

IOT BASED AUTONOMOUS ROBOT FOR AGRICULTURAL MONITORING AND HAZARD DETECTION

ABSTRACT

The rising need for smart agricultural practices and automation has led to the emergence of intelligent systems that aim to boost productivity while ensuring environmental and operational safety. In response to this demand, the project titled "IoT-Based Autonomous Robot for Agricultural Monitoring and Hazard Detection" introduces an advanced robotic platform capable of autonomous navigation and real-time environmental assessment in agricultural fields. The central component This system is centered around the Arduino Mega 2560 board, serving as the primary controller for multiple integrated sensors. Among these are the DHT11, used to monitor both temperature and humidity levels, and the MQ135, which is designed for air quality detecting air pollutants, a color sensor for early plant disease identification, and an ultrasonic sensor for detecting obstacles. To support field navigation and communication, the system employs a GPS module for live tracking and a GSM module that transmits alerts during hazardous conditions. The robot moves using DC motors attached to a four-wheel chassis, and a motor driver coordinates its movement.

This autonomous robot is also equipped with a pesticide spraying mechanism powered by a water pump, which is managed through a relay system, allowing it to operate independently in pest control. For enhanced monitoring, sensor data is transmitted to Through the NodeMCU module, the system connects to the Adafruit cloud platform, allowing for internet-based remote monitoring and control. Additionally, an IP camera streams live video, facilitating real-time observation of the agricultural field. The entire system is powered by a 12V battery, and an LCD screen offers immediate feedback on sensor readings and operational status. This integrated IoT-based approach not only streamlines crop management but also introduces a scalable, affordable solution to modern agriculture. By combining automation, data-driven insights, and real-time communication, the robot contributes significantly to the evolution of precision farming.

KEYWORDS: Color Sensor, LCD, Ultrasonic Sensor, Robot, Agriculture, GPS.

INTRODUCTION

Driverless tractors have become a pivotal innovation In contemporary farming, these self-operating machines utilize automation and precision to help farmers increase productivity. By integrating GPS, sensors, and AI technologies, these robots are It is designed to perform various farming-related operations, such as but not limited to agricultural activities plowing.sowing, These machines are designed to carry out tasks such as planting, harvesting, and plowing with little to no human involvement. By lessening the dependence on human labor.

In precision agriculture, drones have emerged as vital instruments, allowing farmers to closely monitor their crops, evaluate soil health, and manage fields with remarkable precision. Equipped with high-tech imaging systems and sensory devices, these autonomous drones are designed to operate without human intervention gather real-time data, enabling the detection of problems like pest invasions, nutrient shortages, and irrigation requirements. By enabling targeted interventions and efficient resource allocation, drones contribute to higher crop productivity and reduced environmental impact. Their role in data collection and analysis also supports timely decision-making, making farming practices more sustainable and cost-effective.

Blockchain technology is increasingly being adopted in agriculture to streamline Blockchain enhances supply chain processes by ensuring clear visibility, secure tracking, and verifiable authenticity. Through decentralized record-keeping of each transaction, it minimizes the risk of tampering, confirms the legitimacy of products, and streamlines the delivery timeline from producers to end-users. This innovation also grants stakeholders real-time access to critical supply chain data. By providing up-to-the-minute information on product origins, handling processes, and delivery schedules, this system enhances transparency and fosters better coordination and trust throughout the supply chain.

Smart contracts offer promising opportunities for automating transactions and agreements within the agricultural sector by using blockchain technology. These digital contracts can help reduce reliance on intermediaries, ensure faster payments, and improve trust among stakeholders through transparent and tamper-proof records. However, their adoption also faces challenges such as limited technological infrastructure in rural areas, legal uncertainties, and the need for farmers to become familiar with complex digital tools. Addressing these barriers is essential for Unlocking the complete capabilities of smart contracts has the potential to revolutionize agricultural operations, leading to more streamlined and efficient management of the supply chain.

Vertical farming offers an innovative and sustainable method for growing crops in urban environments by utilizing vertically stacked layers, often integrated with controlled-environment agriculture technology. This approach significantly reduces By utilizing methods like hydroponics, aeroponics, and LED-based illumination, this approach significantly reduces dependency on cultivable land and conserves water resources. It also facilitates continuous, year-round crop production in proximity to metropolitan areas it enhances productivity and reduces transportation emissions. Vertical farming contributes to food security and environmental conservation, making it a viable solution for addressing the challenges of urbanization and resource scarcity.

MATERIALS AND METHODS

RELATED WORKS:

The integration of IoT in precision agriculture is bringing a revolutionary change to farming practices, Facilitating immediate observation and intelligent decision-making, this system relies on a web of interconnected devices that continuously share and process data in real time This innovation offers numerous advantages, such as better resource management, enhanced crop production, and the early identification of problems like pest outbreaks or soil

health issues. However, its adoption comes with challenges, including the high upfront investment, concerns over data security, connectivity limitations in rural regions, and the need for farmers to acquire specialized technical skills. Despite these obstacles, the growing use of IoT in agriculture is steadily progressing.

The incorporation of IoT and robotics into agricultural practices has revolutionized farming by enhancing automation, accuracy, and overall operational efficiency. These advanced technologies enable continuous monitoring of variables like soil By analyzing factors such as soil quality, plant vitality, and surrounding environmental conditions, farmers are equipped to make informed decisions based on accurate, real-time data insights decisions that minimize resource wastage. Robotics further aids in performing labor-intensive tasks such as planting, harvesting, and spraying, thereby boosting productivity. However, the widespread adoption of these innovations faces several challenges, such as high upfront costs, technical difficulties, data management concerns, and limited availability in rural regions. Despite these hurdles, the potential for these technologies to reshape agriculture into a more efficient, sustainable, and data-centric industry continues to offer significant promise.

The application of IoT technology in agriculture The integration of IoT technology has revolutionized how sensors are applied in agricultural practices to oversee and regulate various farming conditions. By connecting sensors to an intelligent IoT infrastructure, farmers gain continuous access to live data regarding soil moisture levels, ambient temperature, humidity, and the overall condition of crops, thus supporting precise and well-informed agricultural decisions. This data aids in fine-tuning irrigation schedules, identifying potential diseases early, and optimizing the use of resources. Additionally, combining sensor data with automated systems reduces This technology-driven method significantly reduces dependency on human labor while enhancing the effectiveness of farm operations. Additionally, it encourages environmentally sustainable agriculture by optimizing the consumption of essential resources such as fertilizers and water.

Robotics is revolutionizing modern agriculture by enhancing operational efficiency, improving accuracy, and facilitating higher automation levels. These advanced technologies are employed in various tasks such as planting, harvesting, weeding, and crop monitoring, significantly decreasing reliance on human labor. Leveraging sensors and machine learning algorithms, agricultural robots are capable of making instant decisions and adjusting to changing field conditions. This precision not only increases productivity but also reduces waste and the excessive use of resources like water and fertilizers. Consequently, robotics is assisting farmers in addressing the rising demand for food while supporting sustainable and intelligent farming techniques.

The adoption of IoT in agriculture offers significant potential for emerging economies by boosting productivity, improving resource management, and enabling data-driven decisions. By incorporating real-time data, smart devices, and various sensors into a unified system, seamless monitoring and automation of processes becomes achievable., assess crop health, and manage irrigation systems more effectively, ultimately leading to higher yields and less waste. Overcoming these obstacles will be essential to fully harness the benefits of IoT,

driving sustainable agricultural development and enhancing livelihoods in emerging economies.

The integration of swarm robotics and artificial intelligence (AI) is revolutionizing agriculture by providing innovative solutions that enhance efficiency and productivity. Swarm robotics involves the use of multiple robots working together to carry out tasks like planting, harvesting, and crop monitoring. When paired with AI, these systems can analyze data in real time, streamline agricultural operations, and adjust to dynamic environmental factors. Growing investments in autonomous technologies are driving advancements that reduce labor costs, improve precision, and lower the environmental footprint of farming. Despite these promising developments, challenges such as significant initial expenses, technical complexity, and the need for a robust infrastructure remain, and addressing these hurdles is crucial for unlocking the full potential of swarm robotics and AI in agriculture.

Merging robotics with Internet of Things (IoT) technologies in agriculture presents transformative opportunities, especially for small-scale farmers. Through constant monitoring of variables like soil quality, climatic changes, and crop status, these innovations enable smarter crop management. Automated systems can efficiently handle processes like seeding, irrigation, and harvesting, leading to reduced manpower requirements and increased farming efficiency. Meanwhile, IoT devices like sensors and connected networks allow farmers to remotely monitor their fields, facilitating data-driven decision-making. This combination not only improves farming accuracy but also helps optimize the use of resources, minimize waste, and increase crop yields. However, the widespread adoption of these technologies faces challenges, such as high setup costs, limited access to technological infrastructure, and the need for specialized technical skills.

Smart farm modeling employs cutting-edge methods to enhance agricultural practices by utilizing data to inform decision-making. Through the integration of sensors, IoT devices, and sophisticated computational models, smart farms can track key variables such as soil health, crop status, and environmental factors in real time. These models enable farmers to forecast results, optimize resource usage, and automate tasks like irrigation and fertilization. However, successfully implementing smart farm models requires addressing challenges such as the adoption of new technologies, effective data management, and the development of necessary infrastructure.

This technology utilizes a wireless ZigBee device with multi-power capabilities to improve remote sensing in precision viticulture. ZigBee, a low-energy wireless communication protocol, facilitates continuous monitoring of key environmental variables such as temperature, humidity, and soil conditions, all of which are vital for effective vineyard management. The device's multi-power design allows it to function autonomously for long periods, drawing energy from various sources like solar power, making it suitable for remote vineyard settings. These devices provide real-time data, aiding viticulturists in making more accurate decisions regarding irrigation, pest management, and vineyard health, ultimately enhancing farming efficiency and sustainability in viticulture.

The Internet of Things (IoT) is a groundbreaking technology with the potential to transform various industries by facilitating smooth communication and data sharing between devices and systems. By connecting sensors, intelligent devices, and data analytics, IoT enables real-time monitoring and automation across sectors such as healthcare, agriculture, transportation, and smart cities. This technology enhances operational efficiency, reduces expenses, and supports better decision-making, creating vast opportunities for future technological growth. However, as IoT adoption grows, issues related to data security, privacy, and system compatibility must be resolved to fully capitalize on its advantages and foster new avenues for innovation.

The application of big data analytics is reshaping modern agriculture by harnessing vast datasets gathered from various origins, such as sensor networks, meteorological inputs, and satellite imagery. This wealth of information equips farmers with deeper insights, enabling more precise decisions regarding irrigation strategies, pest mitigation, crop planning, and efficient resource distribution—ultimately enhancing productivity and maximizing crop output. Advanced analytical methods allow for predictive models, trend analysis, and real-time decision-making, optimizing farming practices. However, challenges such as ensuring data quality, addressing privacy issues, and the need for specialized expertise in interpreting this data continue to pose barriers to broader adoption within the agricultural industry.

Incorporating Internet of Things (IoT) technology into irrigation systems is revolutionizing modern agriculture by enabling automated, data-driven methods that enhance water efficiency and reduce wastage. By incorporating a range of IoT sensors, including moisture level sensors, climate tracking units, and water flow gauges, farmers are empowered to observe environmental parameters in real-time and determine optimal irrigation schedules. This approach significantly reduces unnecessary water use, guarantees appropriate hydration for crops, and improves overall water management. Furthermore, IoT-enabled platforms allow remote supervision and control, giving farmers the flexibility to adjust irrigation processes dynamically based on live data. As a result, this not only improves agricultural productivity but also promotes sustainable use of water resources.

Temperature monitoring systems for forest fire detection, powered by IoT and enhanced with machine learning algorithms, provide a highly effective method for early detection and prevention of wildfires. The system utilizes a network of temperature sensors placed throughout forested regions to continuously gather environmental data. Machine learning models process the gathered information to detect irregular trends or anomalies that could indicate an early-stage fire risk. By leveraging both historical and real-time information, these models can predict fire risks, enabling faster responses and more precise warnings. This approach not only improves forest safety but also aids in better resource management and reduces fire-related damage, offering a proactive means of safeguarding forests.

The use of robotics in precision agriculture is transforming farming practices by providing automated solutions that enhance operational efficiency, precision, and sustainability. Robots

Equipped with state-of-the-art sensors, GPS systems, and intelligent machine learning algorithms, modern agricultural robots handle tasks like sowing, weeding, watering, and harvesting with precision. These sophisticated technologies enhance crop supervision and enable efficient resource utilization—including water, fertilizers, and pesticides—leading to reduced operational costs and minimized environmental impact. The adoption of robotics in farming not only elevates productivity and crop standards but also advances sustainable agricultural practices. Agricultural practices is supported, benefiting both large-scale and smallholder farmers.

Unmanned Aerial Vehicles (UAVs) are becoming a crucial tool in modern agriculture, offering advanced capabilities for aerial surveillance and data gathering to improve farming techniques. These drones integrated with various advanced tools—including thermal sensors, multispectral imaging systems, and GPS navigation—facilitate precise monitoring of factors like soil condition, plant vitality, and water distribution. These aerial systems deliver up-to-the-minute insights, empowering agriculturalists to optimize practices such as watering schedules, nutrient application, pest control, and general crop maintenance, thereby enhancing productivity while reducing operational costs. With the ability to monitor expansive agricultural areas remotely, UAV technology boosts the scalability and sustainability of farming operations, fostering more efficient and data-driven approaches to agriculture.

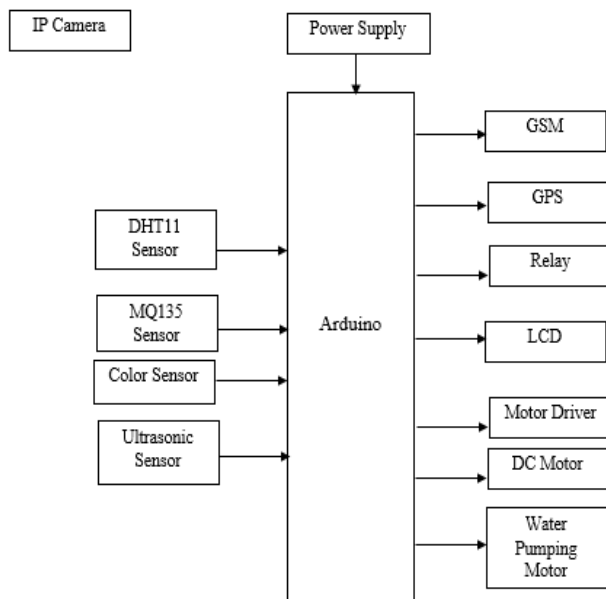
--PROPOSED METHOD--

This project outlines a method for developing and deploying an autonomous robotic system that integrates various sensors to monitor environmental factors and identify potential threats in agricultural fields. The system's primary control unit is the Arduino Mega 2560, which orchestrates multiple sensors to gather critical environmental data. Among these are the DHT11 sensor for detecting ambient temperature and humidity, the MQ135 module for measuring air pollutants, and a color sensor designed to identify early signs of plant disease and an ultrasonic sensor for obstacle avoidance. Together, these sensors offer a detailed environmental overview, enabling the robot to navigate the agricultural landscape independently. The robot's movement is driven by DC motors mounted on a four-wheel chassis, with a motor driver ensuring precise control. For real-time tracking, a GPS module provides location data, while a GSM module sends notifications if hazardous or abnormal conditions are detected, enabling prompt action when needed.

The robot is further designed with an automated pesticide spraying system, powered by a water pump that is regulated by a relay for effective pest control. Sensor data is sent to the Adafruit cloud platform via a NodeMCU, enabling remote access and management through an internet connection. Additionally, an IP camera is incorporated for live video streaming, offering real-time monitoring capabilities. A 12V battery ensures uninterrupted power supply, while an LCD screen continuously shows sensor readings and system status for quick reference. This approach not only provides a fully automated solution for agricultural monitoring but also leverages IoT technology for efficient data gathering, remote control, and instant hazard detection, making it a cost-effective and scalable advancement in contemporary farming techniques.

BLOCK DIAGRAM:

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268 METHODOLOGY

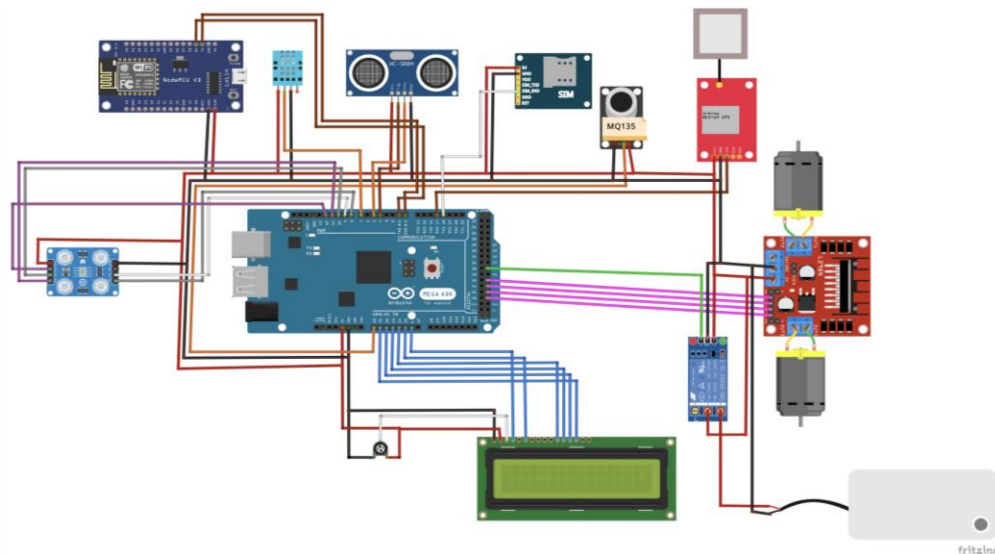
269 WORKING

270 This project operates through the autonomous movement of the robot across agricultural
271 fields, utilizing an Arduino Mega 2560 microcontroller to control various sensors. The system
272 includes a DHT11 sensor to measure temperature and humidity, an MQ135 sensor for
273 detecting air pollution, and a color sensor to detect early signs of plant diseases. An ultrasonic
274 sensor enables the robot to avoid obstacles, ensuring it moves efficiently through the field.
275 The GPS module continuously tracks the robot's location, while the GSM module sends
276 notifications in case of detected hazards, such as extreme weather conditions or unusual
277 sensor data. The robot's mobility is powered by DC motors on a four-wheel chassis, with the
278 motor driver offering accurate control over speed and direction.

279 In addition to navigating the field, the robot is equipped with an autonomous pest control
280 system that manages pesticide application. The water pump, controlled by a relay, allows the
281 robot to dispense pesticides automatically when needed, making it a key asset for effective
282 crop management. Sensor data is transmitted to the Adafruit cloud platform via the
283 NodeMCU, enabling remote monitoring and control. To enhance the system's functionality,
284 an IP camera streams live video, offering real-time visual updates from the field. A 12V
285 battery powers the robot, ensuring it operates continuously, while the LCD screen displays
286 real-time sensor data and system status, providing immediate feedback to the user. This
287 integration of autonomous navigation, environmental monitoring, and pest control positions
288 the robot as a highly efficient tool for modern precision agriculture.

289 **HARDWARE CIRCUIT DIAGRAM**

290 The figure below illustrates the complete circuit wiring of the IoT-based autonomous robot
291 for agriculture monitoring and hazard detection robot. It was designed using the Fritzing
292 software to show actual component connections including:
293



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297 **WORKING PRINCIPLE**

298 The working principle of the IoT-Based Autonomous Robot for Agricultural Monitoring and
299 Hazard Detection revolves around autonomous navigation and real-time data collection from
300 the environment. The Arduino Mega 2560 microcontroller serves as the brain of the robot,
301 managing various sensors that monitor key agricultural parameters. MQ135 sensor detects
302 quality of air, alerting the system to any harmful pollutants. The color sensor is used to
303 identify early signs of plant diseases by analyzing color variations in leaves, and the
304 ultrasonic sensor detects obstacles to prevent the robot from colliding with objects in the
305 field. The GPS module tracks the robot's location, enabling precise navigation, and the GSM
306 module transmits alerts when any abnormal conditions are detected, such as extreme
307 environmental factors or hazardous situations.

308 In addition to monitoring the environmental conditions, the robot integrates a pesticide
309 spraying system, which works autonomously to control pests in the field. This system is
310 controlled by a water pump and relay, ensuring that pesticides are sprayed when needed
311 without requiring human intervention. The data is uploaded to Adafruit cloud platform
312 through the NodeMCU, enabling real-time remote monitoring via the internet. To provide
313 additional surveillance, an IP camera streams live video, allowing users to monitor the field
314 from a distance. The entire system operates on a 12V battery, providing sufficient power for
315 continuous operation, while the LCD screen provides real-time feedback on sensor readings
316 and robot status. This integration of sensors, cloud connectivity, and automation forms the
317 foundation of the robot's operation, making it a smart and efficient solution for modern
318 agricultural practices.

319 KEY FEATURE

320 This IoT-Based Autonomous Robot for Agricultural Monitoring and Hazard Detection offers
321 several key features that contribute to its effectiveness in smart farming. One of the standout
322 features is its autonomous navigation capability, powered by a combination of sensors and a
323 motorized chassis. The robot's navigation is facilitated by the GPS module, which provides
324 precise location tracking, while the ultrasonic sensor ensures obstacle avoidance, allowing the
325 robot to move freely within the agricultural fields. The integration of the color sensor enables
326 early detection of plant diseases by analyzing color changes in leaves, offering timely
327 intervention to prevent the spread of diseases.

328 Another notable feature is the robot's ability to autonomously manage pest control through
329 the pesticide spraying mechanism. This system is activated by a water pump and controlled
330 by a relay, allowing the robot to spray pesticides when necessary without requiring manual
331 intervention. The IP camera adds an extra layer of surveillance by streaming live video,
332 ensuring real-time field observation. Additionally, the robot is powered by a 12V battery,
333 making it energy-efficient and capable of operating for extended periods. The LCD screen
334 provides immediate feedback on the system's operational status, allowing the user to easily
335 track performance and sensor readings. These key features collectively make the robot a
336 comprehensive solution for modern, efficient, and autonomous agricultural management.

337 COMPONENT REQUIREMENTS

338 The hardware components used in this project play a vital role in ensuring the autonomous
339 robot functions effectively within agricultural fields. Central to the system is the Arduino
340 Mega 2560 microcontroller, acting as the main control unit that coordinates and manages
341 different sensors and modules. The DHT11 sensor plays a key role in tracking temperature
342 and humidity, essential for evaluating the environmental factors within the farm. To detect air
343 quality and harmful pollutants, the MQ135 gas sensor is incorporated, providing real-time
344 data on air pollution levels. Additionally, the robot is equipped with a color sensor, which
345 helps identify early signs of plant diseases by analyzing the color variations in plant leaves,
346 enabling timely intervention. For movement, the system employs DC motors connected to a
347 four-wheel chassis, which are controlled through a motor driver to facilitate navigation.

348 The robot's obstacle detection and avoidance are made possible by the ultrasonic sensor,
349 which helps it detect objects in its path and navigate around them. A GPS module provides
350 precise location tracking, ensuring the robot can autonomously navigate the agricultural field
351 and follow specific paths. To handle communication, the system uses a GSM module to send
352 alerts in case of hazardous conditions, and a NodeMCU module facilitates data transmission
353 to the Adafruit cloud platform for remote monitoring. For pest control, the robot features a
354 water pump controlled by a relay system that enables autonomous pesticide spraying. An
355 LCD screen provides immediate status updates, allowing for quick monitoring of sensor
356 readings and system conditions. These hardware components work in tandem to create an
357 integrated, self-sufficient system that is capable of improving efficiency in agricultural
358 management.

Microcontroller



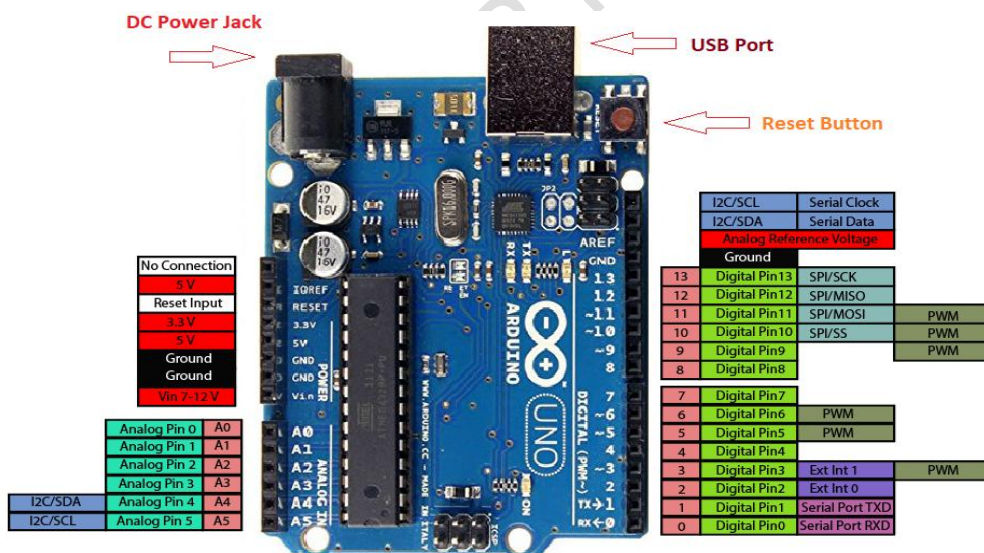
Arduino Board



Microcontroller

Arduino Pinout

- Arduino Uno is based on AVR microcontroller called Atmega328. This controller comes with 2KB SRAM, 32KB of flash memory, 1KB of EEPROM. Arduino Board comes with 14 digital pins and 6 analog pins. ON-chip ADC is used to sample these pins. A 16 MHz frequency crystal oscillator is equipped on the board. Following figure shows the pinout of the Arduino Uno Board



Arduino Uno Pinout

Pin Description:

There are several I/O digital and analog pins placed on the board which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pull-up

371 resistors are used in the board that limits the current exceeding from the given operating
372 conditions. However, too much increase in current makes these resistors useless and damages
373 the device.

374 LED. Arduino Uno comes with built-in LED which is connected through pin 13. Providing
375 HIGH value to the pin will turn it ON and LOW will turn it OFF.

376 Vin. It is the input voltage provided to the Arduino Board. It is different than 5 V supplied
377 through a USB port. This pin is used to supply voltage. If a voltage is provided through
378 power jack, it can be accessed through this pin.

379 5V. This board comes with the ability to provide voltage regulation. 5V pin is used to provide
380 output regulated voltage. The board is powered up using three ways i.e. USB, Vin pin of the
381 board or DC power jack.

382 USB supports voltage around 5V while Vin and Power Jack support a voltage ranges between
383 7V to 20V. It is recommended to operate the board on 5V. It is important to note that, if a
384 voltage is supplied through 5V or 3.3V pins, they result in bypassing the voltage regulation
385 that can damage the board if voltage surpasses from its limit.

386 GND. These are ground pins. More than one ground pins are provided on the board which
387 can be used as per requirement.

388 Reset. This pin is incorporated on the board which resets the program running on the board.
389 Instead of physical reset on the board, IDE comes with a feature of resetting the board
390 through programming.

391 IOREF. This pin is very useful for providing voltage reference to the board. A shield is used
392 to read the voltage across this pin which then select the proper power source.

393 PWM. PWM is provided by 3, 5, 6,9,10, 11pins. These pins are configured to provide 8-bit
394 output PWM.

395 SPI. It is known as Serial Peripheral Interface. Four pins 10(SS), 11(MOSI), 12(MISO),
396 13(SCK) provide SPI communication with the help of SPI library.

397 AREF. It is called Analog Reference. This pin is used for providing a reference voltage to the
398 analog inputs.

399 TWI. It is called Two-wire Interface. TWI communication is accessed through Wire Library.
400 A4 and A5 pins are used for this purpose.

401 Serial Communication. Serial communication is carried out through two pins called Pin 0
402 (Rx) and Pin 1 (Tx). Rx pin is used to receive data while Tx pin is used to transmit data.

403 External Interrupts. Pin 2 and 3 are used for providing external interrupts. An interrupt is
404 called by providing LOW or changing value

405

406 **LCD:**

407 LCD (Liquid Crystal Display) is the innovation utilized in scratch pad shows and other littler
408 PCs. Like innovation for light-producing diode (LED) and gas-plasma, LCDs permit
409 presentations to be a lot more slender than innovation for cathode beam tube (CRT). LCDs
410 expend considerably less power than LED shows and gas shows since they work as opposed
411 to emanating it on the guideline of blocking light.

412 A LCD is either made with a uninvolved lattice or a showcase network for dynamic
413 framework show. Likewise alluded to as a meager film transistor (TFT) show is the dynamic
414 framework LCD. The uninvolved LCD lattice has a matrix of conductors at every crossing
415 point of the network with pixels. Two conductors on the lattice send a current to control the
416 light for any pixel. A functioning framework has a transistor situated at every pixel crossing
417 point, requiring less current to control the luminance of a pixel.

418

419 The directions given to the LCD are put away by the order register. An order is a direction
420 given to LCD to play out a predefined assignment, for example, introducing it, clearing its
421 screen, setting the situation of the cursor, controlling presentation, and so forth. The
422 information register will store the information that will be shown on the LCD. The
423 information is the character's ASCII incentive to show on the LCD

424 **Data/Signals/Execution of LCD**

425 Now that was all about the signals and the hardware. Let us come to data, signals and
426 execution.

427 Two types of signals are accepted by LCD, one is data and one is control. The LCD module
428 recognizes these signals from the RS pin status. By pulling the R / W pin high, data can now
429 also be read from the LCD display. Once the E pin has been pulsed, the LCD display reads
430 and executes data at the falling edge of the pulse, the same for the transmission case.

431 It takes 39-43 μ S for the LCD display to place a character or execute a command. It takes
432 1.53ms to 1.64ms except for clearing display and searching for cursor to the home position.

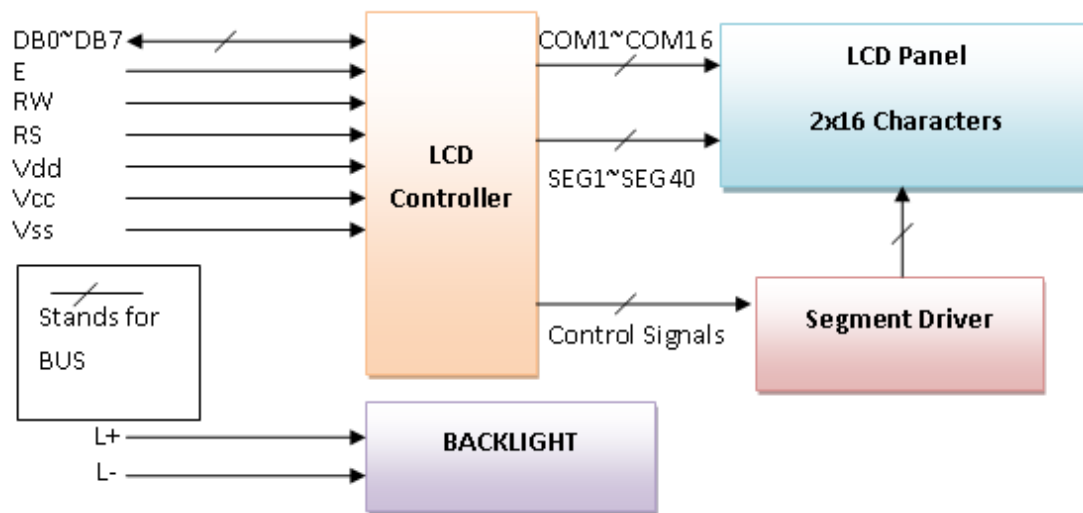
433 Any attempt to send data before this interval may result in failure in some devices to read
434 data or execute the current data. Some devices compensate for the speed by storing some
435 temporary registers with incoming data.

436 There are two RAMs for LCD displays, namely DDRAM and CGRAM. DDRAM registers
437 the position in which the character would be displayed in the ASCII chart. Each DDRAM
438 byte represents every single position on the display of the LCD.

439 The DDRAM information is read by the LCD controller and displayed on the LCD screen.
440 CGRAM enables users to define their personalized characters. Address space is reserved for
441 users for the first 16 ASCII characters.

442 Users can easily display their custom characters on the LCD screen after CGRAM has been
443 set up to display characters.

UNDA



444

445

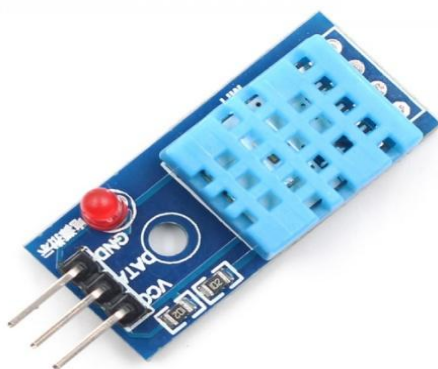
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449 **DHT11 SENSOR (TEMPERATURE/HUMIDITY):**

450 The DHT11 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive
 451 humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal
 452 on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful
 453 timing to grab data. The only real downside of this sensor is you can only get new data from
 454 it once every 2 seconds.

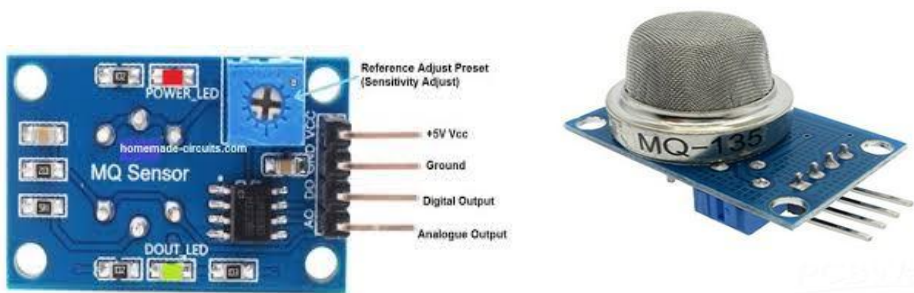


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456

457 MQ135 Gas Sensor Module

458 MQ-135 gas sensor can be implement to detect the smoke and other harmful gases. It has
459 potential to detect different harmful gases, including NH₃, NO_x, alcohol, benzene, smoke
460 and CO₂. MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benzene steam,
461 also sensitive to smoke and other harmful gases. The analog level output provides an output
462 voltage within the range of 0 to 4V based on the concentration of the hazardous gas in the
463 environment; 0V for lowest concentration, 4V for maximum



464

465 The Module requires a 5V power supply and provides a digital Logic output (1 or 0) and an
466 analog level output (0-4V). The digital logic output is LOW (0) when no gas is detected but
467 goes HIGH (1) when hazardous gas concentration in the environment reaches the set
468 threshold set via a potentiometer on the module.

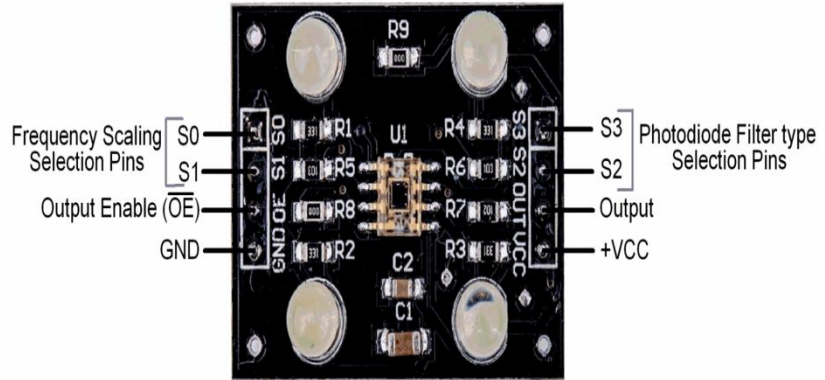
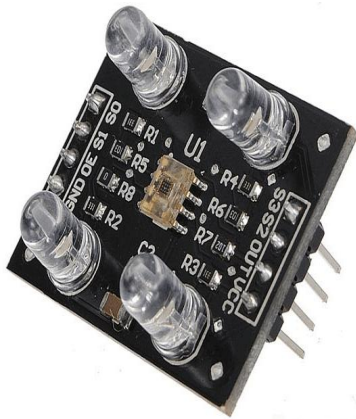
469 After initial power ON, please wait at least 20 Seconds before reading outputs to ensure data
470 validity. The Sensitive material used in MQ135 gas sensor is SnO₂. The conductivity of this
471 material is lower in clean air. The sensor conductivity increases with the increasing
472 concentration of target pollution gas.

473

474 TCS3200 Color Sensor Module

475

- 476
- Color Sensor Module has 4 LEDs with **TCS3200** Color Sensor IC.
- 477
- Module is designed in such way that 4 bright LEDs will light the object and
478 reflections from that object will strike the **TCS3200** Color Sensor IC to detect the
479 colour of an object.



FLOWCHART

1. Start
2. Initialize sensors and peripherals
3. Display welcome message on LCD
4. Read sensor data: temperature, gas, color, GPS, and distance
5. Evaluate conditions:
 - If distance < 25 cm → Stop & send alert
 - If gas > threshold → Stop & send alert
 - If red, green, and blue > 40 → Disease detected → Stop & send alert
 - Else → Continue operation
6. Receive manual control command:
 - '1': Forward
 - '2': Backward
 - '3': Right
 - '4': Left
 - '0': Stop
 - '5': Pump OFF
 - '6': Pump ON
7. Send GPS location via GSM when alert condition is met
8. Repeat loop

SAMPLE CODE SNIPPET (NODEMCU + ADAFRUIT IO)

```
#include <ESP8266WiFi.h>
#include "AdafruitIO_WiFi.h"
#include "DHT.h"
#include <SoftwareSerial.h>
SoftwareSerial bt(4, 5); // (Rx,Tx) only 4
```



```

511 // WiFi & Adafruit IO credentials
512 #define IO_USERNAME "Salonibiradar"
513 #define IO_KEY "aio_XDDJ27jeJPPyLXZYv3YceXqQzDZT"
514 char ssid[] = "water";
515 char pass[] = "123456789";
516
517 // DHT11 configuration
518 #define DHTPIN D2 // GPIO4
519 #define DHTTYPE DHT11
520 DHT dht(DHTPIN, DHTTYPE);
521
522 // Gas sensor pin (analog A0)
523 #define GAS_SENSOR A0
524
525 // Adafruit IO setup
526 AdafruitIO_WiFi io(IO_USERNAME, IO_KEY, ssid, pass);
527 AdafruitIO_Feed *keypad = io.feed("keypad");
528 AdafruitIO_Feed *temperature = io.feed("temperature");
529 AdafruitIO_Feed *humidity = io.feed("humidity");
530 AdafruitIO_Feed *gas = io.feed("gas");
531
532 // Sensor values
533 float h;
534 float t;
535 int gasValue;
536
537 void setup() {
538   Serial.begin(9600);
539   bt.begin(9600); // Define baud rate for software serial communication
540   // Start DHT sensor
541   dht.begin();
542
543   // Connect to Adafruit IO
544   io.connect();
545   keypad->onMessage(handleMessage);
546
547   // Wait for a connection
548   while (io.status() < AIO_CONNECTED) {
549     delay(500);
550   }
551
552   // Serial.println("Connected to Adafruit IO");
553 }
554
555 void loop() {
556   io.run(); // Process Adafruit IO events
557
558   // Read sensors
559   h = dht.readHumidity();
560   t = dht.readTemperature();

```

```

561 gasValue = analogRead(GAS_SENSOR);
562
563 // Send data to Adafruit IO
564 temperature->save(t);
565 humidity->save(h);
566 gas->save(gasValue);
567 // String str = "a" + String(t, 2) + "b" + String(h, 2) + "c" + String(gasValue) + "d";
568 // bt.println(str);
569 delay(10000); // Wait 5 seconds before next update
570 }
571
572 // Handle keypad input from Adafruit IO
573 void handleMessage(AdafruitIO_Data *data) {
574     String reading = data->toChar();
575     Serial.println(reading);
576 }

```

577 **ALERTS**

578 In this project, alert systems are integrated to ensure timely intervention and enhance
579 operational safety. The GSM module is a crucial component in the alert system, as it enables
580 the robot to send real-time notifications to the user or farm operator during hazardous
581 conditions, such as abnormal temperature, humidity, or air quality levels. Additionally, the
582 system can send alerts when potential obstacles are detected or when the robot encounters
583 operational issues, such as a malfunction in the pesticide spraying mechanism. These alerts
584 are designed to keep the operator informed about critical conditions, allowing them to take
585 necessary actions remotely. By transmitting data to the Adafruit cloud platform through the
586 NodeMCU, the system ensures that the operator can monitor the robot's performance and
587 receive updates regardless of their location processes.

588 **POWER REQUIREMENTS**

589 The power requirements for this project are crucial to ensure that all components function
590 efficiently and reliably during operation. The system is powered by a 12V DC battery, which
591 is typically found in most vehicles. This battery supplies power to the Arduino
592 microcontroller, sensors, and other components like the ultrasonic sensor, MEMS sensor,
593 GPS module, GSM module, and the LCD display. The Arduino takes data from sensors and
594 controlling the output devices, including the headlights and alert systems.

595 The sensors and modules used in this project have relatively low power consumption, making
596 them suitable for continuous operation in a vehicle without significantly affecting the overall
597 battery life. For example, the LDR sensor and ultrasonic sensor draw minimal current, while
598 the GSM and GPS modules require slightly higher power, especially when sending messages
599 or updating location data. To manage power consumption efficiently, such as turning off the
600 GSM and GPS modules when they are not in use.

601

602 **RESULT:**

The developed prototype successfully demonstrates autonomous navigation, environmental monitoring, live data transmission, and remote operation capabilities. Key sensor data (temperature, humidity, gas concentration, plant health status) are accurately captured and visualized in real-time on the cloud dashboard. The pesticide spraying mechanism responds effectively to control signals, and the video stream ensures field visibility. The system shows strong potential for scalability and adaptation to diverse agricultural environments





CONCLUSION

To conclude, the IoT-Based Autonomous Robot for Agricultural Monitoring and Hazard Detection marks a significant leap forward in the field of smart farming. It offers a holistic solution to boost productivity, promote environmental sustainability, and enhance safety in agricultural operations. By integrating various sensors, real-time communication systems, and automation technologies, the robot facilitates autonomous navigation, pest control, and environmental monitoring in agricultural settings. This project highlights the promising role of IoT and robotics in precision agriculture, providing an efficient, scalable, and cost-effective approach to meet the growing demand for automation in farming. This innovation

not only optimizes farming operations but also supports sustainable, data-driven agricultural practices, shaping the future of the industry.

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