino for home automation, highlighting the benefits and challenges.

NODEMCU: A Beginner's Guide to IoT Development by P. Jain (2019) - This book provides a comprehensive introduction to NODEMCU covering its features, applications, and development.

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Arduino and NODEMCU: A Comprehensive Guide to IoT Development by A. K. Singh (2020) - This book covers the integration of NODEMCU with Arduino, providing a detailed guide for developers.

NODEMCU Official Documentation - Provides comprehensive documentation on NODEMCU including its features, APIs, and development guides.

2.2 BLOCK DIAGRAM

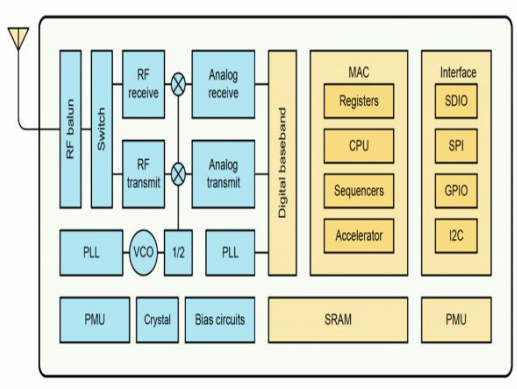

Fig:-2.2 BLOCK DIAGRAM

The NODEMCU board is based on the ESP8266 Wi-Fi SoC, which integrates a microcontroller, Wi-Fi module, and flash memory. When connected to the Arduino platform, the NODEMCU board can be programmed using the Arduino IDE. The working principle involves the following steps. The Arduino IDE sends the program code to the NODEMCU board through a serial communication interface (UART).

The ESP8266 microcontroller on the NODEMCU board executes the program code, which can include Wi-Fi connectivity, digital input/output operations, and analogy-to-digital conversions.

The NODEMCU board can connect to the internet using Wi-Fi, allowing it to communicate with web servers, cloud services, and other devices. The board can also interact with sensors, actuators, and other devices connected to its digital and analogy pins.

The Arduino platform provides a simplified interface for programming the NODEMCU board, making it easier to develop IoT projects. The NODEMCU board can operate in various modes, including Wi-Fi station, access point, and both. This flexibility allows developers to create a wide range of IoT applications using the NODEMCU board and Arduino platform.

2.3 CIRCUIT DIAGRAM

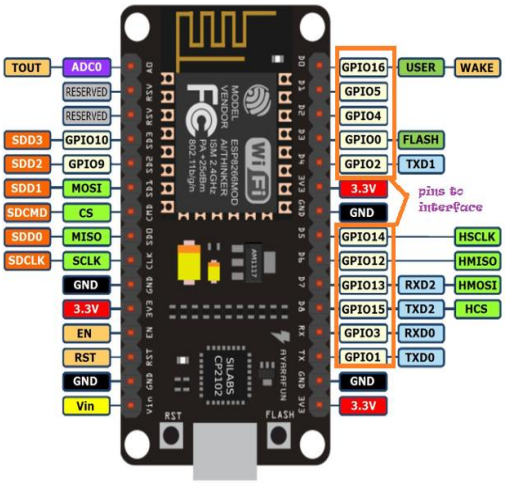

Fig 2.3: Circuit Diagram

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3.1 ESP8266 WIFI Module

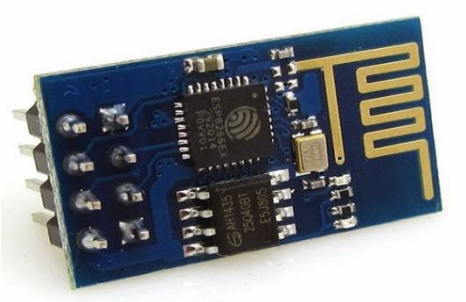

Fig: - 3.1 ESP8266 WIFI Module

ESP8266 is a WIFI SOC (system on a chip) produced by Espresso Systems. It is a highly integrated chip designed to provide full internet connectivity in a small package. ESP8266 is an impressive, low-cost WIFI module suitable for adding WIFI functionality to an Existing microcontroller project via a UART serial connection. The module can even be reprogrammed to act as a standalone WIFI connected device–just add power! ESP8266 is a complete and self-contained Wi-Fi network solutions that can carry software applications, or through another application processor uninstall all Wi-Fi networking capabilities. ESP8266 when the device is mounted and as the only application of the application processor, the flash memory can be started directly from an external Move. Built-in cache memory will help improve system performance and reduce memory requirements. Another situation is when wireless Internet access assume the task of Wi-Fi adapter, you can add it to any microcontroller-based design, the connection is simple, just by SPI / SDIO interface or central processor AHB (Advanced High-performance Bus) bridge interface. Processing and storage capacity on ESP8266 powerful piece, it can be integrated via GPIO ports sensors and other applications specific equipment to achieve the lowest early in the development and operation of at least occupy system resources. The ESP8266 highly integrated chip, including antenna switch balun, power management converter, so with minimal external circuitry, and includes front-end module, including the entire solution designed to minimize the space occupied by PCB. The system is equipped with ESP8266 manifested leading features are: energy saving VoIP quickly switch between the sleep / wake patterns, with low-power operation adaptive radio bias, front-end sign processing functions, troubleshooting and radio systems coexist characteristics eliminate cellular / Bluetooth / DDR / LVDS / LCD interference

Technical Features

- 802.11 b / g / n
- Wi-Fi Direct (P2P), soft-AP
- Built-in TCP / IP protocol stack
- Built-in TR switch, balun, LNA, power amplifier and matching network
- Built-in PLL, voltage regulator and power management components
- 802.11b mode + 19.5dBm output power
- Built-in temperature sensor
- Support antenna diversity
- Off leakage current is less than 10uA
- Built-in low-power 32-bit CPU: can double as an application processor
- SDIO 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU, A-MSDU aggregation and the 0.4 within wake
- 2ms, connect and transfer data packets
- Standby power consumption of less than 1.0m

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3.2 ESP8266-01

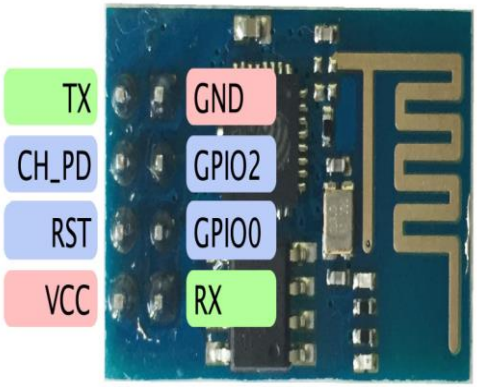

Fig:-3.2 ESP8266-01

This is the first and simplest board using the ESP8266. It allows to attach serial lines, and only breaks out two GPIO pins for native usage.

Pin out details

- Vcc = 3.3v
- GND
- TX = serial TX
- RX = serial RX
- RST = reset
- CH_PD=FLASH reset (3.3v)
- GPIO0, GPIO1=I/O pins

3.3 ESP-03

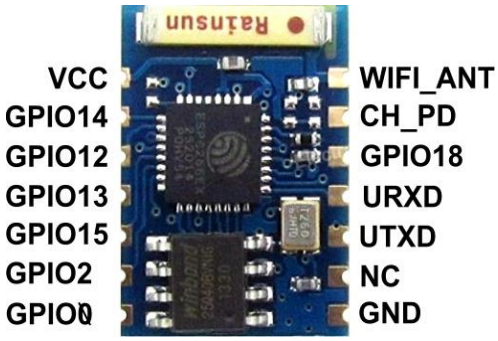

Fig: -3.3 ESP-03

This is the second-generation board, breaking out more GPIO pins, and using a different antenna, plus an external antenna connector.

NODEMCU based on the ESP8266 chip, works seamlessly with the Arduino platform, allowing you to program it using the familiar Arduino IDE. By installing the necessary ESP8266 board support through the Board Manager, users can easily upload code to the NODEMCU and leverage its Wi-Fi capabilities. After setting up the Arduino IDE with the ESP8266 package, users can select the NODEMCU board from the menu, write their sketches in C/C++ using Arduino syntax, and upload them over a USB connection. This integration makes it simple to develop IoT applications, such as controlling devices over Wi-Fi or building simple web servers, all while using the rich library ecosystem available in the Arduino environment.

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3.4 Node MCU

Fig:-3.4 Node MCU

Here are the main features of the chip.

- SDIO 2.0, SPI, UART, I2C
- Integrated RISC processor, on-chip memory and external memory interfaces
- Integrated MAC/baseband processors
- I2S interface for high fidelity audio applications
- Fully integrated WIFI solution
- Open-source
- Interactive
- Programmable
- Low cost
- USB-TTL included
- Plug & Play
- 10 GPIO, every GPIO can be PWM, I2C, 1-wire
- PCB antenna

- NODEMCU is an open source IoT platform. It includes firmware which the ESP8266 Wi-Fi SoC from Espresso Systems, and hardware which is based on the ESP-12 module. The term " NODEMCU " by default refers to the firmware rather than the dev. kits. It combined features of WIFI access point and station microcontroller and uses simple LUA based programming language.
- The ESP8266 is made by a privately held company in China called Espresso. They are a fabless semiconductor company that just came out of nowhere and shook up the whole industry. Now all the major players are working on inexpensive versions of an IOT chip with WIFI connectivity. And they are all struggling to make it as inexpensive as the ESP8266.

- The ESP8266 chip was originally designed for connected lightbulbs (with functionality like the Phillips Hue we used in the iBeacon BeaconAir project), but soon was used in a variety of applications. While the ESP8266 has huge functionality and a good price, the amount of current consumed by the chip makes battery powered solutions problematic, but with very clever programming, possible in some applications.

experiment will demonstrate to create a pattern using LED for example running LED from left to right using NODEMCU

A. Component required

i. NodeMCU
ii. Breadboard.
iii. LED
iv. Connecting Wires

B. Connection Detail

i. Place the NODEMCU on the Breadboard.
ii. Place all the 4 led on the breadboard.
iii. Connect all the GND pin of led with GND rail on breadboard.

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iv. Connect the 1st led with D0, 2nd with D1, 3rd with D2 and 4th with D3 pin of the NODEMCU v. Upload the code.

3.7 Interfacing NODEMCU with Temperature and Humidity Sensor (Dht11)

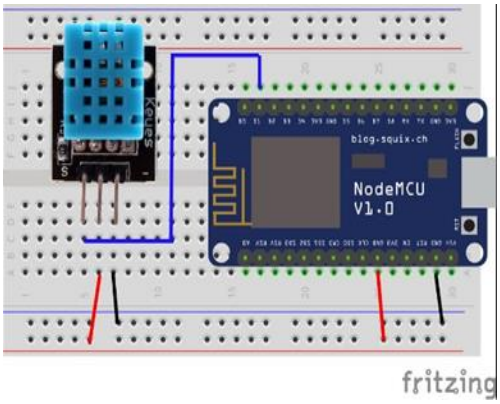


Fig:-3.7 Interfacing NODEMCU with Temperature and Humidity Sensor (Dht11)

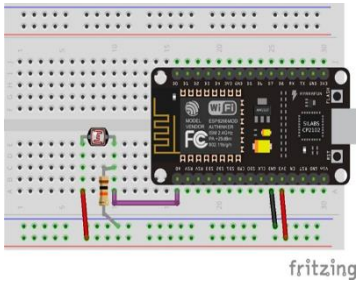
Technical Specification:
• Humidity Range: 20-90% RH
• Humidity Accuracy: ±5% RH
• Temperature Range: 0-50 °C
• Temperature Accuracy: ±2% °C
• Operating Voltage: 3V to 5.5V

A. Components Required
i. NodeMCU
ii. DHT11
iii. Breadboard
iv. Connecting Wires

B. Connection Detail
i. Place the NodeMCU on the breadboard.
ii. Place the DHT11 Temperature and Humidity Sensor on the breadboard (assuming DHT11library is installed).
iii. Connect VCC and GND of DHT11with 3.3v and GND to NodeMCU.

3.8 Interfacing ldr with nodemcu

Fig:-3.8



Interfacing ldr with nodemcu
A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance.

A. Component Used
i. NodeMCU
ii. LDR (Light Dependent Resistor)
iii. 10K resistor
iv. Wire

B. Connection Detail

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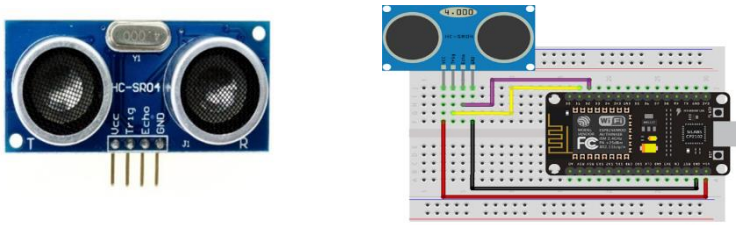
i. Place the NodeMCU (ESP8266) on the breadboard.
ii. Take LDR and place it on Breadboard.
iii. Connect VCC (3.3V) toward any one pin (say pin 1) of the LDR.
iv. Connect Pull down Resistor with ground on the other pin (say pin 2) of LDR.

3.9 Interfacing Ultrasonic Sensor with nodemcu

Fig:-3.9 Interfacing Ultrasonic Sensor with nodemcu



This is the HC-SR04 ultrasonic ranging sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit.
There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground). You will find this sensor very easy to set up and use for your next range-finding project.
It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance.

A. Components used

i. NodeMCU

ii. Ultrasonic Sensor

iii. Wire

B. Connection Detail

i. Place the NodeMCU (ESP8266) on the breadboard.

ii. Take Ultrasonic Sensor and place it on Breadboard.

iii. Connect VCC (3.3V) and GND along with TRIG and ECHO.

iv. Connect TRIG to pin D1 and ECHO to pin D2.

v. Upload the code given.

RESULTS

Hardware Results
1. Successful Connection: NodeMCU board connected to computer via USB cable.
2. Blinking LED: Onboard LED blinked using Arduino IDE.
3. Wi-Fi Connectivity: NodeMCU connected to local Wi-Fi network.

Software Results
1. Arduino IDE Setup: Arduino IDE installed and set up for NodeMCU development.
2. Library Installation: Required libraries (e.g., ESP8266WiFi) installed.
3. Example Sketches: Example sketches (e.g., Blink, Wi-Fi Scan) uploaded and run.

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Programming Results
1. Basic Programming: Basic programming concepts applied to NodeMCU projects.
2. Wi-Fi Programming: Wi-Fi-related programming implemented.
3. Sensor Integration: Sensors integrated with NodeMCU for data collection and transmission.

Project Results
1. Simple IoT Project: Simple IoT project (e.g., temperature monitoring) developed and deployed.
2. Wi-Fi Controlled LED: LED controlled using Wi-Fi commands.
3. Data Logging: Sensor data logged to cloud platform or local database.

Key Takeaways
1. NodeMCU Board: Familiarity with NodeMCU board and its features.
2. Arduino IDE: Understanding of Arduino IDE and its application for NodeMCU development.
3. Wi-Fi Connectivity: Ability to connect NodeMCU to Wi-Fi network.
4. Programming Concepts: Understanding of basic programming concepts and their application to NodeMCU projects.

ADVANTAGES

1. Easy to Use: NodeMCU is compatible with the Arduino IDE, making it easy for developers familiar with Arduino to get started.
2. Low Cost: NodeMCU boards are relatively inexpensive, making them a great option for prototyping and proof-of-concept projects.
3. Wi-Fi Connectivity: NodeMCU boards have built-in Wi-Fi capabilities, allowing for easy internet connectivity and IoT applications.
4. Large Community: The Arduino community is vast and active, providing a wealth of resources, libraries, and example code for NodeMCU development.
5. Cross-Platform Compatibility: NodeMCU can be programmed using a variety of platforms, including Windows, macOS, and Linux.
6. Small Form Factor: NodeMCU boards are compact and lightweight, making them ideal for space-constrained projects.
7. Energy Efficiency: NodeMCU boards are designed to be energy-efficient, making them suitable for battery-powered applications.

REFERENCES

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2. "Arduino and Raspberry Pi Sensor Projects for the Evil Genius" by Robert Chin
3. "IoT Projects with NodeMCU and Arduino" by Agus Kurniawan
Online Resources
1. NodeMCU Official Documentation
2. Arduino Official Documentation
3. ESP8266/ESP32 Wiki
4. Instructables: NodeMCU Tutorials
5. Adafruit: NodeMCU Tutorials
Research Papers
1. "NodeMCU: A Low-Cost IoT Development Board" by S. S. Iyengar et al. (2017)
2. "ESP8266-Based IoT Development Using NodeMCU" by A. K. Singh et al. (2018)
Websites
1. NodeMCU Community Forum
2. Arduino Community Forum
3. Stack Overflow: NodeMCU Tag
4. Large Community: The Arduino community is vast and active, providing a wealth of resources, libraries, and example code for NodeMCU development.
5. Cross-Platform Compatibility: NodeMCU can be programmed using a variety of platforms, including Windows, macOS, and Linux.