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REVOLUTIONIZING AGRICULTURE: IOT AND WIRELESS SENSOR NETWORK-BASED AUTONOMOUS FARMING ROBOT

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Abstract- The primary objective of this paper is to develop a "Wireless Health Monitoring System" capable of systematically monitoring heart rate and SpO2 (oxygen-saturated hemoglobin in blood). In this expanding world, health is a crucial concern for every individual, and monitoring it is essential. Health professionals significantly contribute to the monitoring of individual health; however, the increasing population presents challenges in effectively overseeing health outcomes. In this pandemic, health is a paramount concern for individuals globally. Numerous devices have been developed for health monitoring; however, this device is particularly convenient and efficient. Monitoring the health of elderly individuals through daily hospital visits is a significant burden, while regular check-ups are essential for newborns. We have developed a device capable of wirelessly monitoring our health in various situations. This device comprises an Arduino Nano, an OLED display, a MAX30100 pulse oximeter, an HC-05 Bluetooth module, two capacitors of varying values, and two resistors of identical value. In the future, the addition of more sensors could enhance the device's effectiveness and enable numerous new functions.

Keywords: Body Sensor Network, Pulse Oximeter, Microcontroller, LCD.

INTRODUCTION:

The agricultural industry is the backbone of economies worldwide, providing food and raw materials for a variety of industries. With an increasing demand for food, the world population growth and a shortage of manual labour, it has become essential to develop new technologies to optimize crop production and reduce the impact of farming practices on the environment. In recent years, the development of smart farming solutions using IoT and WSN technologies has shown great promise in this regard. One such solution is the autonomous farming robot, which is a self-contained system that can monitor and control various environmental parameters to optimize crop growth.

This paper presents an autonomous farming robot that utilizes IoT and WSN technologies to optimize crop production. The system is equipped with various sensors, including soil moisture, ultrasonic, temperature, LDR, and GAS sensors, which are used to monitor the environmental parameters that affect crop growth. The robot is powered by Nodemcu and ArduinoUNO microcontrollers, a motor driver, four motors, a servo motor, a motor pump, and an ESP32 camera module. The WSN technology is used to collect data from the sensors and transmit it to a central server for analysis and decision making. The proposed system offers a cost- effective and efficient way to manage crops, while reducing the need for manual labour. The following sections will provide a detailed description of the proposed system, its components, and its capabilities.

LITERATURE SURVEY:

[1]The RF-based joystick-controlled seed sowing robot is a popular research area that uses Arduino Uno, joystick, and RF module. The robot is designed to sow seeds in agriculture fields with precision and efficiency. It shows that the use of the RF module allows for wireless communication between the joystick and robot, enabling greater flexibility in control. The Arduino Uno is used as the central processing unit, controlling the robot's movements and seed distribution. Overall, this technology has the potential to increase productivity in agriculture and reduce labour costs.

[2]This Paper presents a technical working description of a Bluetooth-based environment monitoring robot that utilizes temperature sensors and soil moisture sensors. The robot operates by collecting data from the sensors and transmitting it to a mobile device through Bluetooth communication. The temperature sensors monitor the ambient temperature of the environment, while the soil moisture sensors measure the moisture content of the soil. The robot is equipped with a microcontroller that processes the sensor data and controls the motor to move the robot.

[3]This Proposed system describes the technical working of a Wi-Fi-based seed sowing robot and spraying system that uses NodeMCU, motor pumps, DC motors, and motor drivers. The robot operates by receiving commands through a Wi-Fi connection and then sowing seeds or spraying pesticides accordingly. The system consists of a motor pump that generates the pressure required to spray the pesticide and a DC motor that controls the movement of the robot. The motor driver is used to control the speed and direction of the DC motor. The robot can be used for precision agriculture, and the Wi-Fi connection enables remote control and monitoring of the system.

[4]The Agriculture robot is designed to assist farmers in automating irrigation processes using Bluetooth, Arduino Uno, Soil moisture sensors, a water pump, and servo motor. The robot collects data on soil moisture levels and sends it

to the farmer's smartphone via Bluetooth. The Arduino Uno processes this data and triggers the servo motor to activate the water pump as needed. This system helps farmers reduce water usage and optimize crop growth. Numerous studies have been conducted on various aspects of agriculture robotics, including sensor technology, communication protocols, and control systems.

[5]The RF control agriculture robot utilizes IoT and GPS technology to automate irrigation processes and monitor soil moisture levels. The robot is controlled via RF signals and has a web interface accessible through the internet. Soil moisture data is collected through sensors and transmitted to the web page, allowing farmers to remotely monitor their crops' health. Numerous studies have been conducted on IoT-based agriculture robotics, including control systems, sensor technology, and data analytics for optimal crop management.

[6]The Wifi-based pesticide spraying robot is designed to assist farmers in automating the process of spraying pesticides in their fields. The robot utilizes IoT technology and is controlled via a WiFi connection. The nodemcu board processes the data received from the sensors and triggers the nozzle, sprayer, and pump to apply the pesticide. Studies have been conducted on various aspects of pesticide spraying robots, including control systems, nozzle design, and optimization of pesticide application to increase crop yield and reduce environmental impact.

[7]IoT-based agriculture robot is designed to automate irrigation processes and monitor soil moisture and temperature levels. The robot utilizes a Raspberry Pi board to process data from the sensors and communicate with other IoT devices. Soil moisture and temperature data are collected through sensors, and the robot uses this data to trigger the water pump and optimize irrigation. Studies have been conducted on various aspects of IoT-based agriculture robotics, including sensor technology, data analytics, and control systems for optimal crop management

PROPOSED SYSTEM

An IoT and Wireless Sensor Network based Autonomous Farming Robot can be implemented using Nodemcu and ArduinoUNO as the main control units. The robot would use a motor driver and four motors for movement, and various sensors such as soil moisture sensor, ultrasonic sensor, temperature sensor, LDR sensor, and GAS sensor to gather data about the farm environment. The Servo motor would be used to control the movement of the robotic arm, which would be used for planting and harvesting crops. The 12v motor pump would be used for irrigation purposes. NODEMCU can be used as a communication module to connect the robot to the internet and enable remote monitoring and control of the robot. It can also be used for data logging and analysis of the sensor data collected by the robot.

In addition to the sensors, a camera module can be added to the robot to provide real-time monitoring of the farm. A camera module can be added to the robot to provide real-time monitoring of the farm. The camera module can be connected to the ESP32, allowing farmers to remotely view the farm and monitor crop growth, health, and potential problems. The camera module can be analyse the images captured by the camera, send through email for identifying diseases or pests in the crops and other anomalies that can affect crop growth and yield.

The system can be designed with a user-friendly interface, allowing farmers to easily program the robot to perform specific tasks, such as planting or harvesting certain crops, or monitoring specific areas of the farm. Overall, the implementation of an IoT and Wireless Sensor Network based Autonomous Farming Robot with a camera module can significantly improve the efficiency and productivity of farming operations, while reducing labour costs and improving crop yields. It can also enable remote monitoring and control, which can save farmers time and resources.

METHODOLOGY:

The methodology for a Wireless Forming Robot using IoT involves both hardware and software components.

HARDWARE EXPLANATION:

The robot would use a motor driver and four motors for movement, and various sensors such as soil moisture sensor, ultrasonic sensor, temperature sensor, LDR sensor, and GAS sensor to gather data about the farm environment. An IoT and Wireless Sensor Network based Autonomous Farming Robot can be implemented using Nodemcu and Arduino UNO as the main control units.

COMPONENTS LIST:

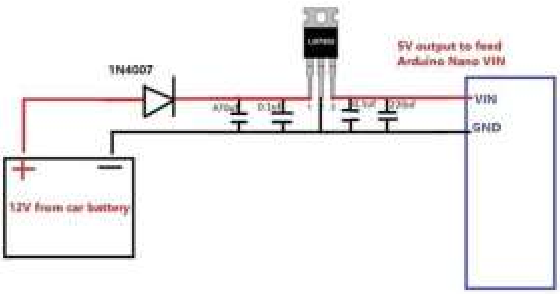
- Battery Power supply system
- Arduino Uno
- Nodemcu
- Ultrasonic sensor
- Motor Driver
- DC Bo motors

- Relay Board
- Motor Pump
- Soil Moisture sensor
- DH11 sensor
- Gas Sensor
- LDR sensor
- Camera Module

HARDWARE COMPONENTS DESCRIPTION BATTERY POWER SUPPLY SYSTEM:

A 12V to 5V battery power supply is a device that converts a 12V voltage source to a 5V voltage source, typically used to power electronic devices that require a 5V power supply. This conversion is achieved using a DC-DC step-down converter or voltage regulator.

This signal is then rectified and filtered to produce a stable output voltage. Voltage regulators, on the other hand, use a feedback loop to adjust the output voltage to a constant value regardless of input voltage fluctuations. When selecting a converter, it is important to consider the input voltage range, output voltage, and output current requirements of the device being powered. The input voltage range of the converter should be able to handle at least 12V to accommodate the 12V battery. The output voltage should be 5V to match the device's power requirements. The converter's output current rating should be higher than the device's maximum current draw to avoid overloading the converter.



To use the converter, the positive and negative wires from the 12V battery are connected to the input terminals of the converter. The positive and negative wires from the output terminals of the converter are then connected to the device that requires 5V power. It is important to follow the manufacturer's instructions for the specific converter being used and take necessary precautions to avoid electric shock or short circuits.

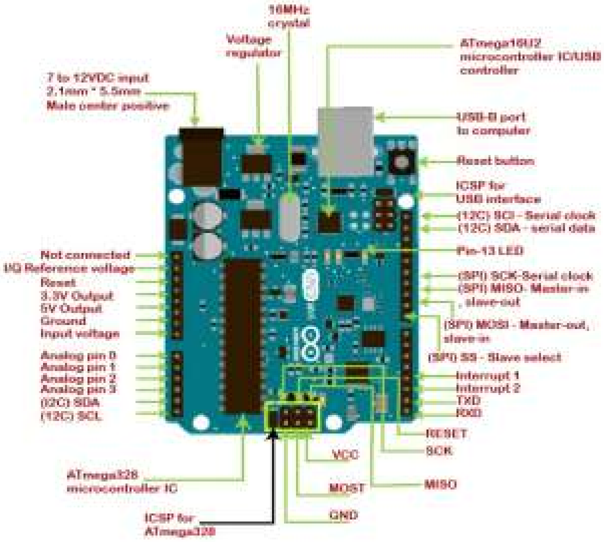
Voltage Regulator: The voltage regulator is the fourth and final component in the power supply system. Its function is to regulate the output voltage to a constant 5V DC voltage. The voltage regulator uses a feedback mechanism to adjust the output voltage to a constant value, even if the input voltage or load current changes.

ARDUINO UNO:

Arduino Uno is a main Brain of the Project. The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller chip. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal oscillator, and a USB connection. The ATmega328P microcontroller has 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM. The digital input/output pins are grouped into two sets of 8 pins each, with each set capable of being configured as either input or output. The analog inputs can read signals in the range of 0 to 5 volts, and are converted to a 10-bit digital value by the on-board analog-to-digital converter. The board can be powered either by connecting it to a computer via the USB cable, or by connecting it to a 9- volt battery or an external power supply.

The board also has a power jack and an ICSP header for programming the microcontroller using an external programmer. The board is programmed using the Arduino Integrated Development Environment (IDE), which is a free software tool that provides a user-friendly interface for writing, compiling, and uploading code to the board.

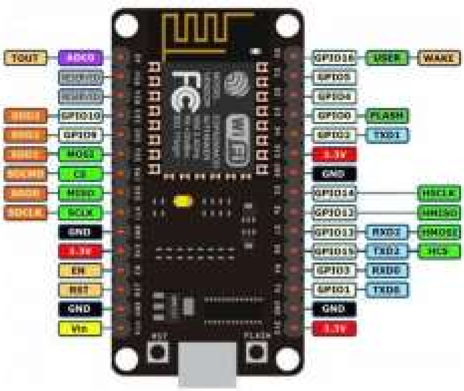
The IDE supports the C++ programming language and provides a large library of pre-written code, making it easy for beginners to get started with programming the board.



NodeMCU:

NodeMCU is a low-cost open-source firmware and development board based on the ESP8266 WiFi module. The board has an 80 MHz 32-bit Tensilica CPU, 4 MB flash memory, and integrated WiFi connectivity, which allows it to connect to the internet and exchange data with other devices. The board also features 11 digital input/output pins and one analog input pin, which can be used to interface with a variety of sensors and actuators.

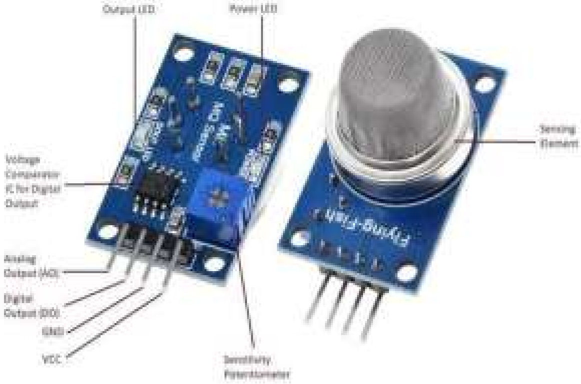
The NodeMCU firmware is based on the Lua scripting language and can be programmed using the NodeMCU Lua API. It also has support for the Arduino IDE, allowing it to be programmed using the familiar C++ programme ng language. Additionally, the NodeMCU supports the MicroPython programming language, which is a popular choice for IoT projects.



The board can be powered using a micro-USB cable or an external power supply, and can be programmed and debugged using a USB-to-serial converter. The NodeMCU firmware provides a range of networking protocols, including HTTP, HTTPS, MQTT, and Web Socket, which makes it an ideal choice for IoT applications that require cloud connectivity. NodeMCU is widely used for a range of IoT applications, such as home automation, weather stations, robotics, and wireless sensor networks. The open-source nature of NodeMCU means that it has a large community of developers who have created libraries, tools, and resources to help users get started with their projects. Overall, NodeMCU is a versatile and powerful development board that offers an affordable solution for IoT projects.

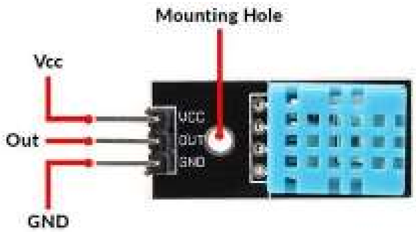
GAS SENSOR:

The MQ2 gas sensor is a widely used gas detection module that is capable of detecting a variety of gases such as smoke, propane, butane, methane, and carbon monoxide. The sensor module consists of a sensing element and an integrated circuit, and works on the principle of gas conductivity. When the gas comes into contact with the sensing element, it changes the resistance of the element, which is measured by the integrated circuit. The sensor requires a 5V power supply and has four pins: Vcc (power), GND (ground), Dout (digital output), and Aout (analog output). The sensor's output signal can be read as either a digital signal (high or low) or an analog signal (varying voltage level). The MQ2 gas sensor is often used in gas leakage detection systems, air quality monitoring, and safety applications. However, it should be noted that the sensor has limitations and can give false readings in certain conditions, and thus should not be relied upon as the sole means of detecting dangerous gases.



DHT11 SENSOR:

The DHT11 sensor is a digital temperature and humidity sensor that is commonly used in a variety of applications, including environmental monitoring, HVAC systems, and indoor gardening. It is a low-cost sensor that provides reliable temperature and humidity readings in a wide range of conditions. The sensor uses a thermistor and a capacitive humidity sensor to measure the temperature and humidity, respectively. It then converts these values into a digital signal, which can be read by a microcontroller or a single-board computer like Arduino or Raspberry Pi.



The DHT11 sensor has four pins: VCC, GND, DATA, and NC (not connected). VCC and GND are used to power the sensor, while the DATA pin is used to communicate with the microcontroller. The NC pin is not used and can be left unconnected. When reading data from the DHT11 sensor, the microcontroller sends a start signal to the sensor, which responds by sending a low signal for 18ms, followed by a high signal for 20- 40us. The sensor then sends the temperature and humidity data as a 40-bit signal, with each bit being transmitted as a 50us low signal followed by a 26-28us high signal. Overall, the DHT11 sensor is a simple and reliable sensor that can be easily integrated into a wide range of projects with its straightforward pin connection and digital output.

SOIL MOISTURE SENSOR:

A soil moisture sensor is a device used to measure the water content in soil. It typically consists of two metal probes that are inserted into the soil, and a module that measures the electrical resistance between the probes. The resistance value is then used to calculate the soil moisture content. To connect a soil moisture sensor to an Arduino, you will need to use the analog input pins on the Arduino board. The sensor typically has three pins: VCC, GND, and AO (analog output).

VCC is the power supply pin and should be connected to the 5V pin on the Arduino board. GND is the ground pin and should be connected to any GND pin on the board.

SOFTWARE DESCRIPTION:

ARDUINO IDE:

Arduino IDE (Integrated Development Environment) is a software tool used for programming and development of Arduino boards. It is an open-source platform, available for free, and is compatible with multiple operating systems including Windows, Mac OS, and Linux.

The main features of the Arduino IDE include:

- **Code Editor:** The code editor is the main interface of the Arduino IDE where you can write, edit and upload code to the Arduino board. It includes features such as syntax highlighting, auto-completion, and code snippets to make programming easier.

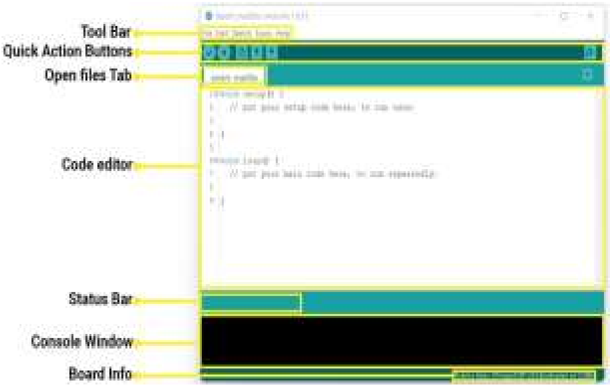
- **Sketches:** Arduino programs are referred to as "sketches" and can be easily created and saved within the IDE. The sketch contains two main functions: the setup() function, which is called once at the start of the program, and the loop() function, which is called repeatedly as long as the program is running.

- **Library Manager:** The Library Manager allows users to easily install and manage libraries for their Arduino projects. It includes a collection of pre-built libraries that can be used to add functionality to your projects. Users can also create their own libraries and add them to the IDE.

- **Serial Monitor:** The Serial Monitor allows users to communicate with the Arduino board and monitor the data being sent and received through the serial port. This is particularly useful for debugging and troubleshooting.
- **Board Manager:** The Board Manager allows users to select the type of Arduino board they are using, configure settings, and install the necessary drivers. This is important because different Arduino boards may have different specifications and require different drivers.

- **Upload:** The Upload feature allows users to upload their sketches to the Arduino board and begin executing the program. Users can select the correct board and serial port before uploading the sketch. **Tools:** The Tools menu includes a range of options for configuring and customizing the IDE. This includes options for setting the board type, serial port, programmer, and other settings.

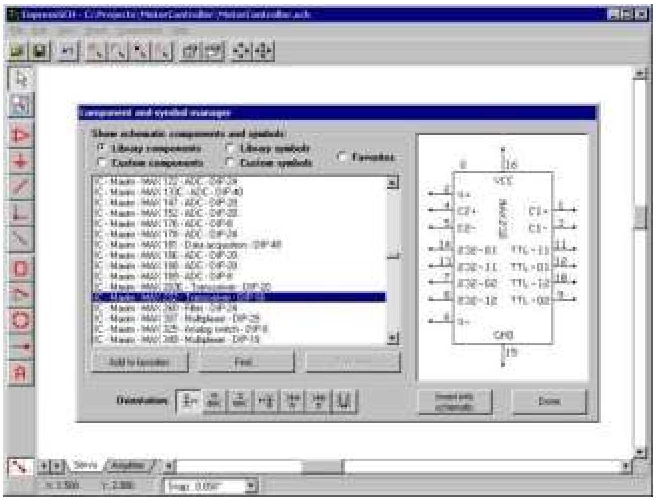
Overall, the Arduino IDE is a user-friendly software tool that simplifies the programming process for beginners and experienced users alike. It is compatible with a wide range of Arduino boards and shields, making it a versatile tool for a variety of applications. With its many features and community support, the Arduino IDE is an essential tool for anyone interested in electronics and programming.



In addition to the basic features listed above, the Arduino IDE also supports advanced features such as debugging and profiling tools, version control integration, and multiple file editing. The IDE can also be extended through plugins and add-ons, allowing users to customize the tool to their specific needs. Additionally, the Arduino community provides a wealth of resources and tutorials to help users get started and troubleshoot any issues they may encounter.

EXPRESS PCB:

Express PCB is a free-to-use software program for designing printed circuit boards (PCBs). It is a simple and user-friendly tool that is ideal for beginners and hobbyists who want to design and create their own PCBs.



Some of the key features of Express PCB include:

- **Schematic Capture:** Express PCB allows users to create schematic diagrams of their circuits using a library of pre-built symbols. The software also provides a range of editing tools to help users create and modify their schematic diagrams.
- **Board Layout:** Express PCB includes a powerful board layout editor that allows users to place components on the board, route traces between components, and add text and graphics. The software also includes a range of design rules to ensure that the PCB meets the required specifications.
- **Gerber Export:** Once the board design is complete, Express PCB allows users to export the design as Gerber files, which can be used to manufacture the PCB.
- **Parts Library:** Express PCB comes with a large library of pre-built parts and components that users can use to create their designs. Users can also create their own custom parts library.
- **Auto-Router:** The software includes an auto-router feature that can automatically route traces between components on the board. This can save users a lot of time and effort, especially for complex designs.
- **3D Viewer:** Express PCB includes a 3D viewer that allows users to view their board designs in 3D, providing a realistic view of how the final product will look.

Overall, Express PCB is a powerful and user-friendly software tool that can help users design and create their own PCBs quickly and easily. The software is free to download and use, making it accessible to hobbyists and beginners who may not have a large budget for PCB design software. Additionally, Express PCB provides a range of tutorials and resources to help users get started and troubleshoot any issues they may encounter during the design process.

WEB SERVER:

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capabilities. It can be used as a standalone microcontroller or as a Wi-Fi enabled communication module with other microcontrollers. One of its popular applications is to create a webserver page to control and monitor devices over the internet.

Here are the details on how to create a webserver page with ESP8266:

- Set up the ESP8266 with Arduino IDE and connect it to Wi-Fi.
- Import the required libraries such as ESP8266WiFi.h and ESP8266WebServer.h.
- Create a web server object using the ESP8266WebServer class.
- Define a callback function that will handle requests made to the webserver. The callback function can take inputs from HTML forms and execute specific actions on the ESP8266.
- Write HTML code for the web page that the user will see.
- Create a server.begin() statement in the setup() function to start the web server.
- In the loop() function, run the server.handleClient() method to handle incoming client requests.
- Upload the sketch to the ESP8266 and test the web page in a browser by entering the IP address of the ESP8266 in the browser address bar.

By following these steps, the ESP8266 can serve up a web page to control and monitor devices over the internet. This can be useful for remote control of home automation devices or other internet of things (IoT) applications.

CONCLUSION:

In conclusion, the IoT and Wireless Sensor Network-based Autonomous Farming Robot is a powerful technology that uses various sensors and devices to automate farming processes. This technology is composed of different components such as NodeMCU, ArduinoUNO, motor driver, and four motors, soil moisture sensor, ultrasonic sensor, temperature sensor, LDR sensor, GAS sensor, Servo motor, 12v motor pump, and an ESP32 camera module for monitoring. This system allows farmers to monitor their crops more accurately and effectively, and take necessary actions based on the data collected from the sensors. It also reduces the time and effort required to perform manual tasks, increasing productivity and efficiency. Overall, the IoT and Wireless Sensor Network-based Autonomous Farming Robot is a game-changer in the agriculture industry, offering numerous benefits for farmers, including better crop management, reduced costs, and increased yields. With further advancements in this technology, we can expect to see even more improvements in the future.

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