# AUTOMATED HYDROPONICS

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# ABSTRACT

This report includes research into how to automate a small-scale system for hydroponics. Hydroponics is a growing technique which features a soil-less environment were the plants roots are exposed to a nutrient-enriched water solution. The research focused mainly on how to regulate the pH and the level of nutrient in the water solvent and finding a system to automate that process.

The research proved that a way to automate a small-scale hydroponics system is by building a computerized system consisting of:

• Micro controller.

• pH sensor.

• Temperature sensor.

• Fluid pumps connected to pH- and nutrient reservoirs.

# CONTENTS

# 1. INTRODUCTION

This project presents the overall design of an Automated Hydroponics with a low-cost and wireless system. It specifically focuses on the development of an IOT-based home automation system that can control various components via the internet or be automatically programmed to operate from ambient conditions. It is an updated version of the existing home automation system.

## 2. SCOPES

Higher yield: they produce between three and ten times more food than conventional agriculture in the same space. The O plants also grow in half the time.

There is no need for herbicides or pesticides: they are safe from weeds and insects, making unnecessary the use of these products.

Lower water consumption: it consumes 20 times less water than conventional agriculture, as the water is recirculated and reused.

Less contamination: since it is a closed system, there is neither water contamination nor soil with the remains of fertilizers or pesticides.

Adaptation to extreme conditions: it allows plants to be grown in harsh environments, with poor soils or extreme weather.

# 3. APPLICATION

This report includes research on how to automate a small-scale hydroponic system and use this system to grow sweet basil. The properties of the environment are of high importance for the plants to grow properly in a hydroponic system, and therefore, maintenance of the properties is important. Parameters that should be considered to maintain a fertile environment for the plants are for example pH-, nutrient-, oxygen- and water-levels along with sufficient exposure to sun light.

# 4. OBJECTIVE

The objective of the automated hydroponics project is to develop and implement a technologically advanced system that optimizes resource utilization, maximizes crop yield, and minimizes environmental impact in hydroponic farming. By integrating automation, sensors, and precise control mechanisms, the project aims to create a sustainable and efficient solution for growing plants in a controlled environment.

# 5. HARDWARE IMPLEMENTATION

## I. ARDUINO

The Arduino Uno is a microcontroller board based on the ATmega328. Arduino is an open source; prototyping platform and its simplicity makes it ideal for hobbyists to use as well as professionals. The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to DC adapter or battery to get started. The Arduino Uno differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it features the Atmega8U2 microcontroller chip programmed as a USB-to-serial converter.

The Arduino Uno is a popular microcontroller board based on the ATmega328P chip. It is widely used in various electronic projects and prototyping due to its simplicity, versatility, and ease of use.

Physical Characteristics:

The Arduino Uno board is relatively small, measuring about 68.6mm (2.7 inches) in length and 53.4mm (2.1 inches) in width. It features a blue PCB (Printed Circuit Board) with various components mounted on it.

Microcontroller:

At the heart of the Arduino Uno is the ATmega328P microcontroller, which is a low-power, high-performance chip developed by Atmel (now owned by Microchip Technology). The microcontroller operates at a clock speed of 16 MHz and has 32KB of flash memory for storing the program code, 2KB of SRAM (Static Random Access Memory), and 1KB of EEPROM (Electrically Erasable Programmable Read-Only Memory) for data storage.

Digital and Analog I/O:

The Arduino Uno provides a set of digital input/output pins, including 14 digital I/O pins, numbered from 0 to 13. These pins can be configured as either inputs or outputs and used to interface with various digital devices such as sensors, LEDs, switches, and more. Additionally, six of these pins (0 to 5) can function as PWM (Pulse Width Modulation) output pins for controlling analog-like signals.

The board also features six analog input pins, labelled A0 to A5, which can measure analog voltage levels in the range of 0 to 5 volts. These pins are useful for interfacing with analog sensors, potentiometers, and other analog devices.

Power and Connectivity:

The Arduino Uno can be powered through a USB connection or an external power source. It has a USB Type-B connector that allows it to connect to a computer for programming and power supply. Additionally, it has a barrel jack for connecting an external power adapter.

For data communication, the Arduino Uno features a USB-to-serial converter chip, which allows it to communicate with a computer via the USB connection. It also has a set of pins for serial communication (UART), enabling it to communicate with other devices using protocols like UART, SPI, and I2C.

Programming and Software:

Arduino Uno can be programmed using the Arduino Integrated Development Environment (IDE), which provides a user-friendly interface for writing, compiling, and uploading code to the board. The programming language used is a variant of C++ with specific libraries and functions designed to simplify hardware interactions.

The Arduino Uno is known for its extensive library support, making it easier for beginners and experienced developers alike to access pre-written code for various components and functionalities.

Overall, the Arduino Uno is a versatile and widely used microcontroller board that serves as a foundation for many electronic projects. Its simplicity, extensive community support, and rich ecosystem of shields and accessories make it an excellent choice for both beginners and experienced makers.

# II. REGULATED DC POWER SUPPLY

A regulated DC power supply is an electronic device used to provide a stable and adjustable direct current (DC) voltage output for powering electronic circuits, devices, and components. It is designed to convert an input voltage (typically AC) into a precise and controlled DC voltage.

Input Power:

A regulated DC power supply usually operates from an AC power source, such as a wall outlet. The input voltage is typically converted to a higher voltage level using a transformer. This higher voltage is then rectified and filtered to produce a relatively smooth DC voltage.

Voltage Regulation:

The main function of a regulated DC power supply is to maintain a stable output voltage regardless of changes in the input voltage or load conditions. It achieves this by using voltage regulation techniques. The most common method is to employ a feedback control loop that continuously monitors the output voltage and adjusts it to the desired level.

Adjustable Output Voltage:

Regulated DC power supplies often have an adjustable output voltage feature. This allows the user to set the desired output voltage within a specified range. It is achieved by incorporating a voltage control mechanism, such as a potentiometer or digital controls, which can be adjusted to increase or decrease the output voltage.

Current Limiting:

Many regulated DC power supplies also include a current-limiting feature. This feature protects the connected circuit or device from excessive current that could cause damage. The current limit can usually be set manually, and when the load current exceeds the set limit, the power supply reduces the output voltage to keep the current within the defined range.

Display and Controls:

A regulated DC power supply often has a display panel that shows the output voltage and, in some cases, the output current. This allows the user to monitor the power supply's output parameters. The controls on the power supply enable adjustments of the output voltage, current limit, and other parameters.

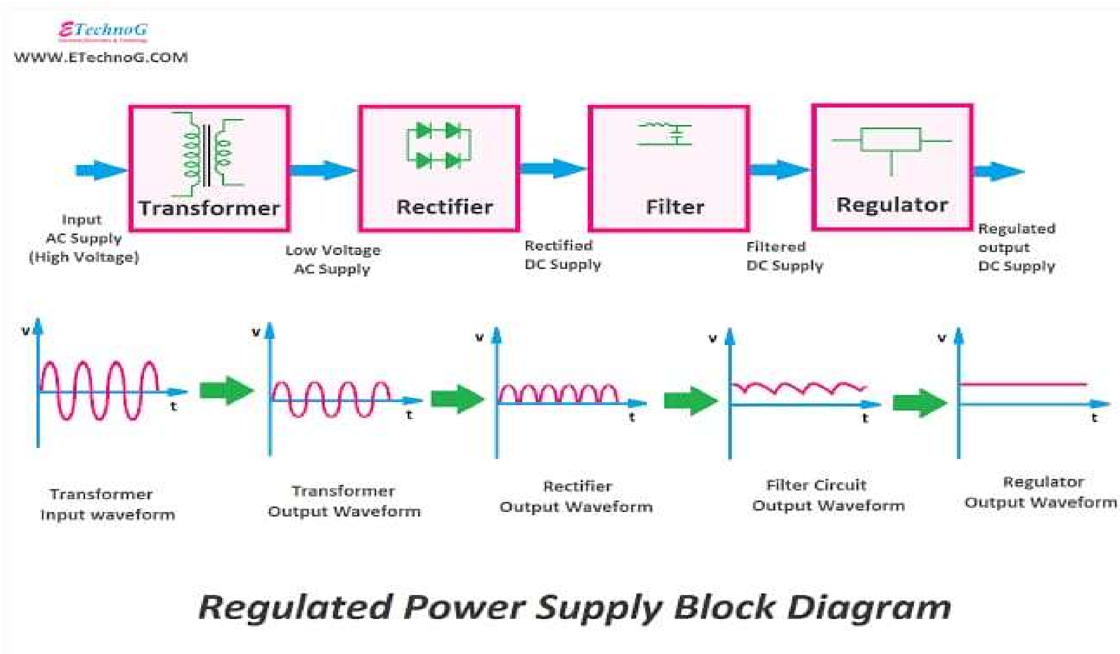
Safety Features:

To ensure safe operation, regulated DC power supplies may incorporate various safety features. These can include overload protection, short-circuit protection, over-temperature protection, and reverse polarity protection. These safety mechanisms help prevent damage to the power supply or the connected devices in case of faults or incorrect connections.

Connectivity:

Regulated DC power supplies typically provide output terminals or connectors for connecting the load or the electronic circuit being powered. These terminals may include banana jacks, binding posts, or screw terminals, depending on the specific model.

In summary, a regulated DC power supply is a reliable and adjustable source of stable DC voltage for powering electronic circuits and devices. Its ability to maintain a constant output voltage, along with features like adjustable voltage and current limiting, makes it a crucial tool in electronics labs, research, and various industrial applications.



# III. MOTOR

A motor is an electromechanical device that converts electrical energy into mechanical energy. It is widely used in various applications to generate motion, provide power, and drive mechanical systems.

Basic Components:

A motor consists of several key components:

1. Stator: The stator is the stationary part of the motor and typically consists of a magnetic core and coils of wire known as windings. The windings are designed to create a magnetic field when an electrical current passes through them.

2. Rotor: The rotor is the moving part of the motor. It is usually made of a conductive material, such as copper or aluminium, and is mounted on a shaft. The rotor interacts with the magnetic field created by the stator and experiences a force that generates rotational motion.

Working Principle:

Motors operate based on the principle of electromagnetic induction. When an electrical current flows through the windings in the stator, it creates a magnetic field. This magnetic field induces a magnetic force on the conductive rotor, causing it to rotate.

There are two main types of motors:

1. DC Motors: DC (Direct Current) motors operate by applying a continuous voltage to the motor's terminals. The current flows through the stator windings, creating a magnetic field. The interaction between the stator's magnetic field and the rotor's conductive material produces torque, resulting in rotational motion.

2. AC Motors: AC (Alternating Current) motors operate by using an alternating voltage source. The AC current passing through the stator windings continuously changes direction, causing the magnetic field to alternate. The changing magnetic field induces currents in the rotor, creating a magnetic field of its own. The interaction between the stator and rotor fields generates rotational motion.

Motor Control:

To control the speed, direction, and torque of a motor, various control methods are used. These can include adjusting the voltage or current supplied to the motor, using electronic speed controllers (ESCs), or employing feedback control systems such as PID (Proportional-Integral-Derivative) controllers.

Applications:

Motors find applications in a wide range of industries and devices, including:

- Industrial Machinery: Motors power various industrial machines such as conveyor systems, pumps, compressors, and manufacturing equipment.

- Automotive: Motors are used in vehicles for applications such as powering the engine, operating windows, controlling the wipers, and driving electric vehicles.

- Robotics: Motors play a crucial role in robotics for controlling movement, joint articulation, and precise positioning.

- Appliances: Motors are found in household appliances like washing machines, refrigerators, fans, and air conditioning systems.

- Aerospace: Motors are used in aircraft for propulsion, actuating control surfaces, and operating various systems.

In summary, motors are essential devices that convert electrical energy into mechanical energy, enabling motion and powering a wide range of machines and devices across various industries. Their versatility, efficiency, and controllability make them indispensable in numerous applications.

# IV. 5-CHANNEL RELAY MODULE

A 5-channel relay module is an electronic device that consists of multiple relays integrated into a single module. Each relay is capable of independently controlling a separate circuit or device

Relay Channels:

A 5-channel relay module features five individual relays, each with its own set of input and output terminals. These channels provide the capability to control up to five separate circuits or devices simultaneously.

Relays:

Each channel on the relay module includes a relay, which is an electrically operated switch. Relays consist of a coil, an armature, and one or more sets of contacts. When an electrical current is applied to the coil, it generates a magnetic field that causes the armature to move, thereby opening or closing the contacts.

Input Control:

The 5-channel relay module typically accepts input control signals from a microcontroller, Arduino, Raspberry Pi, or other similar devices. The control signals are used to trigger the relays, either by applying or removing voltage from the relay coil.

Output Contacts:

The output terminals of each relay channel are connected to the normally open (NO), normally closed (NC), and common (COM) contacts of the corresponding relay. These contacts allow you to connect the relay module to the circuits or devices you want to control. The NO contact is open when the relay is not energized, while the NC contact is closed. When the relay is energized, the NO contact closes, and the NC contact opens.

Voltage and Current Ratings:

A 5-channel relay module usually supports a specific voltage and current rating for both the input control signals and the output circuits. The voltage and current ratings may vary depending on the specific module, so it is important to refer to the manufacturer's specifications to ensure compatibility with your application.

Power Supply:

The relay module requires a separate power supply to operate the relays. The power supply voltage is typically provided through a separate input terminal on the module. The voltage required may depend on the specific relays used on the module.

Applications:

A 5-channel relay module is commonly used in various applications where multiple circuits or devices need to be controlled independently. Some typical applications include home automation, robotics, industrial automation, lighting control, and security systems.

In summary, a 5-channel relay module is a convenient and compact solution for controlling multiple circuits or devices independently. It provides a flexible and reliable method for integrating relay-based control into electronic projects, allowing you to switch and control different components or systems simultaneously.

## V. **ESP8266**

The ESP8266 is a highly popular and widely used Wi-Fi enabled microcontroller module designed for Internet of Things (IoT) applications. It integrates a microcontroller unit (MCU) and a Wi-Fi module into a single chip, making it an efficient and cost-effective solution for adding wireless connectivity to various electronic projects.

Key Features:

1. Microcontroller: The ESP8266 module contains a powerful 32-bit Ten silica microcontroller unit, typically based on the Xtensa architecture. The MCU runs at a clock speed of up to 80 MHz and can execute a wide range of tasks and running embedded applications.

2. Wi-Fi Connectivity: The ESP8266 module includes built-in Wi-Fi functionality, allowing it to connect to Wi-Fi networks and communicate with other devices over the internet. It supports both client and access point modes, enabling it to connect to existing Wi-Fi networks or create its own Wi-Fi network.

3. GPIO Pins: The module provides several general-purpose input/output (GPIO) pins, typically ranging from 6 to 17 pins depending on the specific variant. These pins can be used to interface with various sensors, actuators, and external devices, enabling interaction with the physical world.

4. Programming: The ESP8266 module can be programmed using various programming languages and development environments. The most used programming language is C/C++, and popular development environments like the Arduino IDE or the Espresso IoT Development Framework (ESP-IDF) are commonly used for programming the module.

5. Memory: The module usually includes both flash memory and RAM. The amount of flash memory varies between different versions, typically ranging from 512KB to 4MB. The RAM size is usually 32KB or 80KB, depending on the specific variant.

6. Low Power Consumption: The ESP8266 module is designed to operate efficiently with low power consumption, making it suitable for battery-powered and energy-efficient IoT applications.

7. Supportive Community: The ESP8266 has gained immense popularity due to its affordability, versatility, and an active community of developers. There is a vast amount of documentation, tutorials, and libraries available online, making it easier for developers to get started and find solutions to their IoT projects.

Applications:

The ESP8266 module has found applications in various IoT projects, including:

- Home Automation: Controlling and monitoring smart home devices, such as lights, appliances, and thermostats, over Wi-Fi.

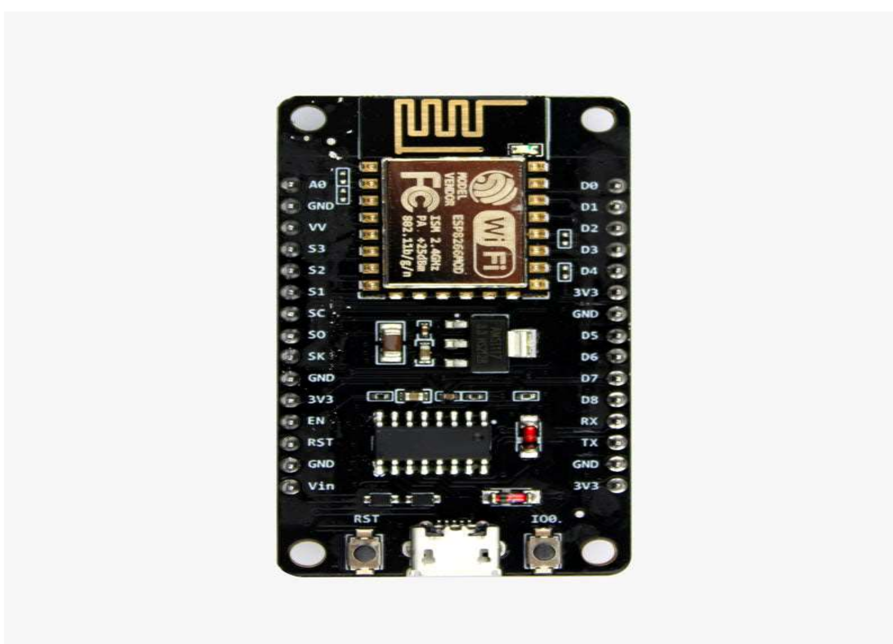
- Weather Stations: Gathering environmental data like temperature, humidity, and pressure and transmitting it to online services.

- Internet-connected Sensors: Building sensor networks to collect and transmit data from various sensors, such as motion sensors, temperature sensors, or moisture sensors.

- Industrial Monitoring: Monitoring and controlling industrial processes, machinery, and equipment remotely.

- Wearable Devices: Creating wearable IoT devices that connect to the internet, such as fitness trackers or smartwatches.

In summary, the ESP8266 IoT module offers an affordable and feature-rich solution for adding Wi-Fi connectivity to IoT projects. With its integrated Wi-Fi capability, GPIO pins, low power consumption, and supportive community, the ESP8266 has become a popular choice for makers, hobbyists, and professionals in the IoT space.



# VI. STEP-DOWN TRANSFORMER

A step-down transformer is an electrical device that reduces the voltage level from a higher value to a lower value. It is commonly used in power distribution systems, electronics, and various applications where a lower voltage is required.

Primary and Secondary Windings:

A step-down transformer consists of two sets of windings, known as the primary winding and the secondary winding.

1. Primary Winding: The primary winding is the input side of the transformer and is connected to the high-voltage source. It typically has a larger number of turns of wire compared to the secondary winding.

2. Secondary Winding: The secondary winding is the output side of the transformer, and it is connected to the load or device requiring the lower voltage. The number of turns in the secondary winding is fewer than the primary winding, allowing the voltage to be stepped down.

Transformer Core:

The windings are wound around a core made of laminated iron or other magnetic materials. The core provides a closed magnetic circuit that efficiently transfers the magnetic flux between the windings.

Voltage Step-Down:

The step-down transformer operates on the principle of electromagnetic induction. When an alternating current (AC) passes through the primary winding, it creates an alternating magnetic field in the core. This changing magnetic field induces a voltage in the secondary winding, resulting in a stepped-down voltage.

Turns Ratio and Voltage Conversion:

The ratio of the number of turns in the primary winding to the number of turns in the secondary winding determines the voltage conversion ratio. For example, if the turns ratio is 1:2, a primary voltage of 240V will be stepped down to 120V at the secondary winding.

Power Transfer and Load:

The step-down transformer allows power to be transferred from the primary winding to the secondary winding while maintaining the voltage step-down. The load connected to the secondary winding receives power at the stepped-down voltage level.

Efficiency and Losses:

Transformers are designed to be highly efficient in transferring power with minimal losses. However, some energy is lost as heat due to resistive losses in the windings and hysteresis losses in the core material. Transformers are often designed with insulation and cooling mechanisms to mitigate these losses and maintain efficient operation.

Applications:

Step-down transformers find numerous applications, including:

1. Power Distribution: Step-down transformers are used in power grids to reduce high-voltage transmission lines to lower voltages suitable for distribution to households and businesses.

2. Electronics: Transformers are employed in electronic devices and appliances to step down voltage levels for various components, such as power supplies, audio equipment, and voltage regulators.

3. Industrial Machinery: Transformers are used in machinery and equipment to provide the appropriate voltage levels for motors, control systems, and other electrical components.

4. Lighting: Transformers are commonly used to step down voltage for lighting systems, including halogen lamps, LED lights, and fluorescent lights.

In summary, a step-down transformer is an essential device for converting higher voltage levels to lower voltage levels. It plays a crucial role in power distribution, electronics, and various applications where voltage reduction is required for safe and efficient operation.

## VII. 12V DC FAN

A 12V DC fan is an electrical device that operates on a direct current (DC) power supply at 12 volts. It is designed to provide airflow and cooling in various applications, including electronic devices, computer systems, automotive cooling, and ventilation systems.

Design and Components:

A 12V DC fan consists of several key components:

1. Fan Blades: The fan blades are responsible for generating airflow by spinning rapidly when the fan is powered. They are designed to efficiently move air and provide adequate cooling.

2. Motor: The motor is the driving force behind the fan's operation. It converts electrical energy from the DC power supply into rotational mechanical energy to spin the fan blades. Brushless DC (BLDC) motors are commonly used in 12V DC fans due to their efficiency, reliability, and quiet operation.

3. Frame: The fan frame provides structural support and protection for the internal components. It is typically made of plastic or metal and may include mounting holes or brackets for easy installation.

4. Bearings: The fan may incorporate different types of bearings to reduce friction and ensure smooth rotation. Common types include sleeve bearings, ball bearings, or fluid dynamic bearings, which offer varying levels of durability and noise output.

Power Supply and Voltage:

A 12V DC fan requires a 12-volt DC power supply to operate. It is essential to ensure that the fan is connected to a compatible power source with the correct voltage rating to prevent damage and ensure optimal performance.

Airflow and Performance:

The performance of a 12V DC fan is determined by its airflow capacity, measured in cubic feet per minute (CFM), and the static pressure it can generate. These specifications indicate the volume of air moved by the fan and its ability to overcome resistance in a system, such as heat sinks or air filters. Fans with higher CFM ratings generally provide better cooling performance.

Control Options:

Some 12V DC fans may include additional features for control and customization:

1. Speed Control: Many fans have multiple speed settings, allowing the user to adjust the fan's rotation speed and airflow to meet specific cooling requirements. Speed control can be achieved through physical switches or using pulse width modulation (PWM) signals.

2. Tachometer Output: Some fans include a tachometer output that provides feedback on the fan's rotational speed. This feature enables monitoring and control of the fan's speed in applications where precise speed regulation is necessary.

Applications:

12V DC fans find numerous applications, including:

1. Computer Cooling: Cooling computer components such as central processing units (CPUs), graphics cards, and power supplies to prevent overheating and maintain optimal performance.

2. Electronics Cooling: Cooling heat-generating components in electronic devices and equipment, including routers, servers, amplifiers, and power supplies.

3. Automotive Cooling: Providing cooling airflow in vehicles for radiator cooling, engine compartments, and air conditioning systems.

4. Ventilation Systems: Assisting with air circulation and cooling in HVAC (Heating, Ventilation, and Air Conditioning) systems, industrial equipment, and confined spaces.

5. DIY Projects: Incorporating fans into DIY projects, prototypes, and custom cooling solutions.

In summary, a 12V DC fan is a versatile cooling device commonly used in various applications. With its 12V power requirement, it can provide reliable airflow and cooling in electronic, computer, automotive, and ventilation systems, ensuring proper thermal management and preventing overheating.

# VIII. SENSORS

- **DHT11**

The DHT11 is a popular digital temperature and humidity sensor module commonly used in electronic projects and IoT applications. It provides a convenient and affordable solution for measuring ambient temperature and relative humidity.

Design and Components:

The DHT11 sensor module consists of a DHT11 sensor chip, which integrates both the temperature and humidity sensing elements, and a small PCB (Printed Circuit Board) that includes necessary components for signal conditioning and communication.

Temperature and Humidity Sensing:

The DHT11 sensor utilizes a resistive humidity sensor and a negative temperature coefficient (NTC) thermistor for temperature measurement.

1. Humidity Sensing: The humidity sensing element in the DHT11 is based on a moisture-absorbing polymer. As humidity changes, the polymer's resistance also changes, providing an electrical signal that corresponds to the relative humidity of the environment.

2. Temperature Sensing: The temperature sensing element is an NTC thermistor, which exhibits a change in resistance with temperature. The resistance is measured to determine the ambient temperature.

Signal Conversion and Output:

The DHT11 sensor module converts the analog signals from the humidity and temperature sensing elements into a digital format for easy processing and communication with microcontrollers or other devices.

1. Data Transmission: The sensor module communicates using a single-wire digital interface protocol. It sends data in the form of 40-bit binary sequences.

2. Data Format: The transmitted data includes information about temperature, humidity, and checksum for error checking. The data format is specific to the DHT11 sensor and needs to be parsed correctly to obtain accurate readings.

Accuracy and Measurement Range:

The DHT11 sensor module has a limited measurement range and moderate accuracy compared to more advanced sensors. It can measure temperatures ranging from 0°C to 50°C with an accuracy of about ±2°C. The humidity measurement range is 20% to 90% relative humidity with an accuracy of about ±5%.

Power Supply and Voltage Levels:

The DHT11 sensor module typically operates on a 3.3V or 5V DC power supply. It requires a stable power source, and care should be taken to provide adequate voltage and current to ensure proper functioning.

Applications:

The DHT11 sensor module is commonly used in various applications, including:

1. Home Automation: Monitoring and controlling temperature and humidity levels in smart homes and buildings.

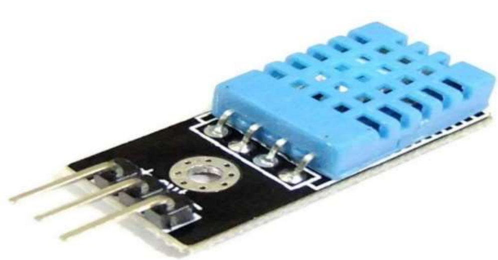
2. Weather Stations: Collecting temperature and humidity data for weather analysis and forecasting.

3. HVAC Systems: Regulating heating, ventilation, and air conditioning systems based on environmental conditions.

4. Agriculture: Monitoring greenhouse environments, crop storage conditions, and irrigation systems.

5. IoT Projects: Integrating temperature and humidity sensing into Internet of Things (IoT) devices and systems for data collection and analysis.

In summary, the DHT11 temperature and humidity sensor module offers a cost-effective solution for measuring environmental conditions in electronic projects. While it may have limitations in terms of measurement range and accuracy compared to more advanced sensors, it still provides reliable temperature and humidity data for a wide range of applications.



## pH SENSOR

A pH sensor is an electronic device used to measure the acidity or alkalinity of a solution by detecting the concentration of hydrogen ions ($H+$) present in the solution. pH sensors are widely used in various industries, including chemistry, biology, environmental monitoring, agriculture, and water treatment.

pH Measurement Principle:

The pH sensor operates on the principle of electrochemistry. It consists of a glass electrode and a reference electrode immersed in the solution being measured.

1. Glass Electrode: The glass electrode is the main sensing element of the pH sensor. It is typically made of a thin glass membrane that is selective to hydrogen ions. The glass membrane is sensitive to changes in the hydrogen ion concentration, which affect the electrical potential generated across the membrane.

2. Reference Electrode: The reference electrode provides a stable and constant electrical potential against which the potential of the glass electrode is measured. It is usually filled with a potassium chloride (KCl) solution or a gel electrolyte, ensuring a constant reference potential.

pH Calibration:

To ensure accurate pH measurements, pH sensors need to be calibrated. Calibration involves adjusting the sensor's output to match known pH values. The sensor is typically calibrated using buffer solutions with known pH values, such as pH 4, pH 7, and pH 10. During calibration, the sensor's response is adjusted to match the expected voltage readings for each buffer solution.

Signal Conversion and Output:

The pH sensor generates a millivolt (mV) electrical signal proportional to the measured pH value. The signal is usually very weak and requires amplification and conversion into a usable format for further processing and display. A pH meter or an analog-to-digital converter (ADC) is commonly used to convert the voltage signal into pH units or a digital format for data acquisition.

Maintenance and Storage:

pH sensors require proper maintenance and storage to ensure their longevity and accuracy. It is essential to keep the glass electrode hydrated by storing it in a pH storage solution or deionized water when not in use. Regular cleaning and calibration are necessary to maintain optimal performance.

Applications:

pH sensors have a wide range of applications, including:

1. Water Quality Monitoring: Measuring pH in swimming pools, aquariums, and natural water bodies to assess water quality and maintain suitable conditions for aquatic life.

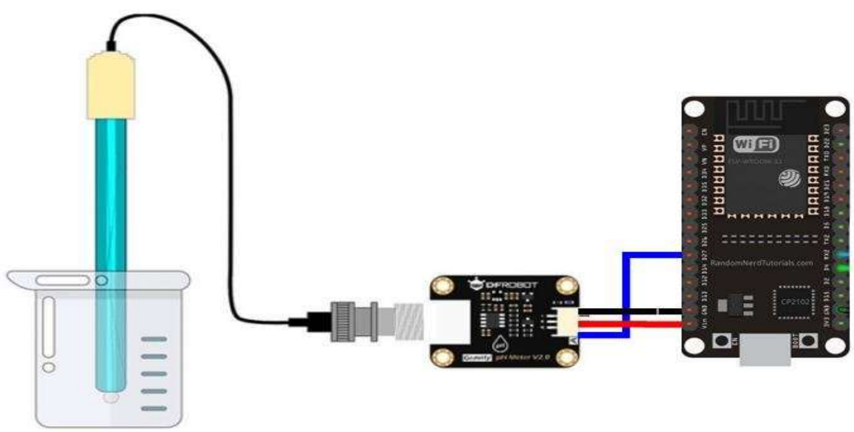
2. Chemical Analysis: pH measurement in chemical laboratories for determining the acidity or alkalinity of solutions in experiments and analysis.

3. Food and Beverage Industry: Monitoring pH levels in food and beverage production processes, such as fermentation, brewing, and dairy production.

4. Environmental Monitoring: Assessing the pH of soil, rivers, lakes, and oceans to monitor environmental health and identify potential issues.

5. Biomedical and Pharmaceutical Applications: pH measurement in medical diagnostics, research, and pharmaceutical manufacturing processes.

In summary, pH sensors are essential tools for measuring the acidity or alkalinity of solutions. They provide crucial information in various fields and industries, enabling precise control and monitoring of pH levels for optimal performance and safety.



## o HC-SR04 ULTRASONIC SENSOR

The HC-SR04 ultrasonic sensor is a popular and widely used electronic device for measuring distance. It utilizes ultrasonic sound waves to determine the distance between the sensor and an object in its vicinity.

Principle of Operation:

The HC-SR04 sensor operates based on the time-of-flight principle. It emits ultrasonic pulses and measures the time it takes for the pulses to bounce back after hitting an object. By calculating the round-trip time, the sensor can determine the distance to the object.

Components:

The HC-SR04 ultrasonic sensor consists of the following components:

1. Transmitter: The sensor's transmitter emits ultrasonic sound waves in the form of short pulses. These pulses are usually in the ultrasonic frequency range of around 40 kHz.

2. Receiver: The receiver picks up the ultrasonic waves that bounce back from nearby objects. It detects and converts these waves into electrical signals.

3. Control Circuitry: The sensor includes control circuitry responsible for triggering the transmitter, measuring the time-of-flight, and processing the received signals.

4. GPIO Pins: The HC-SR04 sensor typically has four pins: VCC (power supply), GND (ground), TRIG (trigger), and ECHO (echo). The trigger pin is used to initiate the ultrasonic pulse, while the echo pin measures the time it takes for the pulse to return.

Measurement Range and Accuracy:

The HC-SR04 ultrasonic sensor has a measurement range of several centimeters to several meters, depending on the specific model. The accuracy of the sensor can vary but is generally within a few millimeters.

Usage and Applications:

The HC-SR04 ultrasonic sensor finds a wide range of applications, including:

1. Object Detection and Avoidance: The sensor can be used to detect the presence and distance of objects, enabling obstacle avoidance in robotics and autonomous vehicles.

2. Proximity Sensing: It can measure the proximity of objects for various purposes, such as automatic door control, hand gesture recognition, and object tracking.

3. Liquid Level Detection: The sensor can be employed to measure the level of liquids in tanks or containers.

4. Distance Measurement: The HC-SR04 sensor is commonly used for distance measurement in applications like robotics, home automation, and industrial monitoring.

Programming and Interfacing:

To use the HC-SR04 ultrasonic sensor, it is typically interfaced with a microcontroller or single-board computer. The sensor requires precise timing and pulse generation, which can be achieved through programming the microcontroller to control the trigger and echo pins. The received time-of-flight information can then be processed and used for distance calculations or other applications.

In summary, the HC-SR04 ultrasonic sensor is a versatile and affordable distance measurement device that utilizes ultrasonic waves to determine the distance between the sensor and objects in its surroundings. With its simplicity and wide range of applications, the HC-SR04 sensor has become a popular choice for distance sensing and proximity detection in various projects and systems.

# 6. SOFTWARE IMPLEMENTATION

```
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <DHT_U.h>
#define DHTPIN 4
#define DHTTYPE    DHT11     // DHT 11
#define RELAYPIN1 8
#define RELAYPIN2 9
DHT_Unified dht(DHTPIN, DHTTYPE);
int water;
uint32_t delayMS;
const int trigPin = 2;//Ultrasonic Sensor Trigger Pin
const int echoPin = 3;//Ultrasonic Sensor Echo Pin
int a=13; //min distance for relay to switch off
int b=5; //min pH for relay to switch ON
int max_distance = 400;
#define pH_pin 0          // the pH meter Analog
output is connected with the Arduino’s Analog
unsigned long int avgValue;  //Store the average
value of the sensor feedback
int buf[10],temp;
void setup() {
  Serial.begin(9600);
  dht.begin();
  sensor_t sensor;
 dht.temperature().getSensor(&sensor);
  dht.humidity().getSensor(&sensor);
  delayMS = sensor.min_delay / 1000;
  pinMode(RELAYPIN1,OUTPUT); //output pin for relay
board for water pump, this will sent signal to the
relay 1
  pinMode(RELAYPIN2,OUTPUT); //output pin for relay
board for water pump, this will sent signal to the
relay 2
  pinMode(6,OUTPUT); //relay board for fan
}
void loop() {
  //Temperature Sensor
  delay(delayMS);
  sensors_event_t event;
  dht.temperature().getEvent(&event);
```

```
  if (isnan(event.temperature)) {
    Serial.println(F("Error reading temperature!"));
  }
  else {
    Serial.print(F("Temperature: "));
    Serial.print(event.temperature);
   Serial.println(F("°C"));
  }
  dht.humidity().getEvent(&event);
  if (isnan(event.relative_humidity)) {
    Serial.println(F("Error reading humidity!"));
  }
  else {
    Serial.print(F("Humidity: "));
    Serial.print(event.relative_humidity);
    Serial.println(F("%"));
  }
//Ultrasonic Sensor
long duration, cm;
pinMode(trigPin,OUTPUT);
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
pinMode(echoPin, INPUT);
duration = pulseIn(echoPin, HIGH);
//cm = ( duration / 29 ) / 2;
cm = microsecondsToCentimeters(duration);
if (cm <max_distance){Serial.print(cm);
Serial.print(" cm"); Serial.println(); delay(100); }
//pH sensor
for(int i=0;i<10;i++)       //Get 10 sample value
from the sensor for smooth the value
  {
    buf[i]=analogRead(pH_pin);
    delay(10);
  }
  for(int i=0;i<9;i++)        //sort the analog from
small to large
  {
    for(int j=i+1;j<10;j++)
    {
      if(buf[i]>buf[j])
```

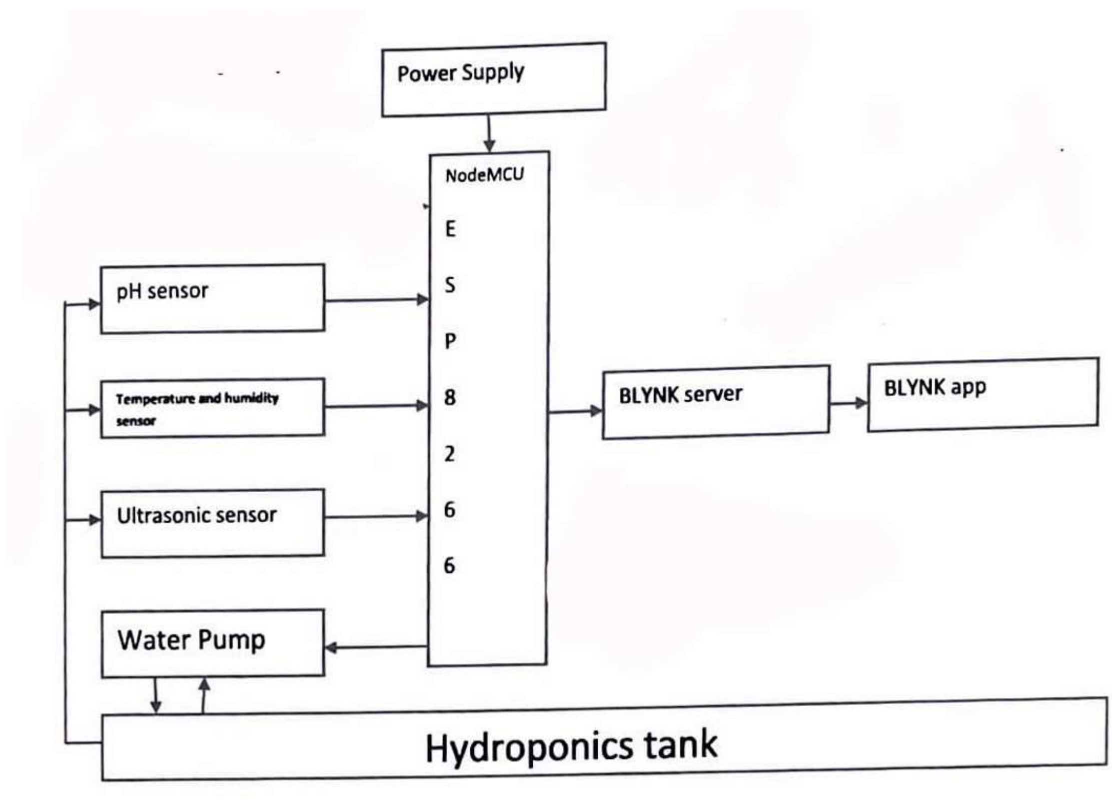
```
        {
          temp=buf[i];
          buf[i]=buf[j];
          buf[j]=temp;
        }
      }
    }
 avgValue=0;
  for(int i=2;i<8;i++)                      //take
the average value of 6 center sample
    avgValue+=buf[i];
  float phValue=(float)avgValue*5.0/1024/6; //convert
the analog into millivolt
  phValue=3.5*phValue;                      //convert
the millivolt into pH value
  Serial.print("    pH:");
  Serial.print(phValue,2);
  Serial.println(" ");
//Relay Module connected to waterpump IN
water=cm;
if (water<a)
  {
  digitalWrite(RELAYPIN2,HIGH); //high to continue
proving signal and water supply
  }
  else
  {
  digitalWrite(RELAYPIN2,LOW); // low is to cut the
relay
  }
  delay(400);
//Relay Module connected to waterpump OUT
if((phValue<6))
  {
  digitalWrite(RELAYPIN1,LOW); // low is to cut the
relay
  delay(40000);
  }
  else
  {
digitalWrite(RELAYPIN1,HIGH); //high to continue
proving signal and water supply
  }
delay(400);
```

```
//Relay Module connected to fan
if (event.relative_humidity>70)
  {
  digitalWrite(6,HIGH); // low is to cut the relay
  }
  else
  {
  digitalWrite(6,LOW); //high to continue proving
signal and water supply
  }
  delay(400);
}
long microsecondsToCentimeters(long microseconds) {
return (microseconds / 29) / 2;
}
```

# 7.BLOCK DIAGRAM

The block diagram for an automated hydroponics system provides a visual representation of the major components and their interconnections. It offers a high-level overview of how different parts of the system work together to create an optimized environment for plant growth.

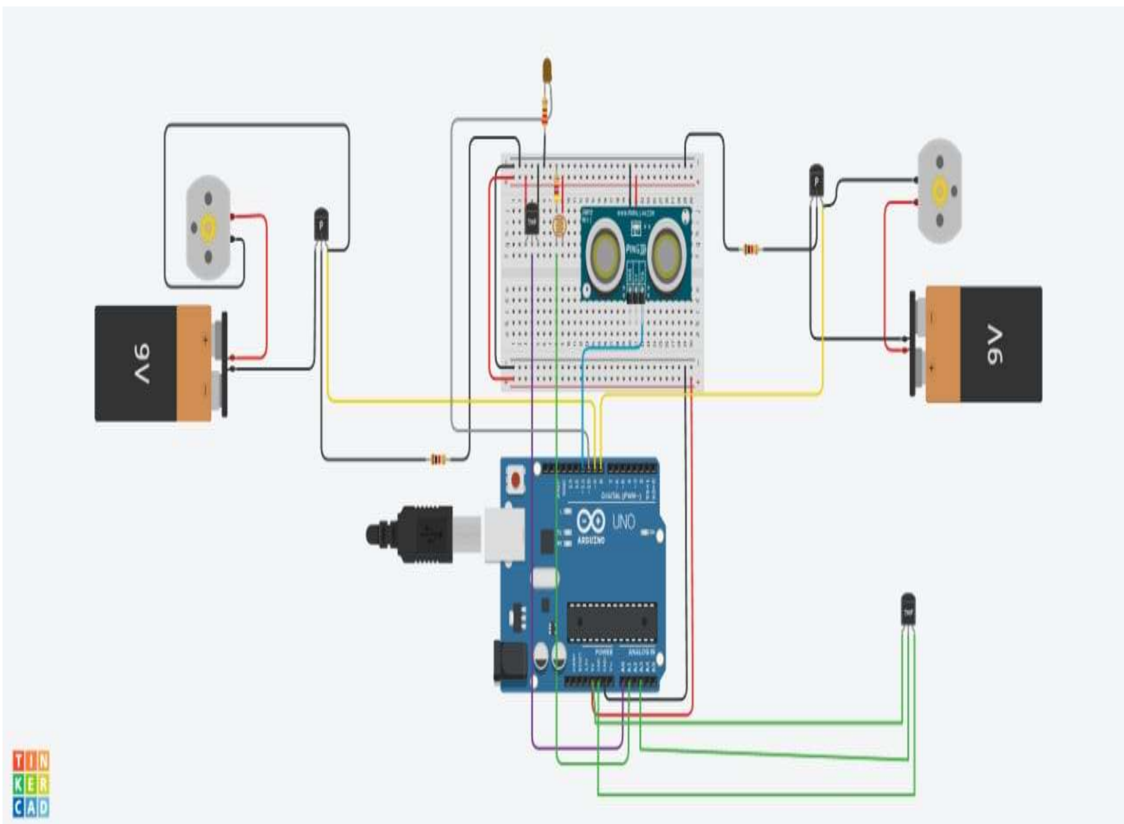
The block diagram provides a simplified overview of the major components and their connections in an automated hydroponics system. The specific components and their arrangement may vary depending on the complexity and specific requirements of the system.



# 8.SYSTEM CIRCUIT

An automated hydroponics circuit diagram illustrates the electrical connections and components required for controlling and automating various aspects of a hydroponic system.

It's important to note that the specific circuit diagram may vary depending on the complexity and specific requirements of the automated hydroponics system. Customizations and additional components may be incorporated to meet the needs of a particular project.



# 9.CONCLUSIONS

In conclusion, the finished automated hydroponics project combines innovative technology with sustainable farming practices to create an efficient and controlled system for growing plants. By implementing automation and hydroponics techniques, the project offers numerous benefits such as optimized resource utilization, increased crop yield, and reduced environmental impact.

The automated hydroponics system incorporates various components and features that work seamlessly together. It utilizes sensors to monitor crucial environmental parameters such as temperature, humidity, pH level, and nutrient concentration. These sensors provide real-time data, enabling precise control and adjustments to create an optimal growing environment for plants.

The project also includes an automated irrigation system that delivers water and nutrients directly to the plant roots. This system ensures a consistent and precisely controlled supply of water and nutrients, promoting healthy plant growth and minimizing water waste.

To automate the system, a microcontroller or programmable logic controller (PLC) is employed to manage and coordinate the different components. The microcontroller or PLC receives input from the sensors, processes the data, and triggers appropriate actions based on predefined parameters. This automation allows for continuous monitoring and adjustment of environmental conditions, ensuring that plants receive the ideal conditions for growth.

In addition to the automation features, the hydroponics project promotes sustainability by minimizing the use of soil and reducing water consumption compared to traditional soil-based farming methods. The controlled environment of the system also reduces the need for pesticides and herbicides, making it an eco-friendly choice.

Overall, the finished automated hydroponics project represents an innovative and efficient approach to modern agriculture. It combines technology, sustainability, and precision to create an optimized growing system that maximizes crop yield while conserving resources and minimizing environmental impact. This project serves as a model for future agricultural practices, offering a glimpse into the potential of automation and hydroponics for sustainable food production.

# 10.FUTURE SCOPES

As technology continues to evolve, there are several exciting scopes and possibilities for further development in this field:

1. Smart AI-based Systems: Integration of artificial intelligence (AI) and machine learning algorithms can enable automated hydroponic systems to analyse and interpret sensor data in real-time. This can lead to more precise and adaptive control of environmental parameters, optimizing plant growth conditions based on dynamic factors.
2. Internet of Things (IoT) Integration: Connecting automated hydroponic systems to the internet can enable remote monitoring and control. IoT integration allows farmers to access real-time data, receive alerts, and manage the system through mobile applications or web interfaces. This connectivity opens doors for data analytics and advanced decision-making algorithms.
3. Enhanced Nutrient Delivery Systems: Developing more efficient nutrient delivery systems that can precisely monitor and adjust nutrient levels in real-time can further improve plant health and growth. This includes the use of advanced nutrient dosing techniques, automated nutrient mixing, and integration with water quality sensors
4. Vertical Farming and Urban Agriculture: As land availability becomes limited in urban areas, vertical farming, and urban agriculture present promising opportunities. Automated hydroponic systems can be scaled and integrated into vertical farming structures, maximizing space utilization, and enabling year-round cultivation in urban environments.
5. Integration with Renewable Energy Sources: Incorporating renewable energy sources, such as solar power, can make automated hydroponics more sustainable and environmentally friendly. This integration can help reduce energy costs and dependency on fossil fuels, making hydroponics a greener solution for food production.
6. Data-Driven Optimization and Predictive Analytics: Analyzing large datasets collected from automated hydroponic systems can provide valuable insights into crop performance, resource usage, and system efficiency. Predictive analytics and optimization algorithms can help optimize growing parameters, predict yield, and improve overall productivity.

7. Collaboration with Genetics and Plant Science: Collaborations between automated hydroponics and genetics/plant science researchers can lead to the development of specialized crops that are specifically optimized for

hydroponic growth. This can result in increased crop yield, nutritional value, and resistance to pests and diseases.

In conclusion, the future of automated hydroponics holds immense potential for technological advancements, sustainable farming practices, and improved food production. By embracing emerging technologies, optimizing resource usage, and integrating with other scientific disciplines, automated hydroponics can contribute to the development of more efficient and environmentally friendly methods of cultivation.

# 11.REFERENCES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