Indian Journal of Electronics and Communication Engineering (INDJECE)
Volume 2, Issue 1 (January- April 2025), PP: 13-20.
https://fdrpjournals.org/indjece
ISSN NO: 3048-6408

An Intelligent Irrigation Control System Using IoT

Md Khaja Pasha[1], Mohammed Baqtiar Hussain[2], Mohd Abdul Quddoos[3], Md Faisal[4], Samaleti Ajay[5]

[1]Assistant professor, Department of Electronics and Communication Engineering, Lords Institute of Engineering and Technology, Hyderabad, Telangana, India.
[2,3,4,5]Students, Department of Electronics and Communication Engineering, Lords Institute of Engineering and Technology, Hyderabad, Telangana, India.

To Cite this Article: *Md Khaja Pasha[1], Mohammed Baqtiar Hussain[2], Mohd Abdul Quddoos[3], Md Faisal[4], Samaleti Ajay[5] "An Intelligent Irrigation Control System Using IoT", Indian Journal of Electronics and Communication Engineering, Volume 02, Issue 01, January-April 2025, PP: 13-20.*

Abstract: *An adequate water supply is important for plant growth. When rainfall is not sufficient, the plants must receive additional water from irrigation. Irrigation is the artificial application of water toland to assist in the production of crops. The success of irrigation depends on the selection of the most proper irrigation method as per the conditions and planning, projecting and establishing. A good knowledge of soil moisture can lead to higher yields, better quality crops. Here we are goingto develop an intelligent irrigation control using moisture sensor.*

The proposed system consists of a network of sensors and actuators that collect data on soil moisture, temperature, humidity, and weather conditions. This data is transmitted to a central control unit that uses algorithms to make decisions about when and how much water to be irrigated. The system is designed to be energy-efficient and cost effective, using a regular power source to operate. The system provides several benefits over traditional irrigation systems. It reduces water wastage and conserves water resources, resulting in improved crop yields and reduced costs. The system is easy to install, operate, and maintain, and can be customized to suit specific crops and soil types.

Overall, the proposed IoT-based smart irrigation system is a significant improvement over traditional irrigation systems, providing a sustainable and efficient solution for agriculture. The system's scalability, energy efficiency, and customizability make it a viable option for farmers looking to adopt new technology to improve their irrigation systems. First it reduce water wastage and conserves water resources by only irrigating when needed. This, in turn, results in improved crop yields and reduced costs. Second, the system is easy to install, operate, and maintain.

I.INTRODUCTION

Agriculture is the unquestionably the largest livelihood provider in India. With rising population, there is a need for increased agricultural production. In order to support greater production in farms, the requirement of the amount of fresh water used in irrigation also rises. Currently, agriculture accounts 83% of the total water consumption in India. Unplanned use of water inadvertently results in wastage of water. This suggests that there is an urgent need to developsystems that prevent water wastage without imposing pressure on the farmers. Over the past 15 years, farmers started using computers and software systems to organize their financial data and keep track of their transactions with third parties and also monitor their crops more effectively.

In the Internet era, where information plays a key role in people's lives, agriculture is rapidly becoming a very data intensive industry where farmers need to collect and evaluate a huge amount of information from a diverse number of devices (eg., sensors, faming machinery etc.) in order to become more efficient in production and communicating appropriate information, it is viable to create devices that can monitor the soil moisture content and accordingly irrigating the fields or the landscape as an when needed.

Plants not only add a natural beauty to our surroundings but also provide us with oxygen, which is essential for our survival. However, maintaining healthy plants requires proper care, including providing them with adequate water, sunlight, and nutrients. While plants require low maintenance, taking care of them becomes challenging when we are away from our homes for extended periods. In such scenarios, plants may wither, die or become susceptible to diseases due to the lack of proper watering. To address this issue, we propose an automatic irrigation system thatcan water plants automatically and maintain their health, even when we are not around.

II.LITERATURE REVIEW

IoT Based Smart Irrigation System, Srishti Rawal (2017)

A system to monitor moisture levels in the soil was designed and the project provided an opportunity to study the existing systems, along with their features and drawbacks. The proposed system can be used to switch on/off the water sprinkler according to soil moisture levels thereby automating the process of irrigation. Information from the sensors is regularly updated on a webpage using GSM-GPRS SIM900A modem through which a farmer can check whether the water sprinklers are ON/OFF at any given time. Also, the sensor readings are transmitted to a Thing speakchannel to generate graphs for analysis.

Arduino Based Smart Irrigation System Using Iot, R.Nandhini, S.Poovizhi, Priyanka Jose, R.Ranjitha, Dr. S.Anila (2017):

The main objective of this smart irrigation system is to make it more innovative, user friendly, time saving and more efficient than the existing system. Measuring four param- eters such as soil moisture, temperature, humidity and pH values and the system also includes intruder detecting system. Due to server updates farmer can know about crop field nature at anytime, anywhere.

Smart Irrigation System, R. Suresh (2014):

This paper mentioned about using automatic micro controller based rain gun irrigation system in which the irrigation will take place only when there will be intense requirement of water that save a large quantity of water. These systems bring a change to management of field resource where they developed a software stack called Android is used for devices that include an operating system, middleware and key applications. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language. Mobile phones have almost become an integral part of us serving multiple needs of humans.

III.PROPOSED SYSTEM

Using this system it automatically pours the water to the dry land without the help of farmers. Here we use moisture sensor to identify the moisture level of soil. The sensor detail is given to the LM358 comparator. The comparator compares the given input to the reference input and produces some voltage variations. This voltage variation is then given to the microcontrollerunit and it controls the relay according to the given input. If the land gets dry means the controller switch ON the motor to spread the water throughout the land, otherwise it is in the OFF state. The relays are used to drive the motor. LCD display used here is to indicate the moisture level of the soilcontinuously. The soil moisture sensor senses the amount of moisture content in the soil. The controller board transfers the control over the system to the relay module which is responsible for switching operations. The relay module ensures proper irrigation of the field turning it on when the value of moisture is below the threshold value and turns off the supply when the moisture content is sufficient for the crop or plant thereby preventing under irrigation or over irrigation. The state of therelay module is indicated by the LED.

The proposed system also incorporates additional features such as the use of a rain sensor and ultrasonic sensor to prevent overwatering and protect plants from animals. These features enhance the efficiency and effectiveness of the system, promoting optimal plant growth and yield. Overall, the proposed IoT-based smart irrigation system is an excellent example of how technology can be used to address real-world problems and promote sustainability in agriculture

Block Diagram:

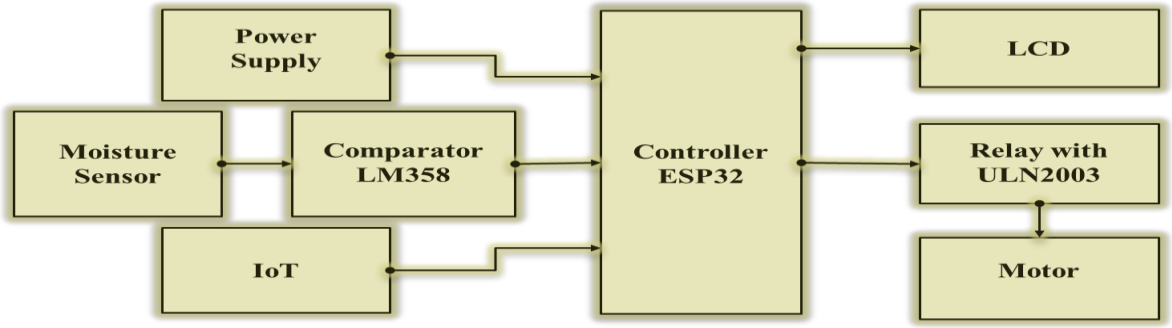

Fig 1-Block diagram of Intelligent Irrigation Control System Using IoT

Hardware Components:

Power Supply:

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connectedto a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

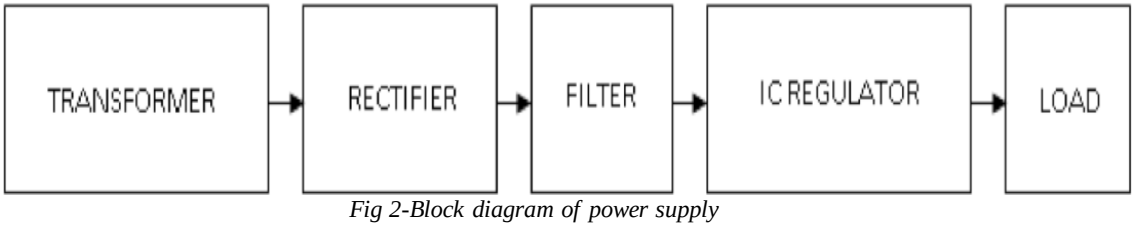

Fig 2-Block diagram of power supply

Transformer:

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-uptransformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

Rectifier:

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.

Voltage Regulators:

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

ESP32 Module:

The ESP32 module is a low-cost, low-power system-on-chip (SoC) microcontroller with integrated Wi-Fi and Bluetooth capabilities. It is manufactured by Espressif Systems, and is designed for use in a variety of applications, including Internet of Things (IoT) devices, wearable electronics, and other embedded systems. The ESP32 module features dual-core processors running at up to 240 MHz, as well as a variety of built-in peripherals, including touch sensors, analog-to- digital converters, and pulse width modulation (PWM) controllers. It also includes support for a wide range of communication protocols, including Fi, Bluetooth, and Ethernet.

The ESP32 is a powerful microcontroller that has gained immense popularity due to its versatile features and low cost. One of the most crucial aspects of the ESP32 is its pins. There are a total of 38 pins on the ESP32, and they are divided into various categories such as power pins, ground pins, GPIO pins, ADC pins, DAC pins, and many more.

Moisture Sensor:

This Soil Moisture Sensor Module can be used to detect the moisture of soil or judge if there is water around the sensor, let the plants in your garden reach out for human help. Insert this module into the soil and then adjust the on-board potentiometer to adjust the sensitivity

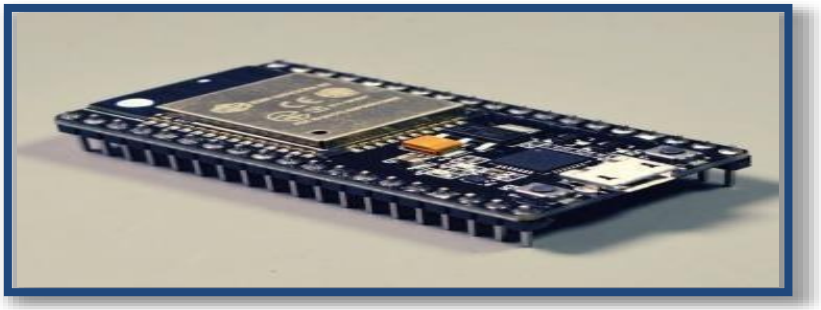

Fig 3-ESP32 Module

The sensor would outputs logic HIGH/LOW when the moisture is higher/lower than the threshold set by the potentiometer. With help of this sensor, it will be realizable to make the plant remind you : Hey, I am thirsty now, please give me some water.

Soil moisture sensors measure the volumetric water content in soil.[1] Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample,soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential;

Fig 4- Moisture Sensor

Relay ULN2003:

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

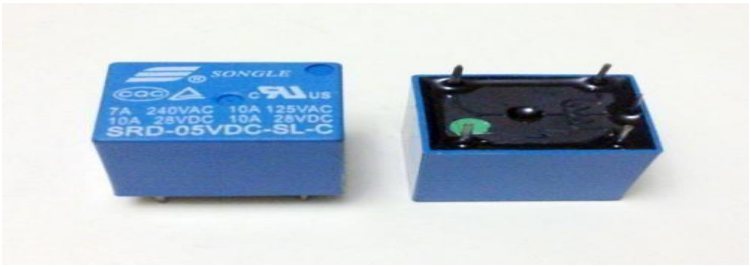

Fig 5- RelayULN2003

Working of relay:

Generally, the relay consists a inductor coil, a spring (not shown in the figure), Swing terminal, and two high power contacts named as normally closed (NC) and normally opened (NO). Relay uses an Electromagnet to move swing terminal between two contacts (NO and NC). When there is no power applied to the inductor coil (Relay is OFF), the spring holds the swing terminal is attached to NC contact.

Whenever required power is applied to the inductor coil, the current flowing through the coilgenerates a magnetic field which is helpful to move the swing terminal and attached it to the normally open (NO) contact. Again when power is OFF, the spring restores the swing terminal position to NC.

Comparator LM358:

The LM358 series consists of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply overa wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

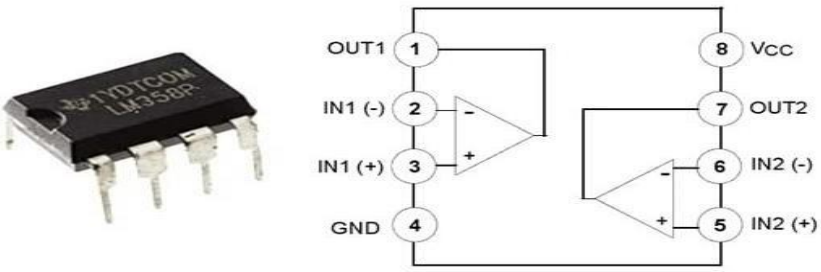

Fig 6- Comparator LM358

LCD Display:

The most commonly used Character based LCDs are based on Hitachi HD44780 controlleror other which are compatible with HD44580. In this tutorial, we will discuss about character based LCDs, their interfacing with various microcontrollers, various interfaces (8-bit/4-bit), programming,special stuff and tricks you can do with these simple looking LCDs which can give a new look to your application.

An LCD screen is an electronic display module that uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates a display of 16 characters per line in 2 such lines. In this LCD, each character is displayed in a 5×7 pixel matrix.

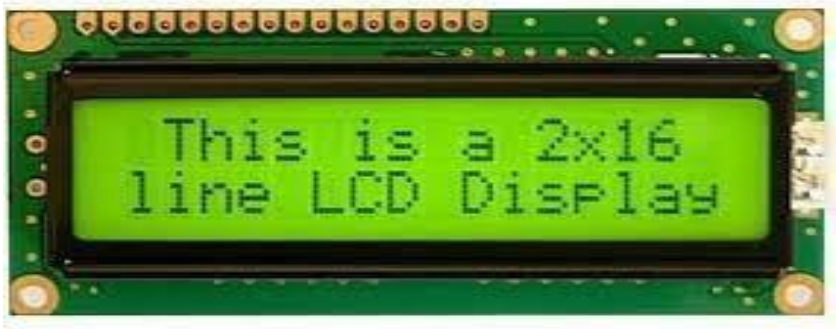

Fig 7- LCD Display

Table 1-Pin Description of LCD.

Pin No	Symbol	Level	Description
1	Vss	0 V	Ground
2	V_{DD}	5.0V	Supply voltage for logic
3	V o	variable	Operating voltagefor LCD
4	RS	H/L	H data/L instruction code
5	R/W	H/L	H/Read (MPU-module) L/write (MPU-module)
6	E	H, H-L	Chip enable signal
7	DB0	H/L	Data bit 0
8	DB1	H/L	Data bit 1
9	DB2	H/L	Data bit 2
10	DB3	H/L	Data bit 3
11	DB4	H/L	Data bit 4
12	DB5	H/L	Data bit 5
13	DB6	H/L	Data bit 6
14	DB 7	H/L	Data bit 7
15	A		Power supply for LED backlight (+)
16	K		Power supply for LED backlight (-)

Motor (Pump):

A pump is a device that moves fluids (liquids and gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers and other components of heating, ventilation and air conditioning systems. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis. When a pump contains two or more pump mechanisms with fluid being directed to flow through them in series, it is called a multi-stage pump.

Working of Motor Pump:

A water pump, specifically a submersible water pump used to extract water from the ground,operates on the principle of hydrodynamics. The main components of a submersible water pump arean electric motor, an impeller, and a housing.

The electric motor is designed to rotate the impeller, which is a series of vanes or blades arranged in a circular pattern. As the impeller spins, it creates a low-pressure zone at the center, drawing water into the pump. The impeller then forces the water outward through the pump's discharge port, creating a high-pressure zone.

This pressure differential, generated by the rotating impeller, is the driving force that lifts thewater from the ground and pushes it up through the discharge pipe. The housing of the pump is designed to efficiently channel the water flow and direct it towards the discharge outlet.

Fig 8-Motor Pump

IV.RESULT

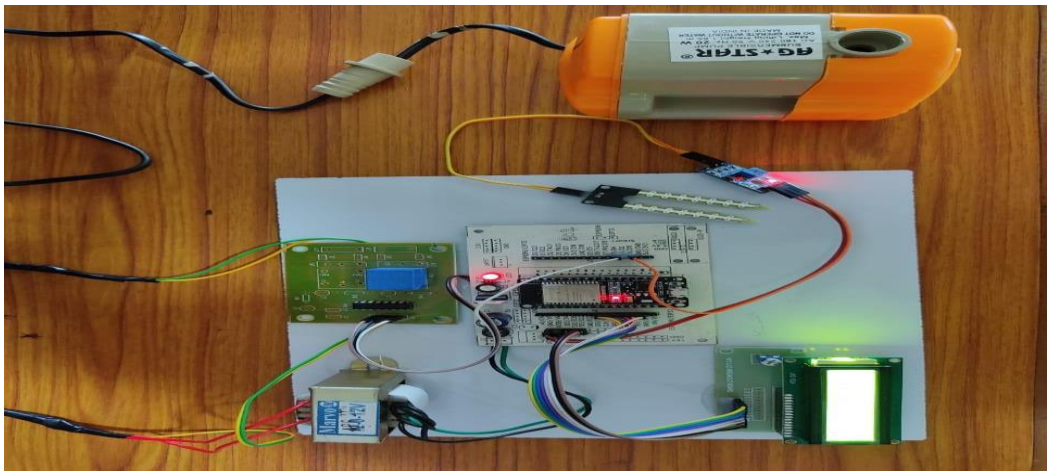

Fig 9-Hardware Kit

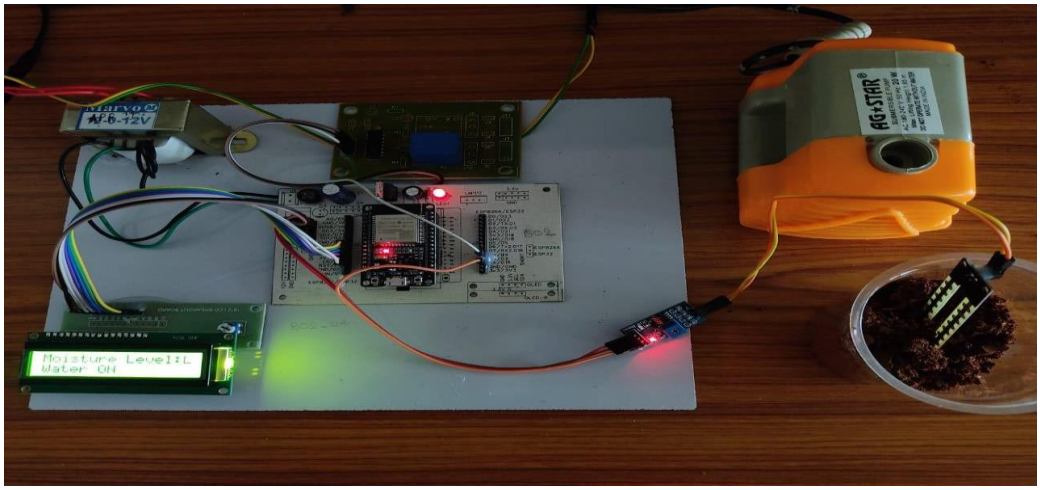

Fig 10-Power Supply to Haedware Kit

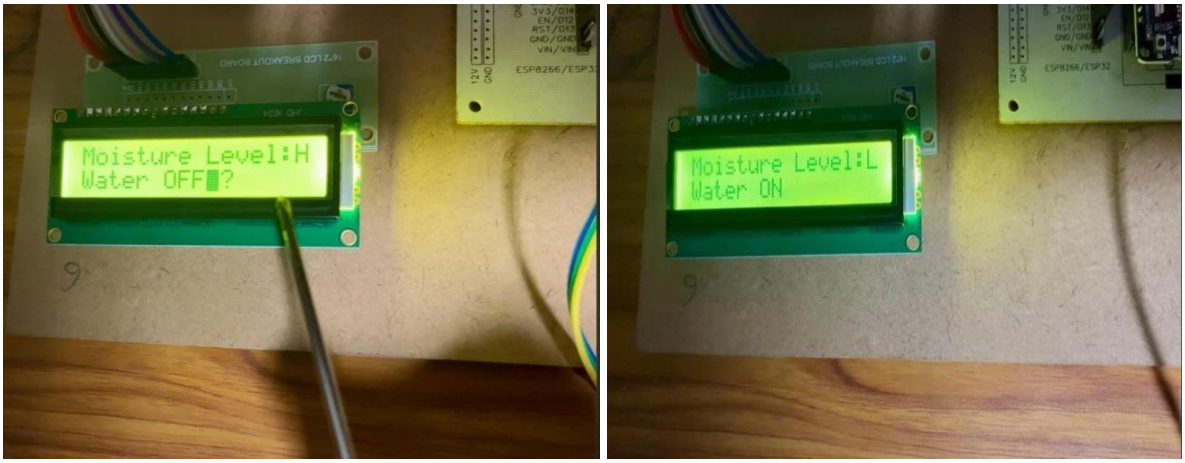

Fig 11-Output Displayed in LCD

Result:

The successful implementation of the An Intelligent Irrigation Control System Using Moisture Sensor and ESP32.

Yielded the following results:

Automatic Irrigation Control:

The system automatically controlled the water pump based on the soil moisture level detected by the moisture sensor. Users did not need to manually water the plants, as the system ensured the soil was adequately moist.

LCD Display for Real-Time Monitoring:

The LCD display provided real-time information on soil moisture levels, showing the current status of the soil's moisture content and system status. This feature allowed users to visually monitor the soil moisture without needing to access the control unit.

Stable System Operation:

The ESP32 maintained stable operation, ensuring continuous monitoring and control of the irrigation system without interruptions.

Effective Data Processing:

The ESP32 efficiently processed sensor data and executed control commands in real-time, turning the pump on or off based on soil moisture levels.

Reliable Relay Switching:

The relay unit reliably switched the water pump on and off, ensuring that the irrigation system responded correctly to the moisture sensor's signals.

User-Friendly Interface:

The LCD display and simple control logic made the system easy to use and understand, evenfor individuals with minimal technical knowledge.

Successful Sensor Integration:

The moisture sensor and LM358 comparator were successfully integrated, providing accurate soil moisture readings that the ESP32 used to control the irrigation pump.

Scalability:

The system demonstrated scalability, with the potential to add more sensors or pumps without significant modifications to the core setup.

Low Power Consumption:

The system operated efficiently with low power consumption, primarily powered by a stable12V power supply, reducing energy usage and operational costs.

V.CONCLUSION

The project “AN INTELLIGENT IRRIGATION CONTROL SYSTEM UDING IOT” has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly u sing highly advanced IC’s and with the help of growing technology the project has been successfully implemented.

A system to monitor moisture levels in the soil was designed. The proposed system can be used to switch on/off the water supply (or) motor according to soil moisture levels thereby automat- ing the process of irrigation which is one of the most time consuming activities in farming. The system uses information from soil moisture sensors to irrigate soil which helps to prevent over irrigation or under irrigation of soil thereby avoiding crop damage. Through this project it can be concluded that there can be considerable development in farming with the use of IOT and automation. Thus, the system is a potential solution to the problems faced in the existing manual process of irrigation by enabling efficient utilization of water resources.

The proposed system also incorporates additional features such as the use of a rain sensor and ultrasonic sensor to prevent overwatering and protect plants from animals. These features enhance the efficiency and effectiveness of the system, promoting optimal plant growth and yield. Overall, the proposed IoT-based smart irrigation system is an excellent example of how technology can be used to address real-world problems and promote sustainability in agriculture.

REFERENCE

1. *International Journal of Recent Trends in Engineering & Research (IJRTER) Volume 03, Issue 03; March - 2017 [ISSN: 2455-1457]*
2. *J. Cong, M. Huang, and Y. Zou, "Accelerating Deep Neural Networks with Specialized Hardware," IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, vol. 37, no. 8, pp. 1510-1521, Aug. 2018. doi: 10.1109/TCAD.2018.2808810.*
3. *N. Domala and G. Sasikala. “Low power flipped voltage follower current mirror with improved input output impedances.”. Sadhana, 46:1–11, 2021. DOI: https://doi.org/10.1007/s10470-023-02205-4..*
4. *N. Jouppi et al., "In-Datacenter Performance Analysis of a Tensor Processing Unit," Proceedings of the 44th Annual International Symposium on Computer Architecture (ISCA), Toronto, ON, 2017, pp. 1-12. doi: 10.1145/3079856.3080246.*
5. *S. Han, H. Mao, and W. J. Dally, "Deep Compression: Compressing Deep Neural Networks with Pruning, Trained Quantization and Huffman Coding," International Conference on Learning Representations (ICLR), San Juan, Puerto Rico, May 2016. [Online]. Available: https://arxiv.org/abs/1510.00149.*
6. *D. Shin, J. Park, and M. Pedram, "A Power-Aware Neural Network Training System Using Dynamic Voltage Scaling," IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 25, no. 4, pp. 1153-1162, April 2017. doi: 10.1109/TVLSI.2016.2633988.*
7. *A. Krizhevsky, I. Sutskever, and G. E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks," Communications of the ACM, vol. 60, no. 6, pp. 84-90, 2017. doi: 10.1145/3065386.*

8. *N. Domala, G. Sasikala, and N. Raj.Low volt-age high bandwidth FVF current mirror using quasifloating self-cascode output stage.Analog In-teg. Circ. Signal Process,:1–13,2023 DOIhttps://doi.org/10.1007/s10470-023-02205-4*
9. *S. Liang, Y. Du, S. Song, and H. Shen, "Low-Power and High-Throughput VLSI Architecture for Neural Network Processing," IEEE Transactions on Signal Processing, vol. 68, pp. 2306-2316, May 2020. doi: 10.1109/TSP.2020.2974728.*
10. *C. Zhang et al., "Optimizing FPGA-Based Accelerator Design for Deep Convolutional Neural Networks," Proceedings of the 2015 ACM/SIGDA International Symposium on Field-Programmable Gate Arrays, Monterey, CA, USA, 2015, pp. 161-170. doi: 10.1145/2684746.2689060.*
11. *N. Domala and G. Sasikala.Low voltagequasi floating gate current mirror with im-proved output impedance.Int. J. Public Sec-tor Perform. Manag,10:499–512, 2022.DOI: 10.1504/IJPSPM.2022.126404*
12. *N. Raj, A.K. Singh, and A.K. Gupta. Low power highoutput impedance high bandwidth QFGMOS currentmirror.Microelectron. J,45:1132–1142, 2014. DOI https://doi.org/10.1016/j.mejo.2014.05.005*
13. *N.Domala, Gsasikala, A Low Input Impedance Wide Bandwidth Flipped Voltage Follower Current Mirror, Indian Journal of Engineering & Materials Sciences Vol. 30, August 2023, pp. 622-628 DOI: 10.56042/ijems.v30i4.365.*
14. *P. A. Kumar, S. Tamil, and N. Raj. "Low voltage improved impedance wide bandwidth current mirror.". International Journal of* Information *Technology, 13:2411–2417, 2021. DOI: https://doi.org/10.1007/s41870-021-00785-w.*