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AUTOMATED SMART SOIL IRRIGATION SYSTEM

SHERLEY SUZANE TREMOT

UG Student
Department of ECE
Manakula Vinayagar Institute of Technology
Pondicherry, India.

Abstract:
The main objective of our project is to keep the agriculturists at ease in continuously monitoring the process of irrigation. By making use of this process there is no need to continuously monitor whether the agricultural lands are being properly irrigated since this process will be done automatically by making use of the soil moisture sensor which enables the motor pump automatically set, to switch ON and OFF.

This helps the farmer to avoid unnecessary tension whether the fields are being irrigated, while he is in out of station. Since the process of watering the fields are done automatically there is no need for the agriculturists to stay on the spot till the watering process is over.

Keywords: Smart Irrigation, Water conservation, Precision agriculture, Soil moisture sensor, Agriculture automation, Remote irrigation control, Hardware irrigation system.

1. INTRODUCTION

The Automated Smart Soil Irrigation System has been designed with an idea of automatically irrigating lands without making use of Man Power for monitoring purpose. This system functions with a specially designed circuit which senses the moisture present in the soil and automatically irrigates the agricultural lands based on the requirements.

In normal condition it is a regular duty of a farmer or an agriculturist to monitor the soil condition whether it is wet or dry and irrigate the land by manually Switching ON the motor and Switch OFF the motor when the process of irrigation (watering) is completed.

Leaving the agriculture land to become dry without irrigation or over irrigating the land with excess amount of water damages both the corps and also results in wastage of water. The above mentioned act occurs frequently due to human carelessness.

The farmer was kept at a distress since he will not be in a position to move out of station because he was bound to irrigate and monitor the agricultural fields at regular intervals.

The Automated Smart Irrigation System has resulted as a solution to the above mentioned problems. This system can be prepared with low budget simple electrical and electronic components and has become more cost effective.

Keeping in mind the above mentioned aspects, the idea of designing an automated smart irrigation system has emerged.

2. LITERATURE REVIEW

a) Water Scarcity

"GROUNDWATER – THE LIFELINE OF THE NATION"

Water is indispensable for the survival of all living organisms. Without water, life on Earth would cease to exist. **Groundwater** refers to the water present beneath the Earth's surface in the pores, cracks, and spaces of soil, sand, and rocks. It is stored and slowly transmitted through geological formations known as **aquifers**. The scientific study of the occurrence, distribution, and movement of groundwater is known as **Hydrogeology**, also referred to as **Groundwater Hydrology**.

World Water Day is observed annually on **22nd March** to emphasize the importance of **freshwater resources** and to advocate for their sustainable management. Each year, the **United Nations Organization (UNO)** declares a specific theme to raise global awareness regarding water-related issues.

In India, **Dr. B. R. Ambedkar** played a pivotal role in the development of major multipurpose river valley projects such as the **Damodar Valley Project** and the **Hirakud Project**, which significantly contributed to the nation's water resource development. In recognition of his contributions, the **Government of India** has declared **14th April**, the birth anniversary of Dr. Ambedkar, as **Water Day** in the country.

Formation of Groundwater

Groundwater is primarily replenished through **rainfall and snowmelt**, which percolate down through the soil and rock layers beneath the Earth's surface. Groundwater can be found almost everywhere. Aquifers are generally composed of materials such as gravel, sand, sandstone, or fractured rocks like limestone. These materials are **permeable**, allowing water to move through interconnected pore spaces. The rate of groundwater movement depends on the size of these pores and the degree of their interconnection.

Potable (Drinking) Water

Potable water is defined as water that is **colourless, tasteless, odourless**, and free from **pathogenic organisms and harmful chemical substances**, making it safe and suitable for human consumption.

Uses of Groundwater

Groundwater plays a vital role in sustaining **human, plant, and animal life**. It is extensively used for **drinking, cooking, sanitation, and domestic purposes**. In addition, groundwater is indispensable for **agricultural irrigation and industrial applications**. In many regions, groundwater is accessed freely by people and animals. Where groundwater availability is limited, it is supplied by **municipal corporations and public works departments**. The government strives to ensure a **continuous and reliable water supply** throughout the year.

Extraction of Groundwater

Groundwater is extracted by drilling **wells** into aquifers. A well consists of a pipe inserted into the ground, which fills with groundwater. This water is brought to the surface using a **pump**. Shallow wells may dry up if the **water table** falls below the well depth. Some wells, known as **artesian wells**, do not require pumping, as natural underground pressure forces water to rise to the surface.

Shortage of Groundwater

According to the **World Health Organization (WHO)**, more than **663 million people worldwide** lack access to safe drinking water, and in India alone, approximately **97 million people** do not have access to an improved drinking water source. Regions that lack rivers, lakes, ponds, and sufficient rainfall often experience severe groundwater shortages. In such areas, the construction of **ponds and reservoirs for rainwater harvesting** is essential.

In several parts of the world, groundwater is being extracted at a rate faster than its natural recharge, leading to severe depletion. Additionally, groundwater pollution caused by human activities further aggravates the crisis.

Water Table

The **water table** represents the upper surface of groundwater and serves as a key indicator of groundwater availability. It may vary from shallow to deep levels and fluctuates due to factors such as rainfall, snowmelt, and groundwater extraction. Heavy rainfall raises the water table, while excessive pumping causes it to decline.

Groundwater Situation in India

In India, **overexploitation of groundwater** and **intensive irrigation practices** in major canal command areas have led to significant challenges. These include declining water tables, saltwater intrusion, drying of aquifers, groundwater pollution, waterlogging, and soil salinity.

Reports indicate that in many regions, groundwater levels are declining at a rate of **1–2 meters per year**, while in some canal command areas, water tables are rising by as much as **1 meter per year**, causing waterlogging. Deterioration of groundwater quality is another serious concern. For instance, increased **arsenic contamination** in shallow aquifers in parts of **West Bengal** has caused widespread alarm.

If these trends continue unchecked, India may face a **severe water crisis** in the near future. Although the Government of India has implemented various regulatory and protective measures, their effectiveness has been limited due to insufficient public awareness and inadequate political and administrative commitment.

Considering these challenges, the need for **water conservation** has become critical. This has led to the development of engineering-based solutions such as the **Automated Smart Soil Irrigation System**, which aims to minimize groundwater wastage and ensure sustainable agricultural practices.

b) Electricity Scarcity

“ELECTRICITY – THE ENERGY OF THE NATION”

Definition of Electricity

Electricity is defined as the **flow of electric charges** through a conductor. These charges move from one terminal to another, typically from the positive terminal to the negative terminal. Electrons move freely within a conductor as they are loosely bound to the atomic nucleus. Electricity is measured in units of **power called watts**, named after **James Watt**, the inventor of the steam engine. **Voltage** is the force that drives electrons through a conductor, while **current** represents the rate of electron flow. The SI unit of electric current is the **ampere (A)**.

Uses of Electricity

Electricity is widely used for **lighting, heating, cooling, refrigeration**, and for operating **household appliances, computers, electronic devices, industrial machinery**, and **public transportation systems**.

Sources of Electricity in India

Electric power in India is generated through two main categories:

1. **Conventional Energy Sources**
   - Thermal Power Plants
   - Nuclear Power Plants
2. **Renewable Energy Sources**
   - Wind Power
   - Solar Power
   - Hydropower

- Biomass Energy
- Geothermal Energy

Despite the growing contribution of renewable sources, approximately **75% of India's electricity generation** is still derived from **coal-based thermal power plants**.

Price index of Electricity in India for the period (2013-2022):-

Need for Conserving Electricity

The conservation of electricity is essential due to the **rapid depletion of non-renewable energy resources**. Conserving electricity helps reduce environmental pollution and mitigates the effects of **global warming**.

Energy conservation also plays a crucial role in reducing costs and ensuring the long-term availability of energy resources. Conventional energy sources emit harmful gases that degrade the environment, and their limited availability poses a serious threat to future generations. Therefore, it is our responsibility to conserve energy and protect the environment from further deterioration.

Moreover, electricity generation requires the import of fuels from other countries, which involves significant expenditure in foreign currency and negatively impacts the nation's **Gross Domestic Product (GDP)**. By reducing fuel imports through energy conservation, foreign exchange expenditure can be minimized, thereby strengthening the national economy. An increase in GDP leads to higher national and per-capita income, contributing to overall economic development. Hence, electricity conservation is vital for maintaining a **stable and sustainable Indian economy**.

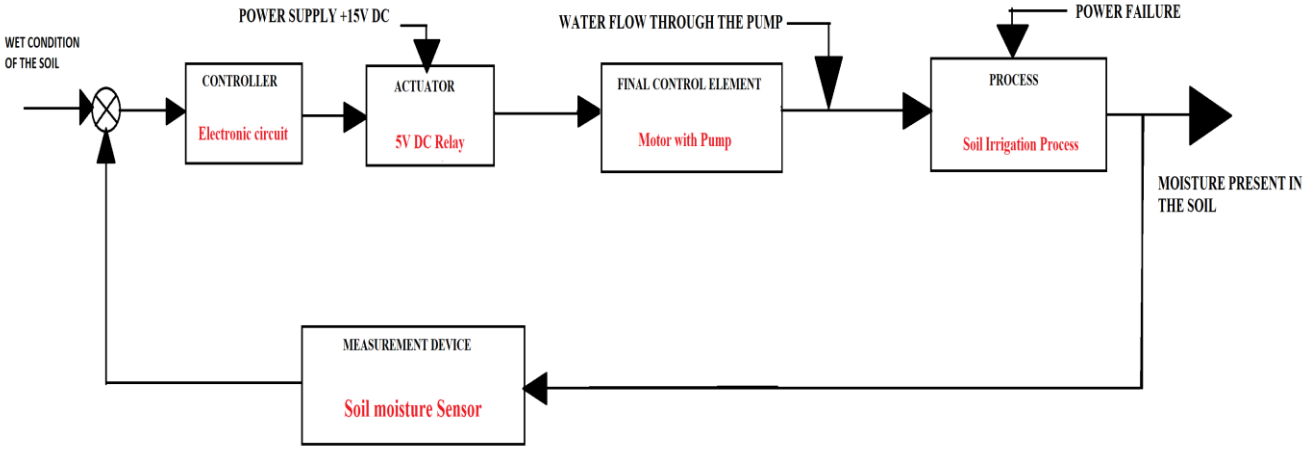
c) Aim of the Project

The primary aim of this project is to **design and develop a system for the conservation of both water and electricity**. The system focuses on the **efficient utilization of resources** while minimizing wastage. It also aims to reduce the **manual effort** involved in agricultural irrigation, particularly the need for switching motors ON and OFF manually.

The proposed system employs a **specially designed electronic circuit** that continuously monitors the **moisture content of the soil** and automatically irrigates agricultural fields based on actual water requirements. This intelligent approach ensures optimal water usage, energy efficiency, and sustainable agricultural practices.

3. SIMPLIFIED BLOCK DIAGRAM OF THE PROCESS

Fig 1: Simplified Block Diagram of the process



The figure shown above is the simplified block diagram of the process which is fitted in a closed loop block diagram.

Open loop control system is a system in which the control action is independent of the output. Any physical system which does not automatically correct the variations in its output is called as open loop system.

Nowadays, the soil irrigation process functions in a open loop manner. This project introduces the soil irrigation process as a closed loop system as shown in figure.

A closed loop control system is a mechanical or electronic device that automatically regulates a system to maintain a desired state or set point without human interaction. It uses a feedback element or sensor.

Closed loop control system is a system in which the control action is dependent on the output. The provision of feedback automatically corrects the changes in output due to disturbances. Hence the Closed loop system is also called as Feedback control system (or) Automatic control system.

The basic elements of a Feedback Control Loop are as follows:

a) Process
b) Measuring instruments
c) Controller
d) Final control element

a) Process:-
The material equipment (tanks, heat exchangers, reactors, separators, silos, etc.,) in which the physical or chemical reactions take place is known as a process.

b) Measuring Instruments:-
The measuring instruments are the device which measures the process variable. Appropriate measurement device must be selected for the measurement of process variables such as RTD (or) Thermistor for the measurement of temperature, Bourdon tube for the measurement of pressure, DPT (Differential Pressure Transmitter) for the measurement of differential pressure, Ultrasonic

transducer for the measurement of Level, Magnetic flow meter for the measurement of flow, Gas Chromatography for composition measurement and so on. The measurement device (or) measuring instrument can also be called as Sensors (or) transducers.

c) Controller:-
This is the unit with logic that decides, how much to change the value of the manipulated variable based on the deviation of controlled variable and set point.

d) Final Control Element:-
It is the device that receives the control signal from the controller and implements it by physically adjusting the value of the manipulated variable.

A feedback control action takes the following steps:-

i. Measures the value of output using appropriate measuring devices.
ii. Then compares the measured value indicated by the measurement device to desired set point value of the output.
iii. An error signal is applied to the controller. The controller modifies and amplifies the error signal to produce better control action. The controller in turn changes the value of manipulated variable in such a way to reduce the magnitude of deviation.
iv. Usually, the controller does not affect the manipulated variable directly but it affects through another device known as the final control element.
v. The manipulated variable is fed to the plant to correct its output.

In this Automated Smart Soil Irrigation System, the process is defined as Soil irrigation process. Hence the controlled variable is the moisture present in the soil. In this system, soil moisture sensor is used as the measurement device. Based on the moisture condition of the soil an error signal will be provided to the controller. The error detector (or) comparator produces the error signal to the controller. The error detector is an integral part of controller.

An electronic circuit consists of Transistor (2N2222A), a resistor and a +5V DC applied voltage acts as the controller of this automated smart soil irrigation system.
Based on the feedback signal the controller produces a control signal to the actuator. Here a 5V DC Relay acts as the actuator. The final control element requires more energy to operate.

So the control signal will not be sufficient for the operation of final control element. Hence the actuator is used. It boosts up the control signal and operates the final control element. In this system, the final control element is a 15V DC motor with pump.

When the soil is not wet, the motor will start running and the irrigation process will be done by the pump. Therefore the manipulated variable is the water flowing through the pump. And the disturbance that affects the process is Power Failure. In case of power failure the entire process will stop functioning.

Advantages of an Automated System:

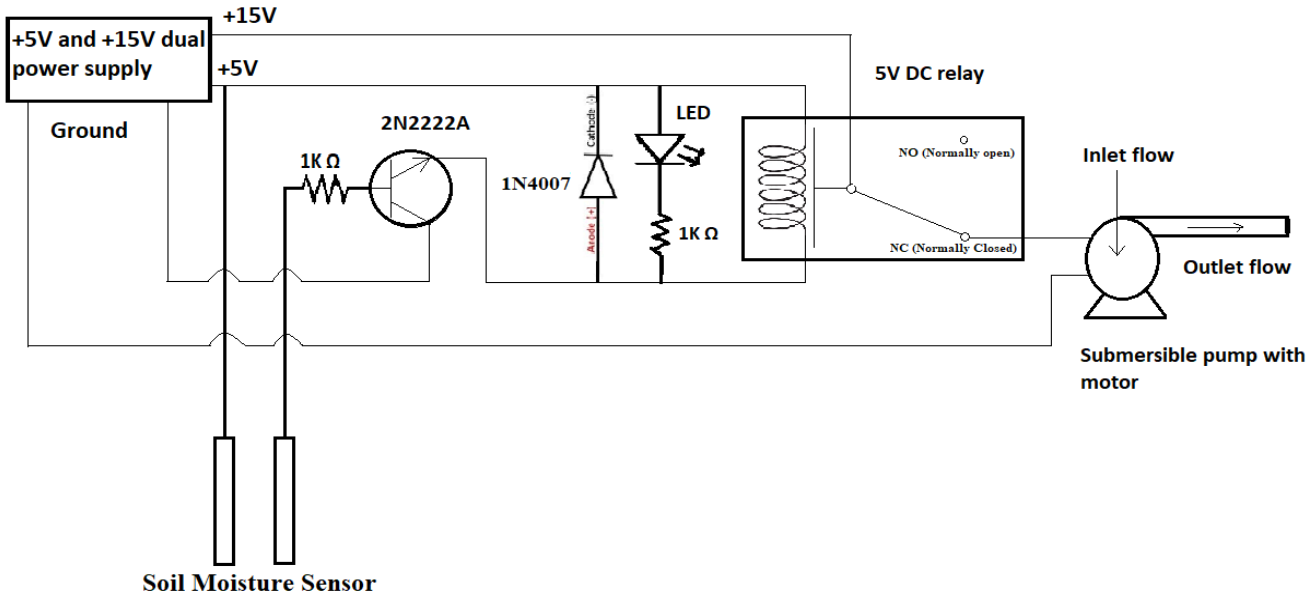
1) This system will be more accurate.
2) It does not require manpower.
3) Initial cost of this system is less.

Disadvantages of an Automated System:-

1) The design of these systems will be complex.
2) In case of power failure the entire process will shut-down.

4. CIRCUIT DIAGRAM OF THE SOIL IRRIGATION SYSTEM

Fig 2: Circuit Diagram of Soil irrigation system



This system consists of a dual regulated power supply, two 1KΩ resistors, one 1N4007 diode, one LED (Light Emitting Diode), one 2N2222A transistor, one 5V DC Relay and a submersible pump.

The moisture content of the soil is sensed by the soil moisture sensor. One terminal of the soil moisture sensor is connected to the base terminal [2nd pin] of the transistor (2N2222A) through a 1KΩ resistor.

The ground terminal of the power supply is connected to the collector terminal of the transistor (2N2222A).

The second terminal of the soil moisture sensor is connected to the +5V power supply. The +5V DC Regulated voltage is applied to one of the coil pins of the relay.

A diode is used in reverse bias between the +5V DC Regulated Voltage, Coil pin of the relay and the emitter pin [3rd pin] of the transistor (2N2222A).

This diode is used to prevent the circuit from reverse voltage which returns from the relay. An LED and a 1KΩ resistor are used to indicate the function of relay.

The anode terminal of the LED is connected to the +5V DC Regulated voltage and one terminal of the coil pin of the relay.

Another terminal (cathode terminal) of the LED is connected with the one terminal of the resistor. Another terminal of the resistor is connected to the emitter terminal of the transistor (2N2222A) and another coil pin of relay.

The emitter terminal of the transistor (2N2222A) is connected with another terminal of the coil pin. The +15V Regulated voltage is applied to the common pin of the 5V DC Relay.

The positive terminal of the submersible pump is connected to the NC (Normally Closed) terminal of the 5V DC relay.

The +15V DC Regulated voltage will be applied to the submersible motor when the moisture is not present in the soil.

This +15V DC regulated voltage is applied to the submersible pump when the relay switch is at NC terminal.

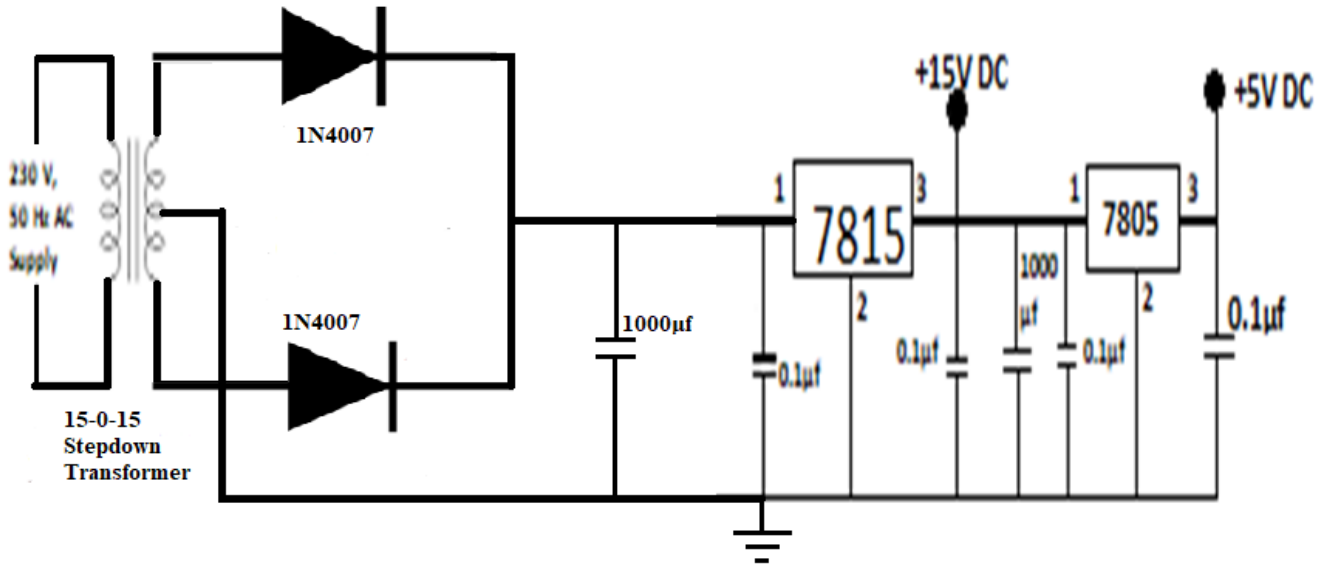
The negative terminal of the submersible pump is connected to the ground terminal of the power supply.

When the soil moisture sensor senses the moisture of the soil, an electrical conductivity (Electrolytic Conductivity) takes place between the probes of soil moisture sensor.

Due to this conductivity, the base of the transistor (2N2222A) will be energized. So that the relay switches from NC (Normally Closed) to NO (Normally Opened), which in turn disconnects the supply of submersible motor.

5. CIRCUIT DIAGRAM OF POWER SUPPLY

Fig 3: Circuit diagram of power supply



The power supply unit adopted in this system utilizes a centre-tapped full-wave rectifier topology to convert the 0–15 V AC output of the step-down transformer into a stable DC supply suitable for the sensing and control circuitry. In this rectifier configuration, the secondary winding of the transformer is provided with a centre tap that serves as a reference ground, and two 1N4007 rectifier diodes conduct alternately during the positive and negative half-cycles of the AC waveform.

This arrangement enables both halves of the AC cycle to be utilized for rectification, resulting in full-wave DC conversion with improved transformer utilization and reduced forward conduction loss across the diodes when compared to certain bridge-rectifier implementations. The pulsating DC obtained at the rectifier output is subsequently filtered using a 1000 μF electrolytic capacitor, which smooths the waveform and significantly reduces ripple content prior to voltage regulation. To ensure reliable and noise-free operation of the soil-moisture sensing and control electronics, a dual-stage linear regulation scheme is employed.

A 7815 voltage regulator generates a stable +15 V DC rail, while a cascaded 7805 regulator derives a regulated +5 V DC supply required for low-voltage digital and sensor-interface circuitry. The combination of full-wave rectification, large-value filtering, and linear regulation provides enhanced DC quality, reduced electrical noise, and improved operational stability of the system.

The selection of the centre-tapped full-wave rectifier configuration is therefore motivated by its efficiency in utilizing the transformer winding and its compatibility with the dual-voltage regulation framework used in the design, rather than by any notion of current amplification, since the available load current in such power supply systems is primarily governed by the transformer capacity, diode ratings, and regulator limitations.

6. FUTURE SCOPE FOR DEVELOPMENTS

This project can be further modified and developed by making use of Arduino as a Controller and solenoid valve as an alternative for motor and pump.

Since the usage of Arduino and Solenoid valve costs more, the same is not used in this project. This project has been designed in a low cost budget since this is only a model which is going to be used for study (Educational) purpose and not to be used in a wider range.

If the project is to be made use in a large scale, the above mentioned components can be made use ignoring the cost.

This centralized system can be connected with various sub systems for Multiple Sectors.

Whereas the above project can be made use at a simplified level for irrigating small gardens and roof gardens.

The problem of power failure can be managed by making use of UPS (Uninterruptible Power Supply) and automatic running generators.

7. CONCLUSION

This project has been designed with a holistic approach of conserving water and electricity. “Water and Electricity can be used, but under any circumstances it must not be wasted”.

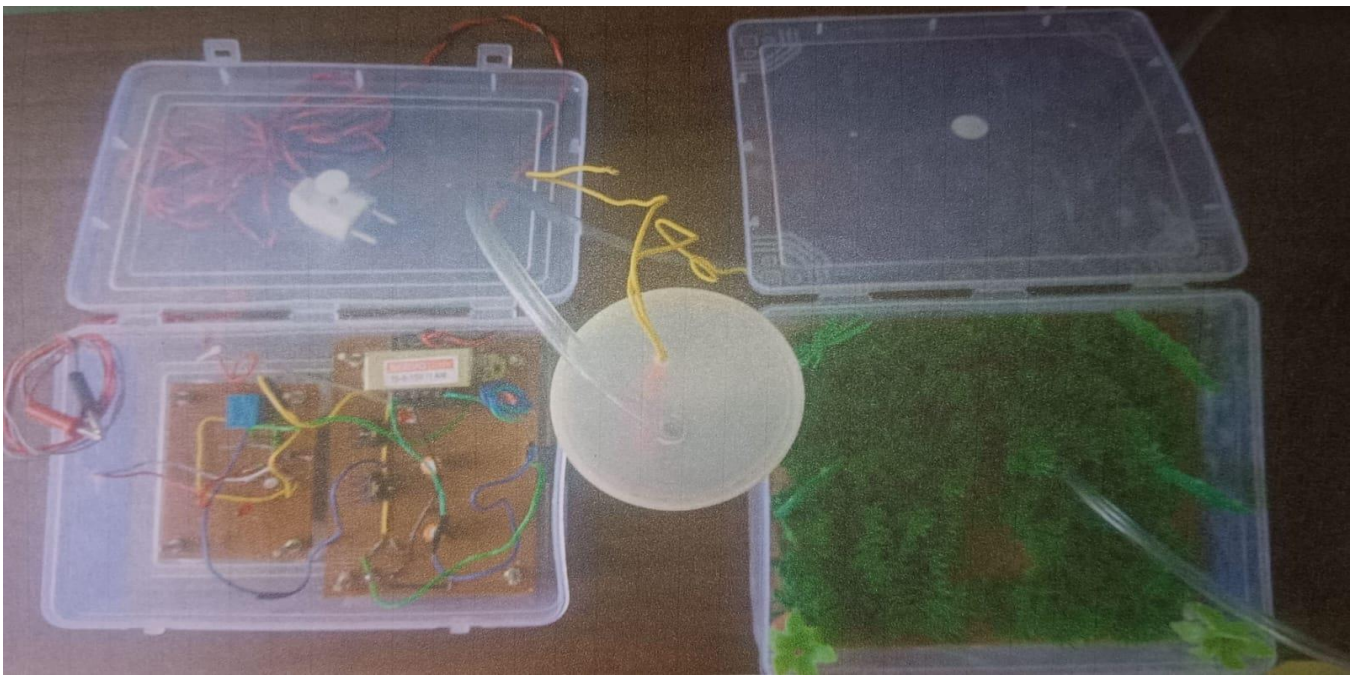
Conserving Water and Electricity helps to save the family income, the income of a village, town, city and finally a nation. This helps to improve the national income and per-capita income of the nation.

Moreover this project has satisfied its aims, objectives and also the target as per the goal set successfully.

Further, lot of developments and improvements can be brought in this project as per the requirements. Now-a-days, the younger generation has got lot of responsibilities to conserve water and electricity to build our nation.

Keeping in mind, the above mentioned factors, this project has been designed. If these techniques are utilized and adopted at a wide range at national level, definitely this will create a revolution and result with a great success.

8. PROTOTYPE OF AUTOMATED SMART SOIL IRRIGATION SYSTEM



9. Authors' Biography

I am Sherley Suzane Tremot, pursuing my under-graduation in Electronics and Communication Engineering at Manakula Vinayagar Institute of Technology, Puducherry. I have completed my Diploma in Instrumentation and Control Engineering at Women's Polytechnic College, Karaikal with superlative distinction. I had completed my 10th standard (Brevet) in French medium of instruction at Collège d'Enseignement Secondaire, Karaikal.

REFERENCES:

[1] P. Dharashive et al., "An Automated Irrigation System for Smart Agriculture Using the Internet of Things," IEEE Conf. Pub., 2025.
[2] B. Saraf and D. H. Gawali, "IoT based smart irrigation monitoring and controlling system," in Proc. IEEE RTEICT, 2017, pp. 815–819.
[3] M. R. H. Naeem et al., "An IoT Based Smart Irrigation System," 2nd Int. Conf. on Robotics, Electrical and Signal Processing Techniques, 2021.
[4] J. Gutiérrez, J. F. Villa-Medina, A. Nieto-Garibay and M. A. Porta-Gándara, "Automated Irrigation System Using a WSN and GPRS Module," IEEE, 2013.
[5] S. A. Pathan and S. G. Hate, "Automated Irrigation System Using Wireless Sensor Network," Int. J. Engineering Research & Technology, vol. 5, no. 6, 2016.
[6] M. V. Gurao and U. B. Vaidya, "IoT based Smart Irrigation System," Int. J. Engineering Research & Technology, vol. 11, no. 11, 2022.