*PSYCHOLOGY AND EDUCATION (2019) 56(1):526-536*
*ISSN: 1553-6939*

# DESIGN AND IMPLEMENTATION OF A SMART IRRIGATION SYSTEM USING RASPBERRY PI FOR EFFICIENT WATER MANAGEMENT

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**ABSTRACT**

The agricultural sector has major issues due to water shortages and poor irrigation techniques, which calls for the creation of creative solutions for sustainable water management. In order to optimize water utilization in agricultural areas, this research demonstrates the design and construction of a smart irrigation system utilizing Raspberry Pi. The system accurately controls water delivery depending on crop demands and environmental circumstances by integrating soil moisture sensors, meteorological data, and real-time monitoring capabilities. The core controller, the Raspberry Pi, uses an intuitive interface to evaluate sensor data and automate the watering operation.

By incorporating IoT elements, the system's functionality is improved and farmers can monitor and manage irrigation remotely using a web interface or mobile app. Because the smart irrigation system makes sure that plants get the right quantity of water, it not only saves water but also lowers labor expenses and increases agricultural production. The system's efficiency is shown by experimental findings, which show that large water savings may be achieved while preserving or even increasing agricultural yield. This research demonstrates how intelligent technology may be used to solve global water management issues and advance sustainable agriculture methods.

## I. INTRODUCTION

### 1.1 INTRODUCTION TO SMART IRRIGATION

The importance of building an automation system for an office home or field is increasing day-by-day. Automation makes an efficient use of the electricity, water and reduces much of the wastage. Smart water sprinkler irrigation system makes an efficient use of water for the growth of plants. Heart of the system is Raspberry Pi 3 mini computer, shown in figure 1. Raspberry Pi model 3 has dedicated general purpose input outputs (GPIO) pins. These all GPIO pins can be accessed for controlling hardware such as LEDs, sensors, and relays, which are examples of outputs.

Need of automatic Irrigation

- Simpler and easy to install and configure.
- Saving energy and resources, so that it can be utilized in appropriate way.
- Farmers would be able to spread the proper quantity of water at the proper time by automating farm or nursery irrigation.
- Avoiding irrigation at the incorrect time of day, reduce runoff from overwatering saturated soils which will enhance crop/plant's performance.
- Automated irrigation system uses shower to turn motor ON and OFF.

Irrigation engineering comprises of a full knowledge of sources of irrigation water, their proper preservation and application of this water to the land after conveying it from the source through an irrigation system, consisting of canal and connected works. It also includes a working knowledge of different types of soils and the water requirements of various crops sown in them.

In this project work lot of importance is given for the drip irrigation, such that by sensing the soil humidity water supply can be controlled automatically. For this purpose relay is used, to energizing the pumping motor to supply water to the plants. The motor is energized automatically when the message is sent from the mobile to switch ON the motor. By sensing the soil sensitivity the motor will be switched OFF automatically when the soil is in wet condition. For sensing the soil condition copper electrodes are used.

Irrigation is usually required when the yearly rainfall is either insufficient or ill distributed or ill timed. Yield is much better where irrigation is practiced and fields are watered at the proper time. In countries like India and Egypt, Irrigation provides employment for large sections of people. It raises the standard of living and prosperity. Irrigation projects are successful only when sufficient quantities of water are available and the land is suitable to grow remunerative crops. No irrigation is normally required if the total annual rainfall is 100cms. Or more and takes place at correct times. When it is proposed to grow valuation and better types of crops like Rice, Sugar cane, Vegetables, Cotton etc., Irrigation is very essential.

The term Automation refers to means of control of electrical and mechanical operations without human interference. Definition of automation can be extended to field Automation which states "monitoring and control of various electrical equipments used for modern drip irrigation to their predetermined levels without human interference". In real time application with one micro-controller we can process large number of micro-controller or other IC device to be tailored to implement a specific function. The application program executed by a micro-controller drives the system hardware in order to implement the desired system function for a given micro-controller, different application programs allow different systems function to be implemented within a range limited by the available system hardware. As the technology advances, changing lifestyles patterns and willingness to spend in crop improvement, fulfill the desire for intelligent, fully automated field. In a typical automated field various equipments can be used for various methods of irrigation.

The concept is to switch on the lights in evening and switch off these lights in the early morning automatically. Now coming to the project work, the scope of the project work is to energize the lights or any other outdoor lights automatically by sensing the natural light. Solar outdoor lights are ideal in remote locations. The cost of extending a grid connection to remote security, street or parking lot lights is usually prohibitive. But because solar-powered lights eliminate the need to trench underground and dig up asphalt, they are affordable alternatives to grid-connections in many urban settings.

The entire system is designed with raspberry pi unit; the natural light sensing circuit designed using LDR is connected like an input to the controller. Depending on the information given to the micro controller about the status of the natural light, the controller automatically control the outdoor light through the relay. The detailed description is provided in the following chapters.

**1.2 NEED OF SMART IRRIGATION SYSTEM**

The development in smart environmental technology and the application of Wireless Sensor Networks (WSNs) creates a new way of research in the field of agriculture. Now-a day sensor technologies are very much helpful in creating the smart précised environment. Using this technique, the WSN deployments for various farming applications in the Indian as well as global scenario are surveyed. Also, the possibility of using this technique for the crop growth starting from its cultivation to harvesting is analysed. In this way, various parameters needed for particular crop maintenance is focused and the problems for improvement and future development are considered. Agriculture plays a vital role in the development of country‟s economy.

The daily need for food shows the importance of agricultural development. Growing a particular crop in a particular region takes the privilege of monitoring the growth from cultivation till harvesting. One of the main challenges in agricultural activities is irrigation. As the global climate decreases the source of water throughout the world, it is necessary to take steps for preserving it.

However traditional irrigation management is done by the people itself. It requires the presence and continuous monitoring of irrigation by the farmers in the field area. The user must need to manually change the direction of water flow using large pipes in the field. It creates a need for more labour work R. Ilakkiya/2019 South Asian J. Eng. Technol, 2019, 19-24| 20 and maintenance. A little advancement in traditional system involves in establishing centralized control of irrigated land using wired architecture which will also leads to more cost and maintenance manually. Many researches are done in the field of agriculture and most of them signify the use of wireless sensor network that collect data from different sensors deployed at various nodes and send it through the IOT.

It monitors the environment and collects the information. When the temperature get change in the environment the DHT 11 sensor will sense the humidity PH level of soil and send the date to the raspberry pi then motor will be turn ON supply the water to agriculture land. Then water level sensor is used to sense water level and supply the water to the plant as per their requirement. Those all the process will be monitor and operate by an IOT with any manual operation. Two of the most common problems with farm irrigation systems have to do with irrigation scheduling. Irrigation scheduling is simply answering the questions of “When do I water?” and “How long do I water?”. Starting an irrigation cycle too early and/or running an irrigation cycle too long is considered over watering.

At the very least this practice wastes water and money. However, over watering can cause crop damage if done on a prolonged basis. Likewise, starting an irrigation cycle too late or not running the system for a long enough period of time is considered under watering and can cause reduced yields and poor crop quality which can affect price. Looking at these problems in depth is the key to minimizing their financial and practical impact on crops. The two most common methods for dealing with these problems are evapo transpiration based control systems and soil moisture-based control systems.

## II. COMPONENTS DESCRIPTION

**2.1 RASPBERRY PI ZERO W**

Raspberry Pi Zero is a cost-effective, small-to-medium-size board in the Raspberry Pi family. The initial version of the Raspberry Pi Zero was released at the end of 2015, and is now the new version V1.3, with an additional CSI camera connector compared to the initial version. Raspberry Pi Zero adopts the BCM2835 processor with ARM11 single-core, which is an economical choice for many Raspberry Pi enthusiasts.

There are three versions of the Raspberry Pi Zero, the Raspberry Pi Zero is the simplified version without WiFi and Bluetooth; Raspberry Pi W is the network version with the onboard wireless network card, that supports Bluetooth and WiFi; Raspberry Pi Zero WH adds a 40PIN pre-soldered GPIO header for users to debug and use.

Raspberry Pi zero W is an affordable and compact derivative of Raspberry Pi but if you attach Raspberry Pi zero W with monitor, keyboard, and mouse, it takes up a lot more space. There's no need to connect Raspberry Pi to a display or input devices if you're only trying to program it or using it to operate electronics like lights, motors, and sensors because you can control the system remotely using a VNC or SSH client on your primary computer.

This screen less Raspberry Pi zero W system is referred to as a headless setup.Before we get started, let us get acquainted with Raspberry Pi Zero W. It is the newest member of the Pi Zero family and comes with added wireless LAN and Bluetooth connectivity.

This board is specifically designed to get more benefits at affordable price. It provides great connectivity with 2 Micro USB Ports (1 port for Power and other for USB Connectivity), 1 mini–HDMI Port and 1 Micro SD Card Slot and has 512MB of RAM.

A tiny Raspberry Pi that's affordable enough for any project - now with WiFi and Bluetooth. The Raspberry Pi Zero W is one of the smallest members of the Raspberry Pi family but still packs a LOT of features including WiFi, Bluetooth, mini-HDMI, a micro-USB port and a camera connector.

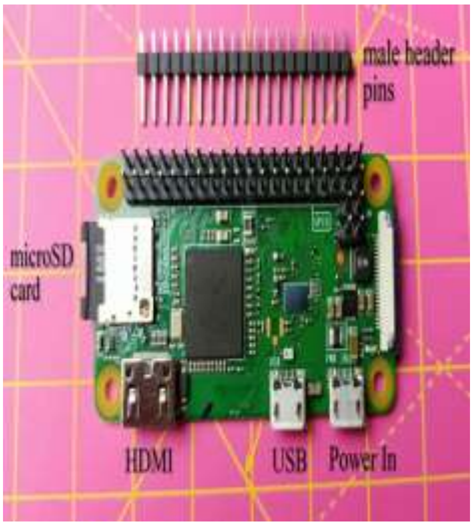


**Fig 1 Raspberry Pi Zero W**

Raspberry Pi is nothing but a computer and it has ARM processor which is very powerful and light weight. It also has USB ports, Wi-Fi modules (Raspberry Pi 3 Model B), HDMI port and Ethernet Port. Raspberry Pi has its own OS like Raspbian, Ubuntu MATE, Snappy Ubuntu, Pidora, Linutop, SARPi, Arch Linux ARM, Gentoo Linux, Free BSD, Kali Linux, RISC OS Pi [18]. It is like small computer it has multimedia application support. It is because of HDMI and graphics support. But it has also some limitation it doesn't have Hard Disk Drive (HDD) or Solid State Drive (SSD) but we can put Micro SD card in it so we can boot the OS of Raspberry Pi.

**2.2 Soil/Moisture sensor**

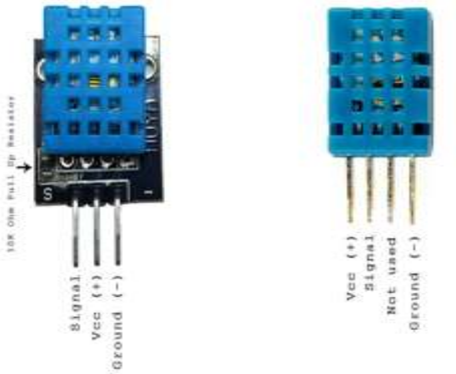


**Fig 2.Soil moisture sensor**

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.

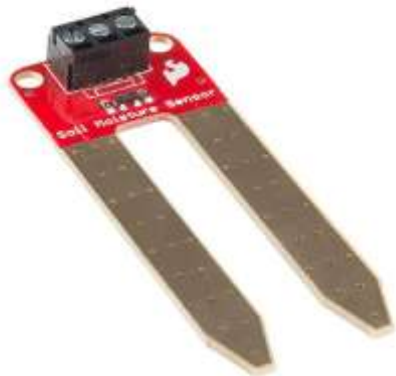


**Fig 3. soil-moisture-sensor-device**

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.

**Soil Moisture Sensor Applications**

The applications of moisture sensor include the following.

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

**2.3Temperature/Humidity Sensor (DHT11)**

**Fig .4 Temperature/Humidity Sensor (DHT11)**

The DHT11 humidity and temperature sensor makes it really easy to add humidity and temperature data to your DIY electronics projects. It's perfect for remote weather stations, home environmental control systems, and farm or garden monitoring system Here are the ranges and accuracy of the DHT11:

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

**The DHT11 Datasheet:**

The DHT11 measures *relative humidity*. Relative humidity is the amount of water vapor in air vs. the saturation point of water vapor in air. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew.

The saturation point changes with air temperature. Cold air can hold less water vapor before it becomes saturated, and hot air can hold more water vapor before it becomes saturated.

$$RH = \left(\frac{\rho_w}{\rho_s}\right) x\ 100\%$$

$RH$ : *Relative Humidity*
$\rho_w$ : *Density of water vapor*
$\rho_s$ : *Density of water vapor at saturation*

Relative humidity is expressed as a percentage. At 100% RH, condensation occurs, and at 0% RH, the air is completely dry.

The DHT11 detects water vapor by measuring the electrical resistance between two electrodes. The humidity sensing component is a moisture holding substrate with electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes, while lower relative humidity increases the resistance between the electrodes.

The DHT11 measures temperature with a surface mounted NTC temperature sensor (thermistor) built into the unit. To learn more about how thermistors work and how to use them on the Arduino, check out our

With the plastic housing removed, you can see the electrodes applied to the substrate:

**Fig 5. Front view with cover removed**

An IC mounted on the back of the unit converts the resistance measurement to relative humidity. It also stores the calibration coefficients, and controls the data signal transmission between the DHT11 and the Arduino:

**Fig 6. Rear view with cover removed**

The DHT11 uses just one signal wire to transmit data to the Arduino. Power comes from separate 5V and ground wires. A 10K Ohm pull-up resistor is needed between the signal line and 5V line to make sure the signal level stays high by default (see the datasheet for more info).

There are two different versions of the DHT11 you might come across. One type has four pins, and the other type has three pins and is mounted to a small PCB. The PCB mounted version is nice because it includes a surface mounted 10K Ohm pull up resistor for the signal line.

**FLAME DETECTION SENSOR**

**Fig 7 FLAME DETECTION SENSOR**

Flame detection sensor is used to detect flame and also responds accordingly. It used for detecting fire. To detect fire there two more sensor is there heat detector sensor and smoke detector sensor. After detection of fire, responding is depends on the how installation is done. For ex. Some installation have alarm or buzzer to notify user, if it is implemented in fuel line then it is deactivating it. A device which can detect a fire, and provide a signal to an alarm circuit. Fire detectors can be operated by smoke, flames, and heat, or any combination of these factors. Flame detectors are rarely used on board ships these days. Heat detectors are used in places such as the galley and laundry. Smoke detectors are used in machinery spaces, accommodation areas and cargo holds.

Technology for fire detecting depends on the fire's location and nature. In this review, the application and implementation status of alarm systems, advantages of the latest technologies, as well as their limitations and shortcomings are explained. Over a period of time, numerous fire detecting technologies have evolved. Some of these methods are still in use today, while others are becoming obsolete. A brief timeline of the development of fire sensors is given in Figure3.5.2. The key five detecting methods, comprising heat, gas, flame, smoke, and graphene oxide (GO) based sensing, as well as other fire sensing technologies and current research, are explained in depth. In fire detection based on heat sensing, most current fire detection systems use electronic and distributed optical thermal detectors based on thermistors. Thermal sensing based on infrared is a helpful technique, especially appropriate for thermal detection of the targeted location.

Compared with non-visual methods, visual approaches for smoke and flame detecting are attracting research focus because of their rapid response time and low imprecision output rate. The great algorithmic capability of existing digital systems has opened up new research prospects for deep learning of complicated neural network-based technologies. Among different gas sensing technologies, gas sensors based on semiconductor metal oxides have been useful in practice due to their great sensibility, small size and reduced cost. However, they have problems with stability, which require more study to resolve.

Currently, research is also underway in the field of carbon nanotube-based gas sensing for fire detection. Microwave radiometer-based fire sensing is one of the most important contemporary approaches due to its key benefit of fire detection across barriers such as walls. For fire detection, the multi-sensor fusion method based on wireless sensor networks (WSNs) and the Internet of Things (IoT) is suitable. The new emerging technique of graphene oxide (GO) based sensing has shown an outstanding short response time. Given the combustible materials, the property of fire-resistant and fire sensing can certainly reduce fire incidents, but further work still has to be done for its practical implementation. These current fire sensing techniques are illustrated in Figure 3.5.3.

**2.4 LDR**

**Fig 8. Light Dependent Resistor**

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase in the intensity of light. It is often used as a light sensor, light meter, Automatic street light, and in areas where we need to have light sensitivity. It is also called a Light Sensor.

LDR are usually available in 5mm, 8mm, 12mm, and 25mm dimensions.

The Light-dependent resistors made with photosensitive semiconductor materials like Cadmium Sulphides (CdS), lead sulfide, lead selenide, indium antimonide, or cadmium selenide and they are placed in a Zig-Zag shape as you can see in the pic below. Two metal contacts are placed on both ends of the Zig-Zag shape these metal contacts help in creating a connection with the LDRs.

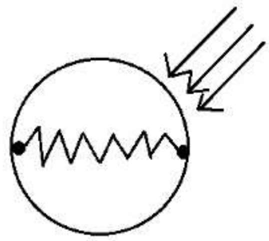

**Fig 9 LDR Symbol**

Now, a transparent coating is applied on the top so that the zig-zag-shaped photosensitive material gets protected and as the coating is transparent the LDR will be able to capture light from the outer environment for its working.

**2.5 BUZZER**

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

The **pin configuration of the buzzer** is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-'symbol or short terminal and it is connected to the GND terminal.


**Fig 10.Buzzer Pin Configuration**

**2.6 LED**

Light-emitting diode (LED) is a widely used standard source of light in electrical equipment. It has a wide range of applications ranging from your mobile phone to large advertising billboards. They mostly find applications in devices that show the time and display different types of data.

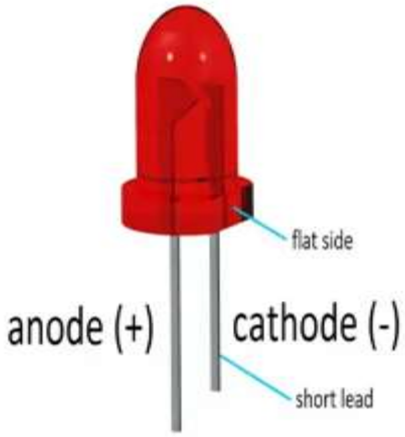


**Fig 11 Light-emitting diode**

A light-emitting diode (LED) is a semiconductor device that emits light when an electric current flows through it. When current passes through an LED, the electrons recombine with holes emitting light in the process. LEDs allow the current to flow in the forward direction and blocks the current in the reverse direction.

Light-emitting diodes are heavily doped p-n junctions. Based on the semiconductor material used and the amount of doping, an LED will emit coloured light at a particular spectral wavelength when forward biased. As shown in the figure, an LED is encapsulated with a transparent cover so that emitted light can come out.

**Fig 12 Symbol of Light Emitting Diode**

**2.7 BATTERY**

A **battery** is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells; however, the usage has evolved to include devices composed of a single cell.

A battery is a device that stores energy and then discharges it by converting chemical energy into electricity. Typical batteries most often produce electricity by chemical means through the use of one or more electrochemical cells. Many different materials can and have been used in batteries, but the common battery types are alkaline, lithium-ion, lithium-polymer, and nickel-metal hydride. Batteries can be connected to each other in a series circuit or a parallel circuit.

There is a wide variety of batteries that are available for purchase, and these different types of batteries are used in different devices. Large batteries are used to start cars, while much smaller batteries can power hearing aids. Overall, batteries are extremely important in everyday life.

Primary (single-use or "disposable") batteries are used once and discarded, as the electrode materials are irreversibly changed during discharge; a common example is the alkaline battery used for flashlights and a multitude of portable electronic devices. Secondary (rechargeable) batteries can be discharged and recharged multiple times using an applied electric current; the original composition of the electrodes can be restored by reverse current. Examples include the lead–acid batteries used in vehicles and lithium-ion batteries used for portable electronics such as laptops and mobile phones.


**Fig 13. Battery**

**2.8 DC Cooling Fan**

Raspberry Pi single-board computers, especially Pi 4 models, can get quite hot. While passive cooling options are often good enough to avoid overheating and thermal throttling, at some point you'll need to think about using a cooling fan. The Raspberry Pi's GPIO pins don't supply enough current to power even a small fan, but there are several ways to power and control a fan with the Pi.

To run a simple 2-wire fan continuously, connect it to the 5V and ground pins, or you can instead hook it up to 3.3V for lower speed and noise. Either is slightly wasteful power-wise, and potentially annoying.

**Fig 14 DC Cooling Fan**

## III. WORKING OF SMART IRRIGATION SYSTEM

**3.1 SYSTEM DESIGN**

Figure 4.1 shows hardware part of project. Here we will be considering connections in our project. Here Raspberry pi is the controller of the project. Here we have two comparator circuits which are connected to the soil moisture sensors. Relay is connected to ON/OFF of the system. LDR is used for automatic control of light.

This project requires three different sensors which consists of soil moisture sensor , temperature and humidity sensor , and flame detecting sensor. These sensors are connected to Raspberry Pi for machine learning process and send the data gathered from the sensors to firebase database. Finally, the data from the database will be given to user to monitor the process.

As Raspberry Pi has only digital pin, we can only detect 0 or 1 means HIGH or LOW signal from sensor. So when a High signal is encountered on Pi pin 8, it means there is no moisture in the soil. It is so because soil moisture sensor works on inverting output circuit op-amp. Using this circuit reverses the output on the digital data pin of soil moisture sensor.

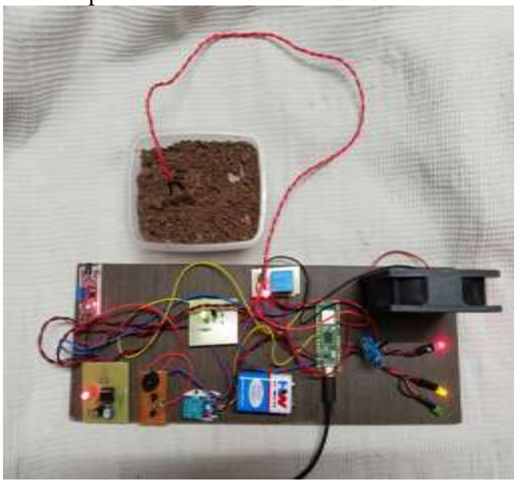

**Fig 15 Smart Irrigation system kit**

**3.2 WORKING PRINCIPLE**

Raspberry Pi is the heart of the overall existing system. The Raspberry Pi Model Zero W incorporates a number of enhancements and new features. Improved power consumption, enlarged connectivity and greater IO are among the improvements to this powerful, small and lightweight GPIO(General Purpose Input Output) pins. The Raspberry Pi cannot directly drive the relay. It has only zero volts or 3.3 V. We need 12V to drive electromechanical relay. In that case we need a driver circuit .The driver circuit takes the low level input and gives the 12V amplitude to drive the relay which operates at 12V .We are using here 2 relay to switch on Water motor , sprinkler. Soil moisture sensor, humidity sensor, temperature detection sensor are connected to Raspberry Pi board through comparator circuit.

Soil moisture sensor gives a resistance variation at the output. That signal is applied to the comparator and signal conditioning circuit. The signal conditioning circuit (LDR) has potentiometer to make a decision the moisture level above which the output of comparator goes high. That digital signal is given to the raspberry pi board. If the soil moisture value is above the moisture level and humidity is high at the given value and also if the temperature is high then the water motor will be on, whereas if the moisture level, humidity, temperature is low the motor will be off through the relay.LDR is used for controlling light automatically, at night light will be ON automatically so that we can observe our farm at night also using mobile phones. The android app will have a GUI which will show all the data to user. The modes as specified can be selected by the user on the app itself.

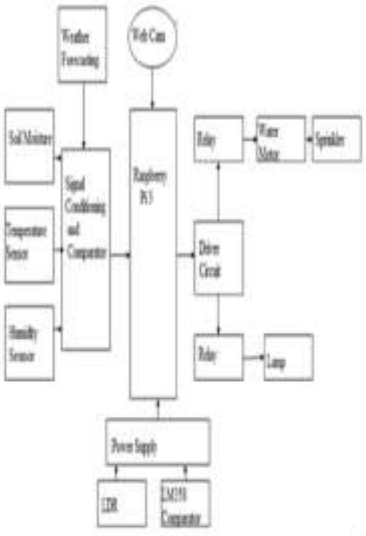


**Fig 16. Block diagram**

**3.3 METHODOLOGY**

In this system, we used raspberry pi, soil moisture sensor, flame detection sensor,LDR, buzzer and servo motor. Raspberry pi is a heart of the system i.e. main controller of the system. In this system we used raspberry pi which has number of new feature. It has improved IO, also increased connectivity as compare to older version of pi. Soil moisture is directly connected to raspberry pi. Now when sensor sense data, it will transfer that data to raspberry pi.

Raspberry pi reacting as per data received from soil moisture sensor. If soil is dry i.e. sensor isn't detecting moisture it will sends message to farmer's registered mobile number and registered email address and also glowing LEDs and start the motor. Flame detection is used for detect fire in a farm. Flame detection sensor takes data from field and send it to raspberry pi. Now if fire is there we will send message to farmer's registered mobile number and registered email address. Simultaneously we blow up buzzer. With ultra-sonic sensor we are measuring water level in well. Now for measure water level in well, we will take depth of and radius of well from farmers. Now with ultra-sonic sensor we will measure the current water level in the well and calculate water level from the bottom of the well and also calculate how much water is there in well. After that we will send it to farmer's registered mobile number and registered email address.

**IV. RESULTS**

**4.1 SMART IRRIGATION SYSTEM KIT**

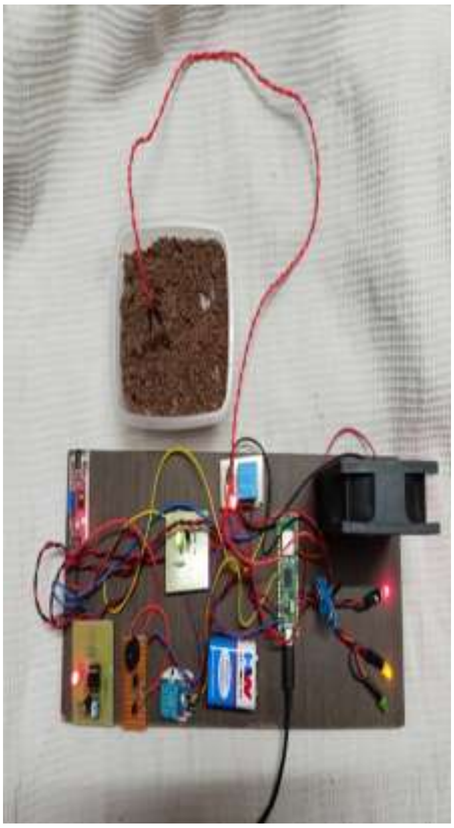

**Fig 17 Smart Irrigation system Kit**

**4.2 IP ADDRESS OF PROGRAM**

**Fig 18 IP address of the program**

**4.3 OUTPUT OF PROGRAM SHOWING HUMIDITY**

**Fig 19 Humidity Output**

**4.4 OUTPUT OF PROGRAM SHOWING TEMPERATURE**

**Fig 20.Temperature output**

**4.5 LDR OUTPUT**

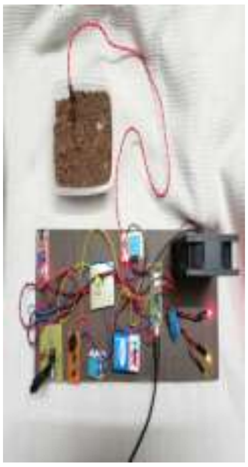

**Fig 21 LDR output**

**4.6 FIRE SENSOR OUTPUT**

Fig 22 Fire sensor output

**4.7 Advantages of smart irrigation system using raspberry pi**

There are several advantages of using a smart irrigation system with Raspberry Pi:

1. Water conservation
2. Cost savings
3. Automaion and convinience
4. Improved plant health and growth
5. Scalability and flexibility
6. Data driven insights
7. Environmental sustainability
8. Integration with other systems

**4.8 Disadvantages of smart irrigation system using raspberry pi**

While smart irrigation systems using Raspberry Pi offer numerous advantages, there are a few potential disadvantages to consider:

**Complexity and technical expertise**: Setting up and configuring a smart irrigation system with Raspberry Pi may require some technical knowledge and skills. Users need to be familiar with programming, hardware setup, and troubleshooting to ensure the system functions properly. This complexity can be a barrier for individuals with limited technical expertise.

**Initial cost**: Implementing a smart irrigation system with Raspberry Pi can involve upfront costs for the hardware components, such as Raspberry Pi boards, sensors, valves, and actuators. While the long-term savings in water and maintenance costs can offset these expenses, the initial investment might be a deterrent for some users.

**Reliance on electricity and connectivity**: Smart irrigation systems powered by Raspberry Pi rely on a continuous supply of electricity to function. In the event of a power outage or disruption, the system may temporarily stop working, potentially affecting irrigation schedules. Additionally, a stable internet connection is required for remote monitoring and control, so any connectivity issues could impact system functionality.

**4.9 Applications of smart irrigation system using raspberry pi**

Smart irrigation systems using Raspberry Pi have a wide range of applications across various sectors. Here are some notable examples:

**Residential gardens and landscapes**: Smart irrigation systems can be implemented in residential settings to automate and optimize watering for gardens, lawns, and landscapes. Raspberry Pi-based systems can adjust watering schedules based on weather conditions, soil moisture levels, and plant water requirements, ensuring efficient water usage and maintaining healthy vegetation.

**Commercial landscaping**: Businesses, parks, golf courses, and other commercial landscaping projects can benefit from smart irrigation systems. Raspberry Pi enables precise control and monitoring of irrigation across large areas, reducing water waste, and maintainingvisually appealing landscapes.

**Agriculture and farming**: Smart irrigation systems using Raspberry Pi have significant applications in agriculture. By integrating sensors, weather data, and crop-specific requirements, these systems can deliver water directly to plant roots based on real-time needs. This improves water efficiency, crop yield, and reduces manual labor in irrigating vast agricultural fields.

**CONCLUSION**

A notable breakthrough in agricultural water management is the creation of a smart irrigation system using a Raspberry Pi. This system automates irrigation based on weather and real-time data from soil moisture sensors, addressing the critical requirement for effective use of water in agriculture. The system may optimize water consumption and save waste by using the Raspberry Pi's processing capability to make intelligent judgments about when and how much to irrigate.

The system's usefulness is further improved by the incorporation of IoT technology, which enables farmers to remotely monitor and manage the irrigation process via an intuitive smartphone app or online interface. In addition to being convenient, this remote access gives farmers the ability to react swiftly to changing environmental circumstances and guarantee that crops get the exact quantity of water they need. The system's efficacy in solving environmental and economic concerns is shown by its capacity to preserve or even increase agricultural yields while conserving water.

Additionally, by reducing the need for human labor, the smart irrigation system lowers operating costs and boosts efficiency. It is appropriate for a range of agricultural uses, from tiny gardens to huge farms, because to its scalability and versatility. The system's ability to save a significant amount of water, supporting long-term food security and sustainable farming methods, is confirmed by the trial findings.

In conclusion, the Raspberry Pi smart irrigation system provides a useful and creative response to contemporary agricultural problems. This solution saves a vital resource and increases agricultural output by integrating automation, real-time data analysis, and IoT connection. Such intelligent irrigation systems will be essential to maintaining sustainable and effective water management in agriculture, since water shortage remains a major worldwide concern.

**8.2 FUTURE SCOPE**

This method has an enormous amount of future potential. It is understandable in a variety of ways. Adding a camera module to it is one method. The camera module takes a photo and uploads it to a website or sends it via mail when the flame sensor detects fire. And gather user feedback on whether or not there is a fire; if so, send a message to the fire bridge. An other method is to connect several kinds of sensors, such as temperature, humidity, and nutrient measurement sensors, to provide additional soil data.

Another option is to connect the water pump to the system so that the motor will start atomically when the moisture level drops. Understanding how the environment affects such a system is essential for this kind of real-world Internet of things farm application. Thus, it is usually preferable to be aware of the hazards in advance.

The technique of giving agricultural land the appropriate quantity of water is called irrigation. This procedure is quite advantageous for the production of croup since it reduces runoffs and drought conditions. Farmers are unable to depend on precipitation from the rain due to concerning climatic shifts.For high-quality crops to be produced throughout the seasonable or non-seasonable time, irrigation is essential.One of the greatest methods for increasing productivity in the shortest amount of time in contemporary agriculture is the use of intelligent irrigation systems. This intelligent irrigation system is mostly automated and meant to reduce the amount of physical labor in agriculture.

Additionally, one benefit is that users' (or farmers') understanding of the idea of IoT and sensors for smart irrigation is rather comfortable.You may use it to gain knowledge about how different sensors can be used, how to use their data to create events, and how to operate irrigation systems.

The following is a list of the few built-in parts of the smart irrigation system: soil moisture sensor, soil temperature sensor, fire sensor, cooling fan, relay, and LDR.

Each part of the automated irrigation system has a distinct function. A switch, relay, actuator, battery, buzzer, 10 DIN socket, voltmeter, ammeter, software, interface software modules (such as USB, Wi-Fi, Zigbee), etc. are also necessary technical components. We can improve our project by employing a sensor to record the pH of the soil, which will allow us to use less fertilizers than we now use. To determine the quantity of water used for irrigation and therefore provide a cost estimate, a water meter may be placed. Additionally, it lowers farmers' investments.

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