

# Development of an Automated Hydroponics System for Optimal Plant Growth and Temperature Regulation

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## ABSTRACT

Hydroponic systems monitor field temperature and humidity and manage water flow using a mobile phone via WI-FI. Soil moisture sensors measure soil moisture. This sensor output is processed by a microcontroller-based control system. IoT module for remote monitoring and controlled hydroponic water delivery is also included. When soil moisture drops below a predetermined level, WI-FI sends the information. Due to the 5volt microcontroller monitoring the high voltage water motor, this system is sensitive and should be handled carefully. In developing the controller-water motor interface circuit, every little parameter should be given considerable priority. It turns on DC fan to cool if temperature and humidity exceed thresholds. An IOT server will receive meteorological parameters and soil moisture-based auto pump control status updates.

**Keywords:** Temperature Control, Healthy Crops, Hydroponics, DC Fan.

## 1. INTRODUCTION

INIDAS major source of income is from agriculture sector and 70% of people depend on the agriculture, most of the Hydroponic systems uses traditional methods which are operated manually. Two scare and valuable resources of Hydroponic that is water and energy are not efficiently utilized by the current Hydroponic system. Today's advanced society has turned into a digital world through the contribution of technology, now we are leaving in such an era where technology is studied to improve our life style. Hence to make life simpler and convenient SMART WATERING SYSTEM had been introduced. A model of controlling Hydroponic facilitates to help millions of people. Smart watering system can be defined as the science of artificial application of water to the soil depending on the soil moisture content. With the advent of open source arduino boards along with the moisture sensor, it is viable to create devices that can monitor the soil moisture content and accordingly irrigating the fields or the land scape when needed. The proposed system

makes use of microcontroller ATMEGA328P on Arduino uno platform and IOT which enables farmers to remotely monitor the status of water level in the soil by knowing the sensor values thereby, making the farmers work much easier as they can concentrate on other farm activities. The agricultural sector has its largest contribution in the Indian economy. Agriculture uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. As our country is an agriculture-oriented country and the rate at which water resources are depleting is a dangerous threat to the mankind. Hence there is a need of efficient way of Hydroponic. In the present era, the farmers have been using Hydroponic technique through the manual control in which they irrigate the land at the regular interval. Hydroponic has always been an ancient practice which has evolved through so many stages over the years. Our ancestral farmers in a bid to irrigate their farm sought for various methodologies they are manual Hydroponic by using buckets and watering cans, flood Hydroponic, drip Hydroponic, sprinkler Hydroponic were and are still being used today. The main reason for our current condition of agriculture is lack of rains & scarcity of land reservoir water. Rain plays the key role in deciding the future of these crops as well as the farmers every year. The over utilization of ground water has drastically reduced the ground water level in the last 15 years. So it is the need of hour to utilize each and every drop of water wisely so that it can also be used by our coming generations also. The existing systems has several limitations; leaching off of soil nutrients, erosion due to flooding, loss of water from plant surfaces through evaporation, water wastage which can result to water scarcity in drought areas and production of unhealthy crops. These problems can be rectified if we use microcontroller based automated Hydroponic system in which the Hydroponic will take place only when there will be acute requirement of water, maintaining proper amount of water level in the soil is one of the necessary requirements to harvest a good crop that can be a source of various types of nutrients whether micro or macro for

their proper growth. This project is designed to develop an automatic Hydroponic system which controls the watering in the fields depending on moisture content of the soil. The main advantage of this project is to reduce human intervention and still ensure proper Hydroponic. The aim of this project is to provide water to the plants or paddy fields automatically using microcontroller (Arduino Uno). There are many timer-based devices available in the market which waters the soil on a set interval. But they do not sense the soil moisture and the ambient temperature to know if the soil actually needs watering or not. The control unit of the system receives the signal of varying moisture condition of the soil through the sensing arrangement. The system has a network of soil-moisture sensor, an LDR sensor, humidity and temperature sensor. These sensors outputs are fed to the microcontroller which will trigger the water pump whenever necessary. And also we should develop some new methods that use the renewable sources of energy. The development of the seen techniques is going to reach our goal of sustainable development as well as to cut off the emission of greenhouse gases to a minimum level. As the name of our project that is "IOT" which uses power for the functioning of the project and to save electricity.

This technique will be a very good option for the small and medium farmers who suffer just because of failure outcrops at takes place every year. The implementation of this technology has a wide scope in the nearby future. Moreover, implementing IOT in the system allows the user to control and monitor the scenario remotely. The interconnected objects referred as Internet of Things (IOT) is continuing to evolve offering more control over our living environment and allowing more ease in doing things. Many consider this as the next big horizon in the evolution of the Internet. IOT has the capability of collecting, storing, analyzing and distributing data among diverse interfaces, apps and devices. The freedom for real-time application of data and data-driven insights has become easier than ever before. The status of the soil as well as the values of all the sensors will be transmitted over the internet and displayed on a web page which will help the user to globally access the values by any digital device like mobile phones. The smart sensors placed in the agriculture fields are also capable of real time notification about the moisture level in land sand can prevent wastage of water. This capability can be further used if the real time sensor data can trigger the water pump by switching it off or on depending on moisture content of the soil. The system is powered by photovoltaic s and has a wireless communication link with the control unit.

## **2. LITERATURE SURVEY**

INDIA is one of the scare water resources in 13 countries in the world, due to low utilization of water resources our country is facing the risk of overheating. In order to effectively scale back the impact of inadequate water resources on INDIA's economy from fashionable

agricultural cultivation and management prospective, online with essential principles of web, with device technology, this paper proposes exactitude agriculture Hydroponic system, and focuses on the hardware design, specification and code method management of the Hydroponic system. The newer scenario of decreasing water tables, drying up of rivers and tanks, unpredictable environment presents an urgent need of proper utilization of water. To cope up with this use of temperature and moisture sensor at suitable locations for monitoring of crops is implemented in [1]. An algorithm developed with threshold values of temperature and soil moisture can be programmed into a microcontroller-based gateway to control water quantity [2]. After the research in the agricultural field, researchers found that the yield of agriculture is decreasing day by day. However, use of technology in the field of agriculture plays important role in increasing the production as well as in reducing the extra man power efforts. Some of the research attempts are done for betterment of farmers which provides the systems that use technologies helpful for increasing the agricultural yield [3]. The use of remote switching and monitoring of Hydroponic system using smart phones to address the need of automatic control of the water is presented. The data about soil moisture, temperature and humidity is sent to the smart phone for the user to make the decision. [4]. In the studies related to wireless sensor network, researchers measured soil related parameters such as temperature and humidity. Sensors were placed below the soil which communicates with relay nodes by the use of effective communication protocol providing very low duty cycle and hence increasing the life time of soil monitoring system. The system was developed using microcontroller, sensors while the transmission was done by hourly sampling and buffering the data, transmit it and provide the necessary water [5]. A connection has been established between climate policies and water management. Water management can be affected by different variables such as the water demand from the different sectors or the consequences of some degrees of warming on hydrological resources. Climate change and its effects are a recurrent topic in research papers regarding water resources and agriculture. The possible consequences of global warming have led to the consideration of creating water adaptation measures to ensure the availability of water for food production and people and to maintain ecosystems [2]. Furthermore, the safety of the water to be consumed by humans and to be returned to the environment must be ensured. The possible risks of climate change are an increase in water shortage, the reduction of water quality, the increase in water and soil salinity, the biodiversity loss, the increase in Hydroponic requirements or the possible cost of emergency and remediation actions. These reasons have led to an increase in the number of studies focused on reducing water usage in Hydroponic processes. Some of these studies suggest the implementation of social, economic and climate change policies, as well as the

implementation of technological innovations to improve water management.

The agricultural sector is one of the most important economic resources in these countries adding to the importance of managing well the available water resources to ensure the continuing of this economical sector. In India, 10% of the area of the country is covered by rice plantations [3]. Furthermore, 20% of the Indian population is below poverty levels and 15% is food insecure. Therefore, low food production affects both the population and the economy. In 2002, the monsoon season produced the least amount of precipitation in the last 130 years. That resulted in a loss of rice production due to the lack of fresh water. To determine the drought caused by anomalies in surface water, the Standardized Precipitation Evapotranspiration Index (SPEI) was utilized. These indexes and the information gathered from sensors that monitor the environment, the soil and the water can be utilized to determine the current state of the water and the possibility of covering all the freshwater needs. Countries with higher funds are already implementing systems for water management and water reuse aiming to optimize water usage and reduce the environmental impact caused by utilizing great amounts of water. However, some countries may find these solutions to be costly.

Commercial sensors for systems aimed for agriculture and its Hydroponic are very expensive, making it impossible for smaller farmers to implement this type of system on their farms. However, manufacturers are currently offering low-cost sensors that can be connected to nodes to implement low-cost systems for Hydroponic management and agriculture monitoring. Furthermore, due to the interest in low-cost sensors for monitoring agriculture and water, new low-cost sensors are being proposed in researches such as a leaf water stress monitoring sensor [4], a multi-level soil moisture sensor comprised of copper rings placed along a PVC pipe [5], a water salinity monitoring sensor made with copper coils [6] or a water turbidity sensor made with colored and infrared led emitters and receptors [7].

Due to the recent advances in sensors for the implementation of Hydroponic systems for agriculture and the evolution of WSN and IoT technologies that can be applied in the development of these systems, we present a survey aimed at summarizing the current state of the art regarding smart Hydroponic systems. In this survey, we are going to provide an overview of the state of the research regarding Hydroponic systems. We will determine the parameters that are monitored in Hydroponic systems regarding water quantity and quality, soil characteristics, weather conditions, and fertilizer usage. We will provide an overview of the most utilized nodes and wireless technologies employed to implement WSN and IoT based smart Hydroponic systems. Lastly, we will discuss the challenges and the best practices for the implementation of sensor-based Hydroponic systems. Other authors have performed studies with a focus on Hydroponic systems, water management or precision

agriculture systems. However, the other available surveys on smart Hydroponic systems analyzed quite a few papers [8,9,10,11,12] and therefore do not provide an in-depth analysis of the state of the art regarding Hydroponic systems. Others are focused on specific aspects regarding Hydroponic such as software for Hydroponic systems [13], pivot-center specific Hydroponic systems [14] or Hydroponic systems for greenhouses [15].

### **3. PROPOSED WORK**

The proposed system having two working units: one is pumping unit and other is smart Hydroponic unit. The proposed system will help us to improve the Hydroponic system using a natural renewable power source such as energy. We can find the level of the water in tanks in the fields, the temperature around, the humidity in the air by using respective sensors. The most important application of this project is to sense the moisture level in the soil. Whenever the moisture content of the soil is low, it automatically sends a signal to the Arduino Uno, this microcontroller will switch on the DC pump through a relay. This system also reduces the attention which saves a lot of time and effort to the human beings. Most of the electricity bill is also reduced as we are using energy. We can conveniently check the temperature, humidity in the fields, moisture level of the soil and water level in the tanks from any location by using the Internet of Things (IOT). This system can also display the measured factors in an LCD. If the moisture level in the soil is adequate, then the microcontroller switches off the motor and thus stops watering the fields which results in the less requirement of water. Thus, this system clearly shows that it requires very less manual attention and also saves a lot of water. This proposed system can be easily affordable by any farmer. What it takes is just a smart phone and an internet connectivity.

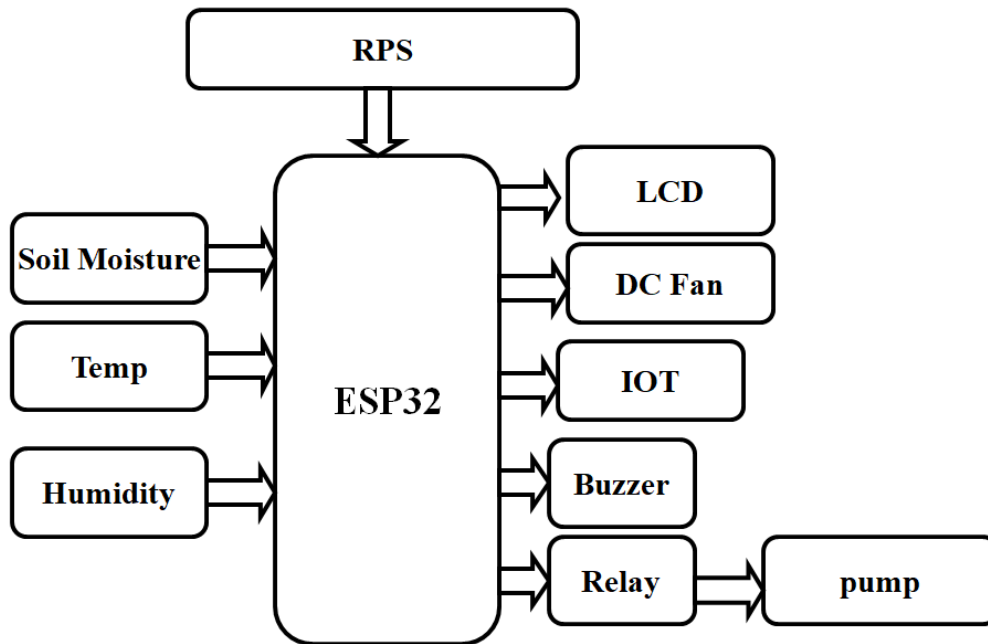


Figure.1: Block Diagram

This energy stored in the battery is converted in to 5 volts DC. From here, the system gets its power supply to the microcontroller. The Temperature sensor, Humidity sensor, Soil moisture sensor, Level indicator acts as the inputs to the microcontroller. These values are studied by the microcontroller and are displayed on the LCD screen. Whenever the soil moisture level is low the relay is turned on and the DC motor is switched on to water the fields. If the moisture level in the soil is adequate, then the relay and Dc motor are turned off. Here, we are using IOT as a platform to write the code and also to display the measured values by the microcontroller.

**WORKING:**

In any farm, the water supply is required as per the wet status of the soil. Depending on that the motor will automatically ON and OFF.

The functionality of this project includes 4 factors i.e. Soil moisture, Temperature, Humidity & Level indicator.

The wet & dry status of the soil can be measured by Soil moisture sensor. If the status of the soil is Dry, the relay will get automatically ON which is interfaced with motor to pump the water to fields and also displays in LCD. As soon as the status of the soil changes from dry to wet, the relay is switched off, also displays in LCD and this information is updated in graphs and cloud server through IOT module.

This system also reads the degree of temperature. When the temperature of the field or in the atmosphere is greater the 50 degrees Celsius, displays present value& it will automatically get updated in cloud server through IOT module and if it is normal it will display in LCD.

It also reads the status of humidity i.e. when the humidity is normal, it will display in LCD, if it is HIGH it will update in cloud server and displays.

IOT Module which is present in the System will store the data continuously, this module requires Wi-Fi i.e. internet to upload the information in local server i.e. Things Speak. So, this set up requires Wi-Fi to upload data and this data will get updated in the form of graphs. Every person or Farmer can open certain respective links to monitor status of the fields.

#### 4. RESULTS

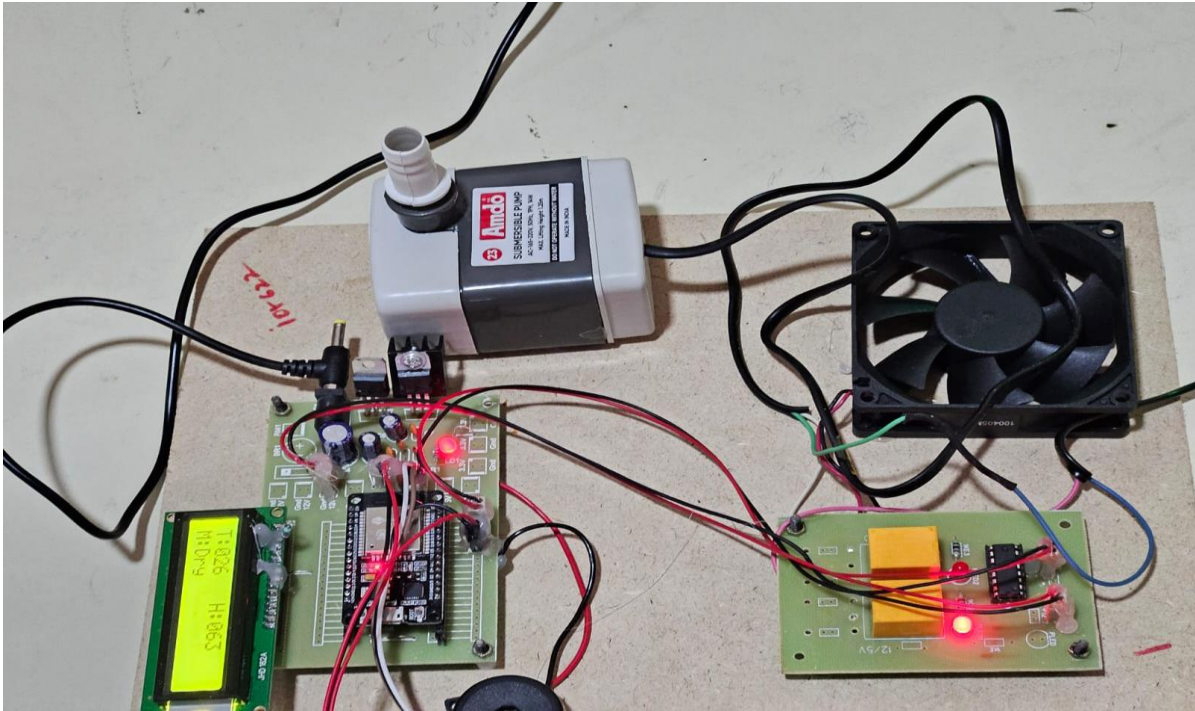


Figure.2: hydroponics plant and temperature control for healthy crops

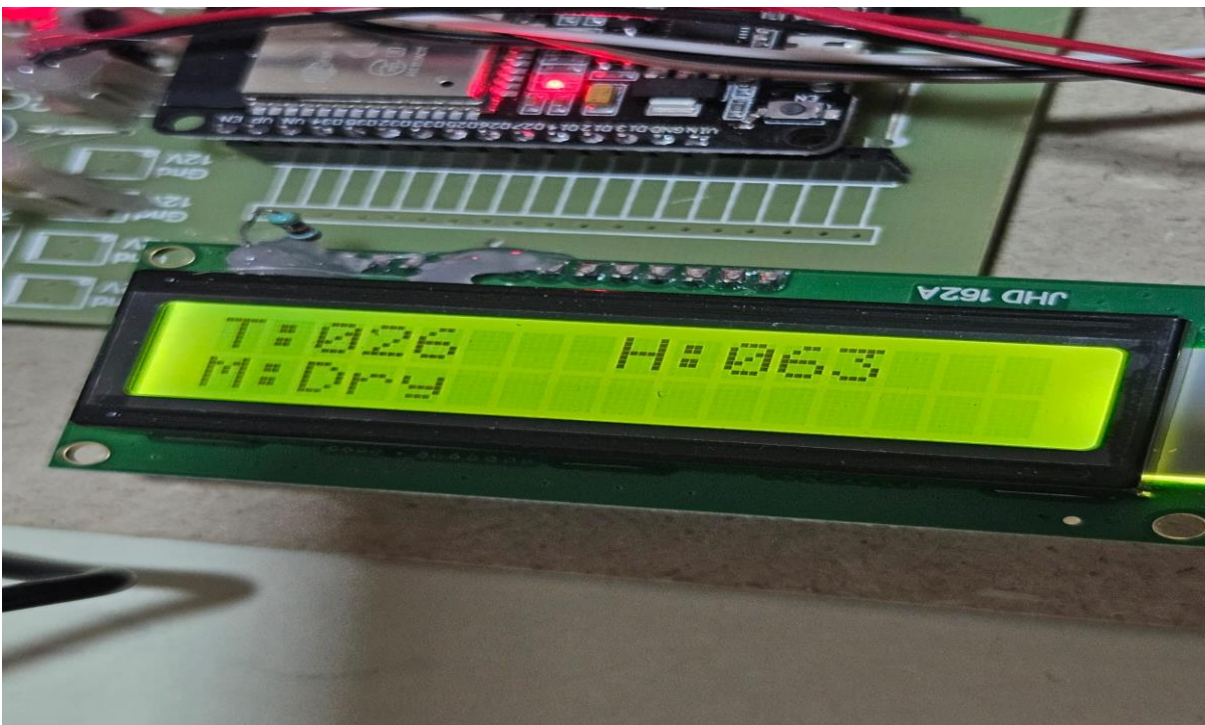


Figure.3: LCD Display the Humidity, Temperature, Moisture





Figure 4: LCD displays the IOT Hydroponic System

## 5. CONCLUSION

This innovative smart Hydroponic system is very beneficial for government as well as farmers. This is one of the best solutions for energy crisis and water consumption. The smart

Hydroponic system reduces the human intervention during the Hydroponic off field and also optimizes the water usages. Once the system is installed, unutilized energy produced by the PV can also be linked with grid system which can be revenue source for farmers. Hence, this Hydroponic system is motivating farming in India and at the same time it is giving solution for the energy crisis. Despite the fact that it required high initial investment for implementation of this system but in the long run this system is more economical than the conventional Hydroponic method. Government should also demonstrate this type of innovative system to motivate the farmers for adopting such type of system. Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using advanced sensors with the help of growing technology, the project has been

successfully implemented. Thus, the project has been successfully designed and tested.

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