SUSTAINABLE VERTICAL FARMING USING IOT

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1 INTRODUCTION

Placing a vertical garden upon the walls of our tall building of offices and colleges.

As the world is suffering from limited space left for cultivating agricultural products, Vertical gardens are now becoming a popular concept. Here is a complete guide to setting up a sustainable vertical garden with waste PVC pipes.

Vertical Farming: Vertical farming is the practice of growing crops in vertically stacked layers. It often incorporates controlled-environment agriculture, which aims to optimize plant growth.

- The main advantage of utilizing vertical farming technologies is the **increased crop yield** that comes with a smaller unit area of land requirement.
- Increase ability to cultivate a larger variety of crops at once because crops do not share the same plots of land while growing.
- Additionally, crops are **resistant to weather** disruptions because of their placement indoors, meaning fewer crops are lost to extreme or unexpected weather occurrences.
- Because of its **limited land usage**, vertical farming is less disruptive to the native plants and animals, leading to further conservation of the local flora and fauna.

This idea comes to my mind after seeing the unused walls behind the indoor garden of our building in the university and offices, if we place some kind of vertical garden in walls it looks attractive and we can also plant some needful and expensive herbs.

Sustainability - Recycling concept:

1. Recycling Unused or waste PVC pipes for plantation. During construction of the building, huge PVC pipe fitting takes place and sometimes changing also takes place. We shall be using those unused PVC pipes as Pots to do plantation.
2. Recycling Water coming out from Watercoolers, water purifiers and washbasins will be used to watering the plants. Ultimately leads to no water wastages.
3. Using Solar panels to convert the energy and keep in portable batteries. This energy will be used for developing auto watering

system.

4. AI based auto watering sensor. Using the solar batteries, using and AI, we shall develop a system. This system will detect the need for water in plants, need for soil and fertilizers in plants, insects or pest attacks in case, readiness of the crop. The system shall be automated and the machines used will run using recycled solar energy.
5. Recycling tree leaves, vegetable peals and fruits peals for making fertilizer for the plants. Therefore, we shall be growing absolutely Organic vegetables and herbs.
6. Recycling coconut shells by crushing them and making cocopeat. It is wonderful fertilizer for plants.
7. Recycling metal wires. Vertical farming will be done on the walls using metal wires. Therefore, no damage to the wall will take place. Plants will be hanged on the metal wire frame.
8. As farming is hanged on the metal wires, therefore once crop is ready to reap, it will be easier to pull them down and cut.
9. Complete process is ecofriendly and on the concept of Sustainability.
10. Once the herbs and vegetables are completely organic, therefore have higher contribution on the health to those who eat and consume organic vegetable and herbs.

2 REVIEW OF LITERATURE:

Concerns about food security, resource conservation, and environmental sustainability have grown increasingly serious as the world's population continues to grow. In response to these issues, Sustainable Vertical Farming (SVF) has emerged as a game changer in agricultural output. SVF uses cutting-edge technology to grow crops in vertically stacked layers or on inclined surfaces, maximizing space and resource use while reducing environmental effect. The Internet of Things (IoT), which blends digital connection with physical farming systems, is one such disruptive technology at the vanguard of this agricultural revolution. This study of the literature digs into the convergence of Sustainable Vertical Farming and the Internet of Things, examining the dynamic terrain where agriculture meets cutting-edge technology (Hegazi F. Ibrahim, Nesma Abd El-mawla, Green Team, 2022). The study seeks to give a complete synthesis of existing research and scholarship on the integration of IoT in SVF systems, uncovering the multiple ways in which these technologies synergize to improve food production efficiency, sustainability, and productivity (Adrian Jandl, 2021). The influence of IoT on resource management, crop yield optimization, energy efficiency, and the total ecological footprint of vertical farming systems are among the key subjects to be investigated. In addition, the study will examine case studies and empirical evidence to give insight on real IoT deployments in SVF (M. Halgamuge, Alexe Bojovschi, P. Fisher, Tu C. Le, S. Adeloju, Susan M. Murphy, 2021).

Vertical farming has the potential to be more sustainable if IoT technology is used. IoT-based systems can monitor and adjust environmental elements including temperature, humidity, and light levels,

improving growth conditions and increasing production (S. Omar, 2021). These systems can help automate growth processes like irrigation and fertilizer supply, saving time and money. Furthermore, IoT technology enables real-time data and analytics, enabling farmers to make data-driven decisions and increase overall efficiency (Saraswathi Sivamani, Namjin Bae, Yongyun Cho, 2013). Sensor systems that can readily interface with any vertical farming system have been created, storing and displaying system parameters and transferring data to a cloud-based server for remote access. The use of IoT in vertical farming can lead to increased crop output and quality, as well as easier maintenance of equipment (M. Halgamuge, Alexe Bojovschi, 2021). The IoT technologies can enhance the adoption of sustainable vertical gardening systems in urban areas, enhancing food security and sustainability (M. Halgamuge, Alexe Bojovschi, P. Fisher, Tu C. Le, S. Adeloju, Susan M. Murphy, 2021). IoTs are rapidly transforming smart farming by optimizing activities and increasing productivity through advanced sensing, networking, communication, and data management technologies (S. Omar, 2021). This IoT-based system allows users to monitor and control soil moisture levels in indoor vertical farming, ensuring plants receive enough water without having to be physically present (Muhammad Ikhwan Hanif bin Ismail, N. M. Thamrin, 2017). Vertical hydroponic farming using IoT platforms and big data analysis can significantly increase crop productivity and profitability while reducing space and manpower requirements for small-scale farmers (A. Shrivastava, C. Nayak, R. Dilip, S. Samal, S. Rout, Shaikh Mohd Ashfaque, 2021). The vertical farm ontology (VFO) model enhances semantic interoperability between IoT devices, paving the way for smart and intelligent agricultural services in vertical farms (Saraswathi Sivamani, Namjin Bae, Yongyun Cho, 2013).

3 METHODOLOGY:

The research on Sustainable Vertical Farming (SVF) with the Internet of Things (IoT) will take a mixed-methods approach, integrating quantitative and qualitative approaches. This multimodal technique is intended to give a thorough knowledge of the implications, constraints, and possibilities connected with incorporating IoT technology into SVF systems. A literature review to be conducted to establish a solid foundation of existing knowledge on Sustainable Vertical Farming, IoT applications in agriculture, and the intersection of these two fields. In the Quantitative Phase, Surveys would be conducted and administered to a diverse sample of SVF practitioners, farmers, and industry experts. Also data on variables such as IoT implementation levels, resource efficiency, crop yield, and economic viability to be collected. In-depth interviews and case studies are conducted during the qualitative phase. In-depth interviews should be conducted with important stakeholders such as SVF operators, agricultural specialists, and technology vendors to investigate qualitative issues such as difficulties encountered, success stories, and perceptions of the influence of IoT on long-term vertical farming. Some cases to be analyzed in-depth to gain insights into specific IoT implementations in SVF through thorough case studies. A pilot feasibility analysis is also

proposed to assess the long-term financial sustainability and viability of IoT-integrated SVF systems. Throughout the study process, ethical guidelines would be followed while collecting, analyzing, and reporting data. With utmost care is to be taken to ensure participant confidentiality and informed consent.

4 WHICH PLANTS WE GROW IN VERTICAL FARMING

Plants that have shallow roots or don't take long to mature, so they won't develop a massive roots system that requires a lot of space.

HERBS:

- Basil
- Chives
- Lemon Balm
- Mint
- Oregano
- Parsley
- Rosemary

SMALL PLANTS:

- Like cherry tomatoes

POLE BEANS
ANNUAL FLOWERING VINES:

- Susan vine
- Morning glory

ANNUAL FLOWERS:

- Alyssum

5 MATERIALS NEEDED SETUP A GARDEN:

- Structure
- PVC pipes, one-square-meter base frame
- main central support connected to the base frame
- pot/grow bag supports
- Drip laterals
- Microtubes
- Drippers
- Seeds and supplies for plant nutrition and protection.

6 AREA WHERE WE'RE PLANNING TO SETUP A FARM

Start by choosing a wall. "If you've got a wall that's unused walls, ugly looking walls, that's the one you're going to want to do". The good news is that almost any wall will do, and unless you want to build a very large vertical garden or plant trees, you don't need to worry about weight load. We're trying to place a built up garden in front of that wall.

What plants you should choose will depend upon the place you pick and how much sunlight it receives. However, if you'd like to try particular plants, then choose a place that will provide the best growing conditions for them.

I'm planning to grow vertical garden in my University building at first so I'm choosing the wall in the backside of indoor gardens.

BUILD A FRAME:

- Take waste PVC pipes of same size for base frame of the garden, elbows, andfour-way joints to build a frame.
- Avoid using metals because of additional weights and expenses.
- No woods because it requires pressure treating to protect against moisturerot.
- Making a frame before placing it

Cut the upper half of pipes and place them horizontally

Make littles holes below the pipes to run out extra water to protect the

soil. Place the pipes horizontally with support on a wall one by one maintainingvertical gap of 3 meters

Put ropes and other pipes on wall for vertical support between horizontalpipes.

7 SETUP IRRIGATION SYSTEM:

To keep plants growing on a vertical surface, we'll need an irrigation system that can provide moisture throughout the layer. We can make one out of poly tubing with fittings that lock. It's basically a tube across the top of your panel with emitters that drip water down. Our best bet is to get them from an irrigation supplier.

We can buy a standard valve and irrigation drippers, but we'll need a propagation timer thatcan be set for seconds rather than minutes. We want a quick flow of water for 10 to 15 seconds from three to six times a day, depending on weather conditions and your particular setup. Attach an emitter every 2 to 3 inches along the top irrigation tube and experiment to find the right balance between keeping the wall wet while not overwatering the plants.

8 ADD FERTILIZER INJECTOR AND ATTACH IRRIGATION SYSTEM TO WATER SOURCE:

To fertilize, attach a fertilizer injector, such as Add-It, with a simple irrigation valve that sends liquid fertilizer into the irrigation system. Then hook up the irrigation system and connect to our water source. We'll need to filter the water with an irrigation water filter, which is cheap and available at most hardware stores.

Remember, there will be some runoff; one way to deal with it is by planting a flower bed underneath your vertical garden.

CHOOSE YOUR PLANTS:

As with any gardening, consider sun, shade, humidity, wind, and cold whenchoosing plants that you're going to leave outside all year.

INSERT PLANTS:

To insert the plants, get as much soil off the plant's root ball as possible (to help stave off root rot), and insert it into pipes with maintaining equal distance. Using a staple gun, insert three to five stainless-steel staples to attach the cloth to the plastic backing in a semicircle around the root ball, creating a secure envelope.

Choose plants that will grow 2 to 3 feet out from the wall, and plant them at the top so they create shade underneath. If you do this, though, keep in mind you'll have to plant shade-tolerant species underneath, such as ferns. Also, a plant that's 8 feet off the ground will often droop, Yates says. That gives a nice waterfall effect but also smothers whatever's underneath, so you'll have to trim it back.

After whole setup, take care of plants every week and let them grow.

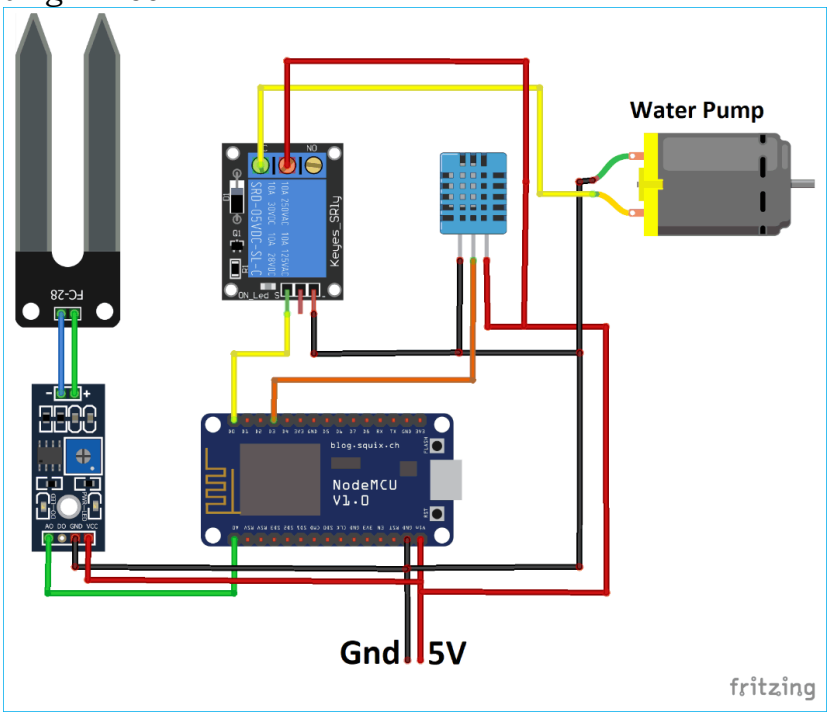
9 THE CONCEPT DESIGN:

IoT based Smart Irrigation System using Soil Moisture Sensor and ESP8266 NodeMCU

Smart irrigation System has wide scope to automate the complete irrigation system. Here we are building a **IoT based Irrigation System** using ESP8266 NodeMCU Module and DHT11 Sensor. It will not only automatically irrigate the water based on the moisture level in the soil but also send the Data to ThinkSpeak Server to keep track of the land condition. The System will consist of a water pump which will be used to sprinkle water on the land depending upon the land environmental condition such as Moisture, Temperature and Humidity.

TheComponents Required

- NodeMCU ESP8266
- Soil Moisture Sensor Module
- Water Pump Module
- Relay Module
- DHT11
- Connecting Wires



Programming ESP8266 NodeMCU for Automatic Irrigation System

For programming the ESP8266 NodeMCU module, only the DHT11 sensor library is used as external library. The moisture sensor gives analog output which can be read through the ESP8266 NodeMCU analog pin A0. Since the NodeMCU cannot give output voltage greater than 3.3V from its GPIO so we are using a relay module to drive the 5V motor pump. Also the Moisture sensor and DHT11 sensor is powered from an external 5V power supply.

DHT11 Sensor and Its Working

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc... Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

What is a DHT11 Sensor?

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc... to measure humidity and temperature instantaneously.

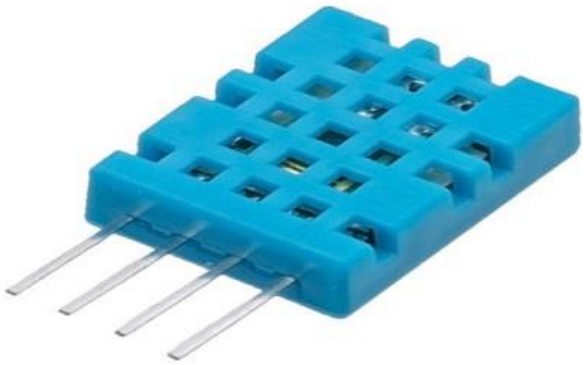
DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

Working Principle of DHT11 Sensor

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.



The DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and microcontroller.

Applications

This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems. Weather stations also use these sensors to predict weather conditions. The humidity sensor is used as a preventive measure in homes where people are affected by humidity. Offices, cars, museums, greenhouses and industries use this sensor for measuring humidity values and as a safety measure.

Its compact size and sampling rate made this sensor popular among hobbyists. Some of the sensors which can be used as an alternative to DHT11 sensor are DHT22, AM2302, SHT71.

10 SOIL MOISTURE SENSOR WORKING AND APPLICATIONS

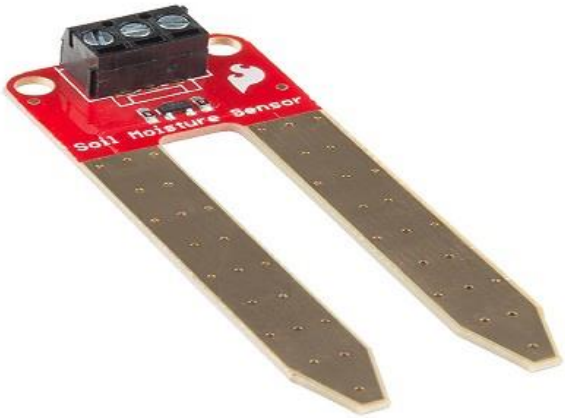
The moisture of the soil plays an essential role in the irrigation field as well as in gardens for plants. As nutrients in the soil provide the food to the plants for their growth. Supplying water to the plants is also essential to change the temperature of the plants. The temperature of the plant can be changed with water using the method like transpiration. And plant root systems are also developed better when rising within moist soil. Extreme soil moisture levels can guide to anaerobic situations that can encourage the plant's growth as well as soil pathogens. This article discusses an overview of the soil moisture sensor, working and its applications.

What is a Soil Moisture Sensor?

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave

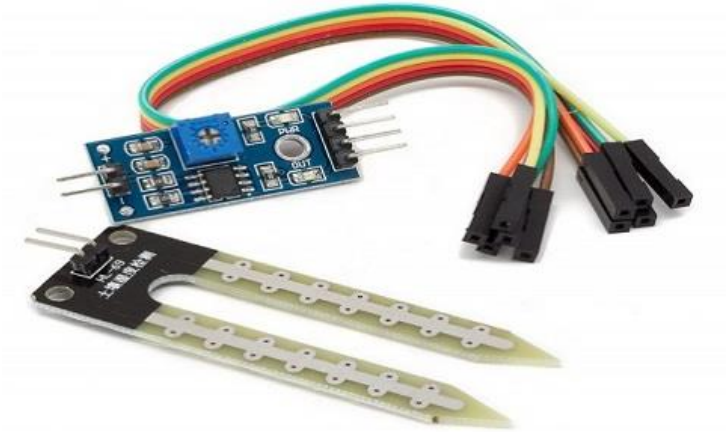
emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.



These sensors normally used to check volumetric water content, and another group of sensors calculates a new property of moisture within soils named water potential. Generally, these sensors are named as soil water potential sensors which include gypsum blocks and tensiometers.

Soil Moisture Sensor Pin Configuration

The FC-28 soil moisture sensor includes 4-pins



- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

This module also includes a potentiometer that will fix the threshold value, & the value can be evaluated by the comparator-LM393. The LED will turn on/off based on the threshold value.

Working Principle

This sensor mainly utilizes capacitance to gauge the water content of the soil (dielectric permittivity). The working of this sensor can be done by inserting this sensor into the earth and the status of the water content in the soil can be reported in the form of a percent.

This sensor makes it perfect to execute experiments within science courses like environmental science, agricultural science, biology, soil science, botany, and horticulture.

Specifications
The specification of this sensor includes the following.
The required voltage for working is 5V
The required current for working is <20mA
Type of interface is analog
The required working temperature of this sensor is 10°C~30°C

Soil Moisture Sensor Applications
The applications of moisture sensors include the following.

- Agriculture
- Landscape irrigation
- Research
- Simple sensors for gardeners

This is all about the soil moisture sensor. From the above information, finally, we can conclude that this sensor is used to gauge the soil's volumetric water content, which makes it perfect to make experiments in the science field like agricultural science, soil science, horticulture, environmental science, biology, and botany.

11 MICRO SUBMERSIBLE WATER PUMP DC 3V-5V
Description:
This is Micro Submersible Water Pump DC 3V-5V, can be easily integrate to your water system project. The water pump works using water suction method which drain the water through its inlet and released it through the outlet. You can use the water pump as exhaust system for your aqurium and controlled water flow fountain.

Specification:
Input Voltage: DC 3V-5V
Flow Rate: 1.2-1.6 L/min
Operation Temperature: 80 Deg.C
Operating Current: 0.1-0.2A
Suction Distance: 0.8 meter (Max)
Outside diameter of water outlet: 7.5mm
Inside diameter of water outlet: 5.0 mm
Diameter of water Inlet : 5.0 mm
Wire Length: 200 mm
Size: 45 x 30 x 25 mm
Weight: 30g

How to Use:
Firstly, simply connect the red wire (+) and black wire (-) to a 3V or 5V DC supply.

Next, make sure the connection is right (+) wire to (+) terminal and (-) wire to (-) terminal.

Submerge the water pump into the water according to your application preferences.

When the supply is on, water will flow into the inlet of the pump and flow out through the outlet.

Application:
Controlled fountain water flow
Controlled Garden watering systems
Hydroponic Systems
Fresh water intake or exhaust systems for fish aquarium
Automatic Hand Sanitizer

What is a 5V Relay Module : Working & Its Applications

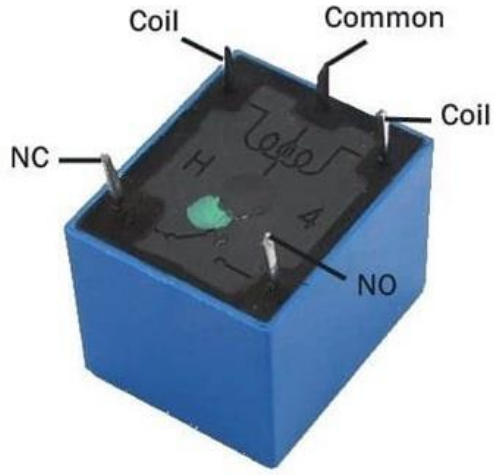
Relay is one kind of electro-mechanical component that functions as a switch. The relay coil is energized by DC so that contact switches can be opened or closed. A single channel 5V relay module generally includes a coil, and two contacts like normally open (NO) and normally closed (NC). This article discusses an overview of the 5V relay module & its working but before going to discuss what is relay module is, first we have to know what is relay and its pin configuration.

What is a 5V Relay?

A 5v relay is an automatic switch that is commonly used in an automatic control circuit and to control a high-current using a low-current signal. The input voltage of the relay signal ranges from 0 to 5V.

5V Relay Pin Configuration

The pin configuration of the 5V relay is shown below. This relay includes 5-pins where each pin and its functionality are shown below.



Pin1 (End 1): It is used to activate the relay; usually this pin one end is connected to 5Volts whereas another end is connected to the ground.
Pin2 (End 2): This pin is used to activate the Relay.
Pin3 (Common (COM)): This pin is connected to the main terminal of the Load to make it active.
Pin4 (Normally Closed (NC)): This second terminal of the load is connected to either NC/ NO pins. If this pin is connected to the load then it will be ON before the switch.
Pin5 (Normally Open (NO)): If the second terminal of the load is allied to the NO pin, then the load will be turned off before the switch.

Features

The features of the 5V relay include the following.
Normal Voltage is 5V DC
Normal Current is 70mA
AC load current Max is 10A at 250VAC or 125V AC
DC load current Max is 10A at 30V DC or 28V DC
It includes 5-pins & designed with plastic material
Operating time is 10msec
Release time is 5msec
Maximum switching is 300 operating per minute

5V Relay Module

The relay module with a single channel board is used to manage high voltage, current loads like solenoid valves, motor, AC load & lamps. This module is mainly designed to interface through different microcontrollers like PIC, Arduino, etc.

5V Relay Module Pin Configuration

The pin configuration of the 5V relay module is shown below. This module includes 6-pins where each pin and its functionality are discussed below.

Normally Open (NO): This pin is normally open unless we provide a signal to the relay modules signal pin. So, the common contact pin smashes its link through the NC pin to make a connection through the NO pin
Common Contact: This pin is used to connect through the load that we desire to switch by using the module.
Normally Closed (NC): This NC pin is connected through the COM pin to form a closed circuit. However, this NC connection will break once the relay is switched through providing an active high/low signal toward the signal pin from a microcontroller.
Signal Pin: The signal pin is mainly used for controlling the relay. This pin works in two cases like active low otherwise active high. So, in active low case, the relay activates once we provide an active low signal toward the signal pin, whereas, in an active high case, the relay will trigger once we provide a high signal toward the signal pin.
However, these modules generally work on an active high signal which will strengthen the relay coil to make contact with the common terminal with the normally open terminal.
5V VCC: This pin needs 5V DC to work. So 5V DC power supply is provided to this pin.
Ground: This pin connects the GND terminal of the power supply.

5Volts 1-Channel Relay Module Components

The components in a 5v relay module with a single channel include a relay, output terminal, status LED, power LED, freewheeling diode, input connector & switching transistor.

Relay

A 5V relay is coated with blue color plastic material. For both AC & DC loads, the utmost operating voltage & current are also displayed on the relay. This relay operates with 5V, so it is called a 5V relay.

Output Terminal

The output terminal of the relay module is located at the left-hand side, used to fix an AC/DC load & AC/DC i/p power source. Every o/p connector's terminal is connected through NC, COM pins & NO of the relay. The relay module consists of screws that are used to connect wires & cables. The max current supported by this module is 10A & the max contact voltage is 250V AC & 30V DC. Thick main cables are mainly used whenever high voltage & current load is used.

Status LED

Status LED is connected by using a current limiting resistor that is located on the top right side of the relay module. So this LED illustrates the relay status by activating the relay & coil through a signal pin. The DC supplies throughout a relay coil.

Power LED

Power LED shows the condition of the power source that is connected through the single channel module. If we provide the above 5V source toward both the pins of the module like Vcc & GND, the LED will be damaged due to high voltage.

Freewheeling Diode

The connection of this diode can be done across the coil to keep away from the back EMF effect, so-called a flyback diode. The type of coil used in the relay is the inductive type. Once the current supplies throughout an

inductive load, then it generates a back EMF voltage, which may harm the circuit. So, this diode is mainly used to keep away from this effect.

Input Connector

The input connector is located on the right side of the module. This connector is mainly used to supply a 5V power supply & input signal. In addition, it also supplies power supply toward the power LED, relay coil & status LED.

Switching Transistor

Generally, the input signal which is given to a relay is from the I/O pins of microcontrollers like ESP32, TM4C123, Arduino, etc. However, the highest current sourcing capacity of GPIO pins is usually below 20mA.

Therefore, a switching transistor is used in this module is to strengthen the current to the requirement of the minimum current level of the relay coil. A switching transistor is used to control the 5V relay from the microcontroller's GPIO pin.

Some kinds of relay modules are available with an optoisolator like a switching device to give optical isolation among high & low voltage circuits. However, if you are utilizing a separate relay exclusive of a module & you want to utilize several relays within your projects, then a relay driver IC can be used to drive several arrays from the pins of GPIO in a microcontroller.

Specifications

The specifications of a 1- channel relay module include the following.

- Voltage supply ranges from 3.75V – 6V
- Quiescent current is 2mA
- Once the relay is active then the current is ~70mA
- The highest contact voltage of a relay is 250VAC/30VDC
- The maximum current is 10A

Working

The relay uses the current supply for opening or closing switch contacts. Usually, this can be done through a coil to magnetize the switch contacts & drags them jointly once activated. A spring drives them separately once the coil is not strengthened.

By using this system, there are mainly two benefits, the first one is, the required current for activating the relay is less as compared to the current used by relay contacts for switching. The other benefit is, both the contacts & the coil are isolated galvanically, which means there is no electrical connection among them.

Advantages

- The advantages of the relay module include the following.
- A remote device can be controlled easily
- It is triggered with less current but it can also trigger high power machines
- Easily contacts can be changed
- At a time, several contacts can be controlled using a single signal

- Activating part can be isolated
- It can switch AC or DC
- At high temperatures, it works very well

Disadvantages

The disadvantages of the relay module include the following.

- When contacts of relay modules are used overtime then they may damage
- Noise can be generated through the opening & closing of the contacts.
- Time taken for switching is High

Applications

Relay modules are used in different applications which include the following.

- Used in over voltage/under voltage protection system
- Mains Switching
- Speed control of motors through start-delta converters
- Automatic electrical appliances
- Electrical isolation in between high & low power sources
- Lights
- AC voltage load switching using less voltage DC
- Delivery of Isolated power
- Home automation projects
- Switching with High Current

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