

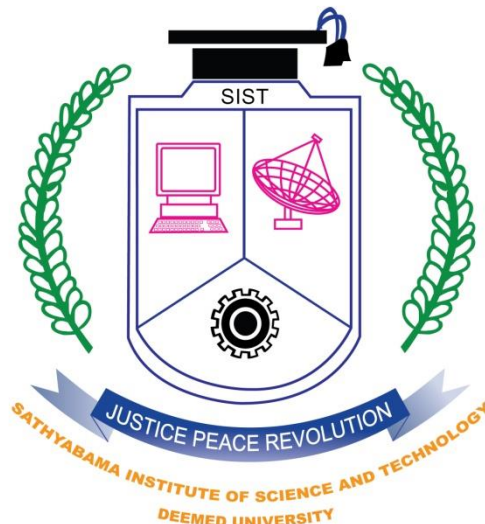
AUTOMATIC FERTILIZED VERTICAL IRRIGATION CONTROL AND MANAGEMENT SYSTEM

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ISWARYA S** (Reg. No. 39140018) and **LALITHA SREE MACHAVARAPU** (Reg. No. 39140709) who carried out the project entitled "**AUTOMATIC FERTILIZED VERTICAL IRRIGATION CONTROL AND MANAGEMENT SYSTEM**" under our supervision from November 2022 to April 2023.

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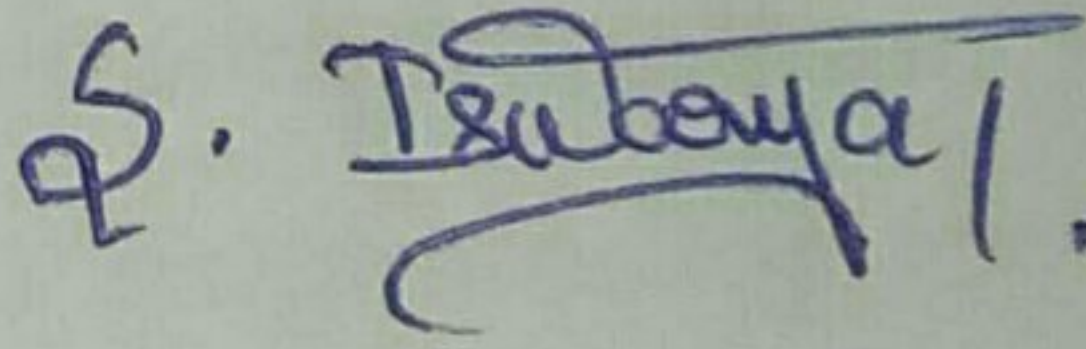
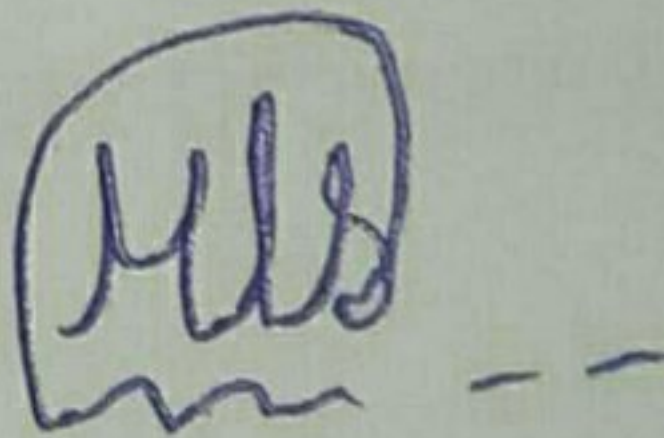
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ABSTRACT

The growth of any nation is primarily based on agriculture. Agriculture plays an important role as it is considered to be the backbone of any country. For decades, agriculture has been related with the production of vital food crops. The input of agriculture towards GDP is about 25% which is highest contribution when compared to any other sectors. Population growth is increasing rapidly in every country when compared to agricultural production. The recent days has witnessed revolutions to increase the yields for sufficient food production. But still the demand for food and the yield obtained are not linear. Agriculture 4.0 has the future of farming technology consisting of several key technologies. This project aims to develop an Automatic Control and Management System which could provide irrigation and nutrient requirements efficiently for the growth of plants. The main objective of this project is to automate the process of irrigation and nutrient supply for the plants. Different sensors and controllers are used to monitor the soil moisture level, nutrient level, and temperature levels. Automatic watering is done by turning on/off the water pump depending on the moisture contents. The nutrient content of the soil is continuously sensed by the NPK sensor in order to automatically provide the required nutrient content. The entire process is controlled by Arduino UNO. This proposed mechanism reduces the wastage of water and fertilizer, reduces the human dependency and requires less cost.

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LIST OF SYMBOLS AND ABBREVIATIONS

GDP	-	Gross Domestic Product
IOT	-	Internet of Things
ML	-	Machine Learning
WSU	-	Wireless Sensor Unit
WIPU	-	Wireless Information Processing Unit
SAIC	-	Smart Automated Irrigation Controller
ANN	-	Artificial Neural Network
SA	-	Smart Agriculture
ICT	-	Information and Communication Technology
NPK	-	Nitrogen, Phosphorus, Potassium
GSM	-	Global System for Mobile communication
Wi-Fi	-	Wireless Fidelity
ARM	-	Advanced RISC Machine
CO ₂	-	Carbon Di Oxide
SMS	-	Short Message Service
NCAP	-	Network Capable Application Processor
LR-WPAN	-	Low Rate Wireless Personal Area Network
ISO	-	International Organization for Standardization
IDE	-	Integrated Development Environment
GND	-	Ground
AO	-	Analog Output

DO	-	Digital Output
LCD	-	Liquid Crystal Display
MH	-	Mega Hertz
USB	-	Universal Serial Bus
OLED	-	Organic Light Emitting Diode
SPI	-	Serial Peripheral Interface
Tx	-	Transmitter
Rx	-	Receiver

CHAPTER 1

INTRODUCTION

1.1 GENERAL

In India, agriculture falls under the primary sector, as most of the people depend on agriculture. Hence, the development of the country depends on a considerable growth rate in the agriculture sector. It contributed about 16% of total GDP and 10% of the total exports of the country. The primary resource for agriculture is water. Most of these irrigation techniques are manually operated ones. Using of these methods results in difficulty in reaching and tracking of water to each corner of the land. The automatic irrigation system will overcome the above problems mentioned. The method drip by drip system may save the water in agricultural fields. This project clearly outlines a useful concept about automatic irrigation systems. The humidity, temperature, soil moisture level, fertilizer application, and irrigation system and management are all continuously monitored by this automatic irrigation and fertilizing system. Irrigation systems assisted in the growing of agricultural crop, maintenance of landscapes and re-vegetation of disturbed soil in the dry area and during the periods of inadequate rainfall. Rain-fed refers to agricultural land that is dependent on rainfall. This system proposes a vertical farming model, by producing multi-layered plants that are stacked vertically. The research approach was carried out to obtain the technology used to achieve the goal of providing land at low cost. This includes protection of the plants against frost, suppression of the weed growing in grain fields and aiding in soil associated prevention. To resolve these challenges, micro-irrigation methods such as Drip irrigation and Sprinkler irrigation system are required.



Fig:1.1 : Vertical Irrigation System

1.1.1 Drip Irrigation System:

Drip irrigation is one of the most common localized irrigation systems. Sometimes also known as a trickle or micro-irrigation system, it consists of a network of pipelines and valves. It is a reliable method of smart irrigation technique that can be mainly used to supply water and fertilizer into the plant. It enables water to drip gradually to the root of plants via tubing or valves pipes.



Fig:1.2 : Drip Irrigation System

1.1.2 Sprinkler Irrigation System:

Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water. .



Fig:1.3 : Sprinkler Irrigation System

Without fertilizers, nature struggles to replenish the nutrients in the soil. When crops are harvested, important nutrients are removed from the soil, because they follow the crop and end up at the dinner table. If the soil is not replenished with nutrients through fertilizing, crop yields will deteriorate over time. Thus monitoring the fertilizer and water is needed. This proposed system supplies required fertilizer content and water to the plants automatically. It helps in good crop yield.

A system for managing and controlling automatic fertilized irrigation, which can automatically feed water and soluble fertilizer to crops based on their requirements, has been developed. Before deciding to irrigate, this device can assess the environment, the soil's temperature, and its humidity. It can also include measures of chloride, nitrate, and ammonia to the sample regimen.

1.1.3 Problems Due to Deficiency of Nutrients:

Deficiency of nutrients can cause several problems for plants. Here are some examples:

Stunted growth:

Nutrient deficiencies can lead to stunted growth in plants, where they do not grow to their full potential.

Yellowing of leaves:

Certain nutrient deficiencies, such as a lack of nitrogen, can cause leaves to turn yellow or even brown.

Poor fruit or flower production:

A lack of certain nutrients can result in poor production of flowers or fruits, or even prevent their development entirely.

Increased susceptibility to pests and diseases:

Plants that lack essential nutrients are more susceptible to pests and diseases, as their weakened state makes them less able to defend themselves.

Reduced shelf life:

Fruits and vegetables that have been grown in nutrient - deficient conditions can have reduced shelf life and are more prone to spoilage.

Decreased yield:

Nutrient deficiencies can result in decreased yield, which can be a major problem for farmers and gardeners who rely on high crop yields for their livelihoods.

Overall, nutrient deficiencies can have a significant impact on the health and productivity of plants. It is essential to maintain optimal nutrient levels in soil to promote healthy plant growth and ensure high crop yields.



Fig:1.4 : Potassium and Nitrogen Deficiency Symptoms

1.2 MOTIVATION FOR THE SELECTION OF THE PROJECT

The motivation for this project came from the countries where economy is based on agriculture and the climatic conditions lead to lack of rains & scarcity of water. For continuously increasing demand and decrease in supply of food necessities, it's important to rapid improvement in production of food technology. Agriculture is only the source to provide this. This is the important factor in human societies to growing and dynamic demand in food production. Agriculture plays the important role in the economy and development, like India. Due to lack of water and scarcity of land water result the decreasing volume of water on earth. Irrigation is moreover the backbone of Agricultural industry .Due to inadequate knowledge of

proper utilization of water resource, lots of water is wastage in the application of irrigation system. So to overcome this problem, it is necessary to make the system automate with the help of modern technology like “Automatic Fertilized Vertical Irrigation Control and Management System”. It is motivated by a number of factors, including the need to improve agricultural productivity, promote sustainable agriculture practices, and reduce water and fertilizer usage.

The use of NPK sensors and soil moisture sensors in an automatic fertilized vertical irrigation system can help address this need by providing accurate and reliable measurements of soil nutrient levels, allowing for optimized fertilizer application rates and reduced fertilizer waste. Additionally, traditional irrigation and fertilization methods can be labour-intensive and time-consuming, particularly for large-scale agricultural operations. The use of an automatic fertilized vertical irrigation system can help automate the irrigation and fertilization process, reducing labour costs and improving efficiency.

Finally, there is a growing awareness of the need to promote sustainable agriculture practices that minimize environmental impact and promote long-term productivity. The automatic fertilized vertical irrigation system using NPK sensors can help achieve these goals by reducing water and fertilizer usage, minimizing nutrient leaching and runoff, and promoting healthy plant growth. Overall, the selection of the automatic fertilized vertical irrigation system using NPK sensor project was likely motivated by a combination of economic, environmental, and social factors, and reflects a growing need to develop more efficient and sustainable solutions for managing irrigation and fertilization in agriculture.

1.3 OVERVIEW OF THE PROJECT

An automatic fertilized vertical irrigation system using NPK sensors is a system designed to provide optimized irrigation and fertilization for plants in a vertical configuration. The system incorporates several technologies such as micro controllers, sensors, and actuators, which work together to automate the fertilizer application process.

In first chapter Introduction of the project is discussed with different irrigation systems and problems due to deficiency of nutrients. The survey has been collected and the problems are identified from the various survey papers and inferences also done in the second chapter. Third chapter contains the aim and scope of the present investigation and the problem identification from the literature survey. Risk analysis has been done for the project, IEEE Standards, Methodologies handled, Algorithms used, Flow chart of the project, about Existing system, advantages and disadvantages are clearly explained in chapter 4. The proposed systems, components used in the project, simulation and outputs, Hardware kit, and working are discussed with results in Chapter 5. In Chapter 6 all summary and conclusion are given.

CHAPTER 2

LITERATURE SURVEY

In this chapter, a detailed literature survey relating to the proposed work is discussed. The literature relates to work done in the automatization of irrigation and fertilization system relating to agriculture.

Joaquín Gutiérrez Jagüey et al., (2015) proposed Smartphone irrigation sensor which was designed and implemented to use in agricultural crops. The sensor uses a smart phone to capture and process digital images of the soil nearby the root zone of the crop, and estimates optically the water contents. The sensor is confined in a chamber under controlled illumination and buried at the root level of the plants. An Android App was developed for the Smartphone to operate directly the computing and connectivity components, such as the digital camera and the Wi-Fi network. The mobile App wakes up the smart phone, activating the device with user-defined parameters. Then, the built-in camera takes a picture of the soil through an antireflective glass window and an RGB to gray process is achieved to estimate the ratio between wet and dry area of the image. After the Wi-Fi connection is enabled, the ratio is transmitted via a router node to a gateway for control of an irrigation water pump. Finally, the App sets the smartphone into sleep mode to preserve its energy. The sensor is powered by rechargeable batteries, charged by a photovoltaic panel. The smartphone irrigation sensor was evaluated in a pumpkin crop field for 45 days. The experimental results show that the use of smartphones as an irrigation sensors could become a practical tool for agriculture.

Achilles D. Boursianis et al., (2021) proposed Smart Irrigation System for Precision Agriculture—The AREThOU5A IoT Platform. In which the subsystems and the architecture of an intelligent irrigation system for precision agriculture, using AREThOU5A IoT platform was discussed. It describes the operation of the IoT node that is utilized in the platform. This applies the radiofrequency energy harvesting technique to the presented IoT platform, as an alternative technique to deliver power to the IoT node of the platform. To this end, rectenna module for radiofrequency energy harvesting is fabricated and validated. Experimental results of the fabricated

rectenna exhibit a satisfactory performance as a harvester of ambient sources in an outdoor environment. Measured results show satisfactory values of the antenna's reflection coefficient (-31.18 dB at 870 MHz and -27.84 dB at 937.5 MHz), as well as of the rectifier's efficiency (68% for $P_{in} = 0$ dBm).

Faruk Bin Poyen et al., (2021) proposed Prototype Model Design of Automatic Irrigation Controller has two operational units, namely, wireless sensor unit (WSU) and wireless information processing unit (WIPU). The purpose of the WSU is to measure weather and soil conditions and calculates the actual water loss due to evapotranspiration. The WIPU processes this calculated value and performs the necessary control action to regulate the actuators supplying the right amount of water to the farm. An exhaustive rule-base combination model is stacked in the lookup table for decision making. The prototype model is first simulated and then validated in the field for checking the performance efficiency. The simulated results showed capabilities to compensate for water loss by almost 100%. The controller achieved a 27% reduction in water usage and a 40% increase in crop yield. The prototype is connected to a cloud server for data repository and remote access and control. The device is efficient, low cost, and user friendly so that the end-users can it with ease and comfort. The model is innovative and unique in the sense that it can the irrigation scheduling for all types of crops, across all climatic conditions for all soil types upon feeding the proper soil–crop–growth stage combinations in the inference engine.

Amogha Hegde M.N et al., (2021) proposed Prediction and Analysis of Water Requirement in Automated Irrigation System using Artificial Neural Network(ANN) and Lora Technology makes use of artificial neural networks (ANN) to optimize water usage in agriculture. Temperature and moisture sensors are used to read the temperature and moisture level of soil in the system. Lora transmitter transmits the sensor data. The data transmitted by the LoRa transmitter is received by the LoRa receiver, which then passes it on to the controller unit. The data is processed and compared to a predetermined threshold value by the controller unit. If the value exceeds the threshold, the motor is activated; otherwise, the motor is turned off. The GSM module is used to convey the motor status to the registered

user through SMS. The readings of the sensors and the quantity of water required to reach the threshold value are broadcast to the web once the motor is turned on/off (Thingspeak). Thingspeak is being used to record all sensor data and water consumption for a specific temperature/moisture. ANN analyses the data and determines the amount of water that will be needed in the next few days.

Et-Taibi Bouali et al., (2021) proposed renewable energy integration into cloud & IOT-based smart agriculture which was developed, presented, and deployed an open source and easy-to-deploy smart agriculture system with the main drivers of cost-effectiveness, water consumption optimization, and renewable energy integration. The deployed SA system leverages up-to-date ICT. It used IoT devices for data acquisition and control (sensors and actuators). We also used Cloud Computing for data processing, visualization, and data storage. Besides, we resorted to fuzzy logic to implement a fuzzy irrigation control unit that decides on the appropriate Id (Irrigation Duration) based on real-time processed data. This approach saves water and energy and provides adequate conditions for the plants, thus optimizing crops' yield. Furthermore, this allows better monitoring for the water level in the basin and adheres to the conventional eco-friendly trend of sustainable agriculture through its total reliance on solar energy. The case study results show that proposed solution is promising compared to the traditional irrigation system due to its cost-effectiveness and ability to reduce water/energy consumption by 71.8%.

Suhinthan Maheswararajah et al., (2011) proposed Management of Orphaned-Nodes in Wireless Sensor Networks for Smart Irrigation Systems which investigated the optimal management of orphaned nodes in a sensor network deployed in an automated irrigation system. In practice, it is unavoidable that sensor measurements contain random noise. The presence of orphan nodes adds to the effect of measurement noise further reducing the precision of irrigation management. However, re connecting/restoring orphaned nodes to the sensor network may require some compromises to be made since the parent nodes are restricted in the maximum number of children they can possess. Optimal restoration can be achieved by finding the optimal parent node for each orphaned node that improves irrigation management.

Zahid Mohad Rosil et al., (2015) proposed Integrated optical sensor for NPK Nutrient of Soil detection which is used to measure the nutrients of the soil. Muhammad Ayaz et al., (2019) proposed Internet-of-Things (IOT)-Based Smart Agriculture toward Making the Fields Talk which is used for horizontal Irrigation.

Zubair Sharif et al., (2019) proposed Internet-of-Things (IOT)-Based Smart Agriculture: Toward Making the Fields Talk.

Keyurbhai A et al., (2022) proposed A Novel Model for Optimization of Resource Utilization in Smart Agriculture System Using IOT (SMAIOT) which takes care of the requirements of crops during the development phase. Farmers can view and handle data and functionalities from remote places. By using this framework, farmers can save valuable resources as well as the workforce required with less human error. This article contains the result of the smart irrigation module, which is proven best than all other irrigation methods.

T. J. R. (Roy) Cobbenhagen et al.,(2019) proposed an optimization framework that computes the allocation of irrigation machinery (agents) and water to arable fields by maximization of a profit function in a receding horizon fashion using realistic model for crop growth dynamics. A key advantage of the proposed framework is that it can use many of the existing crop growth models for prediction and hence can be applied to a wide variety of crops, soils, locations, and weather patterns. The output of the framework is a feasible allocation of agents to fields and delivery of water over the growing season, in such a way that it allows for practical implementation by farmers. The allocation is feasible as the framework takes into account relevant real-world constraints such as the water-carrying capacity and application rates of the agents, but also traveling costs and refilling of water at designated locations. A realistic case study using validated crop-growth models by agronomists are used to show the strengths and the generality of the framework.

Tzu-Ching Chia et al., (2011) proposed Design and Implementation of the Micro-controller Control System for Vertical-garden Applications. A micro-controller control system controls soil moisture and sunlight illumination of a vertical garden is designed and implemented in this work. The sensors of the implemented control

system including the Zinc-Copper battery and the photo diode are selected from the conventional low-cost soil tester. The input resistance of the receiver circuit is designed to be as low as possible to keep the weak signals of the measured moisture and illumination from noise interference. The embedded functions of the micro-controller such as the analog-digital conversion, the low power precision timer and the sleep mode, are key factors in this application.

Kavianand G et al., (2016) proposed Smart Drip Irrigation System for sustainable Agriculture. To make the sustainable agriculture, this system is proposed. In this system ARM 9 processor is used to control and monitor the irrigation system. Different kinds of sensors are used. This paper presents a fully automated drip irrigation system which is controlled and monitored by using ARM9 processor. PH content and the nitrogen content of the soil are frequently monitored. For the purpose of monitoring and controlling, GSM module is implemented. The system informs user about any abnormal conditions like less moisture content and temperature rise, even concentration of CO₂ via SMS through the GSM module.

Joaquín Gutiérrez et al., (2014) proposed an Automated Irrigation System Using a Wireless Sensor Network and GPRS Module has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The system was powered by photovoltaic panels and had a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page. The automated system was tested in a sage crop field for 136 days and water savings of up to 90% compared with traditional irrigation practices of the agricultural zone were achieved. Three replicas of the automated system have been used successfully in other places for 18 months. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.

2.1 INFERENCES FROM LITERATURE SURVEY

From the literature survey, several inferences can be drawn regarding the automatic fertilized vertical irrigation system using NPK sensor project. These include:

1. The use of NPK sensors can improve the accuracy of fertilizer application, leading to more efficient nutrient uptake by plants and reduced fertilizer waste.
2. Vertical irrigation systems can be more efficient in terms of water usage compared to traditional irrigation methods, as they provide a more targeted delivery of water and nutrients to plants.
3. Automation of irrigation and fertilization processes can reduce labour costs and improve efficiency, particularly for large-scale agricultural operations.
4. The use of smart technologies such as microcontrollers and sensors can improve the precision and reliability of irrigation and fertilization systems, leading to better crop yields and reduced environmental impact.
5. The automatic fertilized vertical irrigation system using NPK sensors has the potential to be a highly sustainable solution for managing irrigation and fertilization, promoting healthy plant growth while minimizing water and fertilizer usage.
6. The system has potential applications in a variety of settings, including agriculture, landscaping, and environmental monitoring.

Overall, the literature survey suggests that the automatic fertilized vertical irrigation system using NPK sensors is a promising solution for optimizing plant growth and reducing resource usage in a variety of settings. However, further research is needed to fully evaluate the system's effectiveness in different contexts and to optimize its performance.

CHAPTER 3

PROJECT DESCRIPTION

3.1 AIM

The aim of an automatic fertilized vertical irrigation system using NPK sensors is to optimize plant growth and reduce water and fertilizer usage by automatically adjusting the flow rate of fertilizer based on real-time measurements of soil nutrient levels. The system is designed to deliver water and fertilizer evenly to all plants in a vertical configuration, and to incorporate automation technologies such as micro-controllers, sensors, and actuators.

The use of NPK sensors allows for accurate and reliable measurement of soil nutrient levels, which can help ensure that plants receive the optimal amount of fertilizer, while minimizing waste and reducing the risk over-fertilization. By automating the fertilizer application process, the system can also improve efficiency and reduce labour costs.

The overall aim of an automatic fertilized vertical irrigation system using NPK sensors is to promote sustainable agriculture practices by reducing the environmental impact of agriculture, while increasing productivity and profitability for farmers. This type of system represents a significant advancement in the field of agriculture, and has the potential to revolutionize the way we grow crops and manage irrigation systems in the future.

3.2 PROBLEM IDENTIFICATION

While a smart automatic fertilized vertical irrigation system using NPK sensors can offer numerous benefits, there are also some potential problems that need to be identified and addressed. Some of the key problems that may arise in this type of system include:

1. Sensor accuracy: NPK sensors can be sensitive to a variety of factors, including temperature, moisture, and soil composition. If the sensors are not calibrated properly or are affected by these factors, they may provide inaccurate readings that could lead to under- or over-fertilization.

2. **Cost:** The initial investment required to set up a smart automatic fertilized vertical irrigation system using NPK sensors can be significant. The cost of sensors, pumps, pipes, and other components can be high and on-going maintenance and monitoring may also require additional resources.
3. **Data management:** The system generates a large amount of data that needs to be collected, stored, and analysed. This can be challenging if the data is not managed properly, and could lead to errors in fertilizer application if the data is not analysed accurately.
4. **System complexity:** A smart automatic fertilized vertical irrigation system using NPK sensors is a complex system that requires specialized knowledge to design, implement, and maintain. This may be a barrier for some farmers or agricultural workers who are not familiar with the technology.
5. **Energy consumption:** The system relies on pumps and other components that consume energy. If the system is not designed for energy efficiency, it could increase energy costs and contribute to greenhouse gas emissions.
6. **Environmental impact:** While the system can reduce water and fertilizer usage, the use of fertilizers can still have negative environmental impacts, such as runoff into waterways or groundwater contamination.

Addressing these potential problems through proper planning, design, and implementation can help ensure the success and sustainability of a smart automatic fertilized vertical irrigation system using NPK sensors.

3.3 SCOPE OF THE PROJECT

The scope of a project on automatic fertilized vertical irrigation system using NPK sensors would typically involve designing, implementing, and testing an irrigation system that incorporates NPK sensors to measure soil nutrient levels and adjust fertilizer application rates automatically. The project may include the following elements:

1. **System design:** This involves identifying the components and technologies needed for the irrigation system, including the NPK sensors, pumps, pipes, and drip emitters. The system should be designed to deliver water and fertilizer

evenly to all plants in a vertical configuration, and may also incorporate automation technologies such as microcontrollers, sensors, and actuators.

2. Sensor integration: The NPK sensors should be integrated into the system in a way that allows for accurate and reliable measurement of soil nutrient levels. The sensor data should be collected and transmitted to a central controller for analysis and decision-making.
3. Fertilizer application: The irrigation system should be designed to automatically adjust fertilizer application rates based on the NPK sensor data. This may involve using a computer algorithm or other automated system to adjust the flow rate of fertilizer in response to changes in soil nutrient levels.
4. Testing and validation: The system should be tested and validated to ensure that it is operating as intended. This may involve testing the accuracy of the NPK sensors, measuring the effectiveness of the fertilizer application, and assessing the overall performance of the irrigation system.
5. Monitoring and maintenance: The system should be designed to allow for ongoing monitoring and maintenance. This may involve regularly checking the NPK sensors, monitoring water and fertilizer usage, and conducting routine maintenance on the pumps, pipes, and other components of the system.

The overall goal of a project on automatic fertilized vertical irrigation system using NPK sensors is to develop a more efficient and effective irrigation system that promotes healthy plant growth while minimizing water and fertilizer usage. It gives more yields. Not require more labour. The overall cost of the system was reduced comparing to existing system. The project can also contribute to the development of new technologies and best practices for sustainable agriculture.

CHAPTER 4

METHODOLOGY AND EXISTING SYSTEM

4.1 RISK ANALYSIS DONE FOR THE PROJECT

A vertical irrigation system is a method of watering plants that involves suspending the plants in a vertical configuration and allowing water to flow down through the system. The system typically uses pumps, pipes, and drip emitters to deliver water to the plants. When conducting a risk analysis of a vertical irrigation system, there are several factors to consider:

1. **Water quality:** The quality of the water used in the irrigation system can affect the health of the plants and the soil. Contaminated water can introduce harmful chemicals or pathogens into the system, which can cause damage to the plants or affect their growth.
2. **System design:** The design of the irrigation system can impact its effectiveness and reliability. Poorly designed systems may not deliver water evenly to all plants, leading to uneven growth or dry spots. Additionally, systems that are not properly maintained or checked can result in leaks or other failures that can cause damage to the plants or the environment.
3. **Equipment failure:** The pumps, pipes, and other equipment used in the irrigation system can fail, leading to water damage or other problems. It is important to have contingency plans in place for equipment failure, including regular maintenance and backups.
4. **Environmental factors:** Environmental factors, such as temperature, humidity, and wind, can affect the performance of the irrigation system. It is important to consider these factors when designing and operating the system.
5. **Human error:** Human error, such as incorrect installation or operation of the system, can cause problems with the irrigation system. Proper training and supervision can help reduce the risk of human error.

In summary, a risk analysis of a vertical irrigation system should consider factors such as water quality, system design, equipment failure, environmental factors,

and human error. By identifying and addressing potential risks, it is possible to create a safe and effective irrigation system that promotes healthy plant growth.

4.2 IEEE STANDARDS FOR THE PROJECT

There are several IEEE standards related to agriculture and sensor technology, but none specific to a vertical irrigation system using NPK sensor. However, there are some relevant standards that may apply:

1. IEEE Std 1451.1-2017 - Standard for a Smart Transducer Interface for Sensors and Actuators - Network Capable Application Processor (NCAP) Information Model. This standard provides a framework for integrating sensors and actuators into a networked system. It includes guidelines for the communication protocols, data formats, and software interfaces used to connect sensors and other components.
2. IEEE 422: This standard provides guidelines for the measurement and reporting of soil moisture in agricultural and hydrological applications. It covers topics such as sensor installation, calibration, data processing, and reporting of soil moisture measurements. While it does not provide technical specifications for soil moisture sensors, it provides recommendations for best practices in using soil moisture sensors for various applications.
3. IEEE Std 1596-2012 - IEEE Standard for Electronic Data Interchange for Administration, Commerce, and Transport (EDIFACT) - Application-Level Syntax Rules (ISO 9735). This standard provides guidelines for the exchange of electronic data between different systems. It may be relevant for systems that use NPK sensors to collect data on soil nutrient levels and transmit that data to other components of the irrigation system.
4. IEEE Std 1471 - This standard provides a framework for describing the architecture of software-intensive systems, which can be applied to control systems for irrigation.
5. IEEE 1451.4-2004: This standard defines a sensor interface for temperature sensors, which allows sensors to be easily integrated into measurement and control systems. The interface includes digital communication protocols, sensor identification, and self-calibration capabilities.

It is important to note that these standards are not specific to a vertical irrigation system using NPK sensors, but rather provide general guidance for integrating sensors and other components into networked systems. Additionally, there may be other standards or best practices relevant to the specific components and technologies used in a given irrigation system.

4.3 METHODOLOGY

1. Collecting the information from literature survey - To know more about sensors, controllers and software's using in the system implementation.
2. Selection of sensors, Controllers and other parts - sensor is a device that detects and responds to some type of input from the physical environment. Controller is used to minimize the difference between the actual value of a system and the desired value of the system.
3. Development of software for the system using Arduino IDE - It is used to simulate and testing for the correct output.
4. Implementing the system in hardware - To assemble all the components and making all the connections in it.
5. Testing the output and validating the output – For checking the resultant output.

4.4 ALGORITHM

STEP 1:- NPK sensor data acquisition: The system uses an NPK sensor to measure the nutrient levels in the soil. The data is then collected and processed by the micro controller.

STEP 2:- Soil moisture sensor data acquisition: The system uses soil moisture sensors to measure the moisture content of the soil. The data is collected and processed by the micro-controller.

STEP 3:- Decision-making: Based on the data collected from the NPK and soil moisture sensors, the system makes decisions about whether to irrigate the plants and apply fertilizers.

*STEP 4:-*Irrigation and fertilization: If the system determines that irrigation and fertilization are necessary, it activates the irrigation and fertilization mechanisms to deliver water and nutrients to the plants.

STEP 5:- Monitoring: Throughout the irrigation and fertilization process, the system continuously monitors the soil moisture levels and nutrient levels in the soil to ensure that the plants receive the appropriate amounts of water and nutrients.

STEP 6:- Data storage and analysis: The system stores the data collected from the sensors and uses it to analyse the performance of the system and make improvements.

4.5 FLOW CHART

A flowchart is a diagram that illustrates the step-by-step process of a system or program. Here is an example of a flowchart for an automatic fertilized vertical irrigation system using an NPK sensor:

- i. Start: The flowchart begins at the start point.
- ii. Check NPK sensor data: The system checks the NPK sensor data to determine the nutrient levels in the soil.
- iii. Check soil moisture sensor data: The system checks the soil moisture sensor data to determine the moisture content of the soil.
- iv. Decision-making: Based on the data collected from the NPK and soil moisture sensors, the system makes decisions about whether to irrigate the plants and apply fertilizers.
- v. If the nutrient levels in the soil are low: The system activates the fertilization mechanism to apply fertilizers to the soil.
- vi. If the moisture content in the soil is low: The system activates the irrigation mechanism to deliver water to the plants.
- vii. If both the nutrient levels and moisture content in the soil are low: The system activates both the fertilization and irrigation mechanisms to deliver water and nutrients to the plants.

- viii. Monitor soil moisture and nutrient levels: Throughout the irrigation and fertilization process, the system continuously monitors the soil moisture levels and nutrient levels in the soil.
- ix. End: The flowchart ends at the end point.

This flowchart is a simplified example of the process that an automatic fertilized vertical irrigation system using an NPK sensor would follow. The actual flowchart may be more complex and detailed, depending on the specific design of the system.

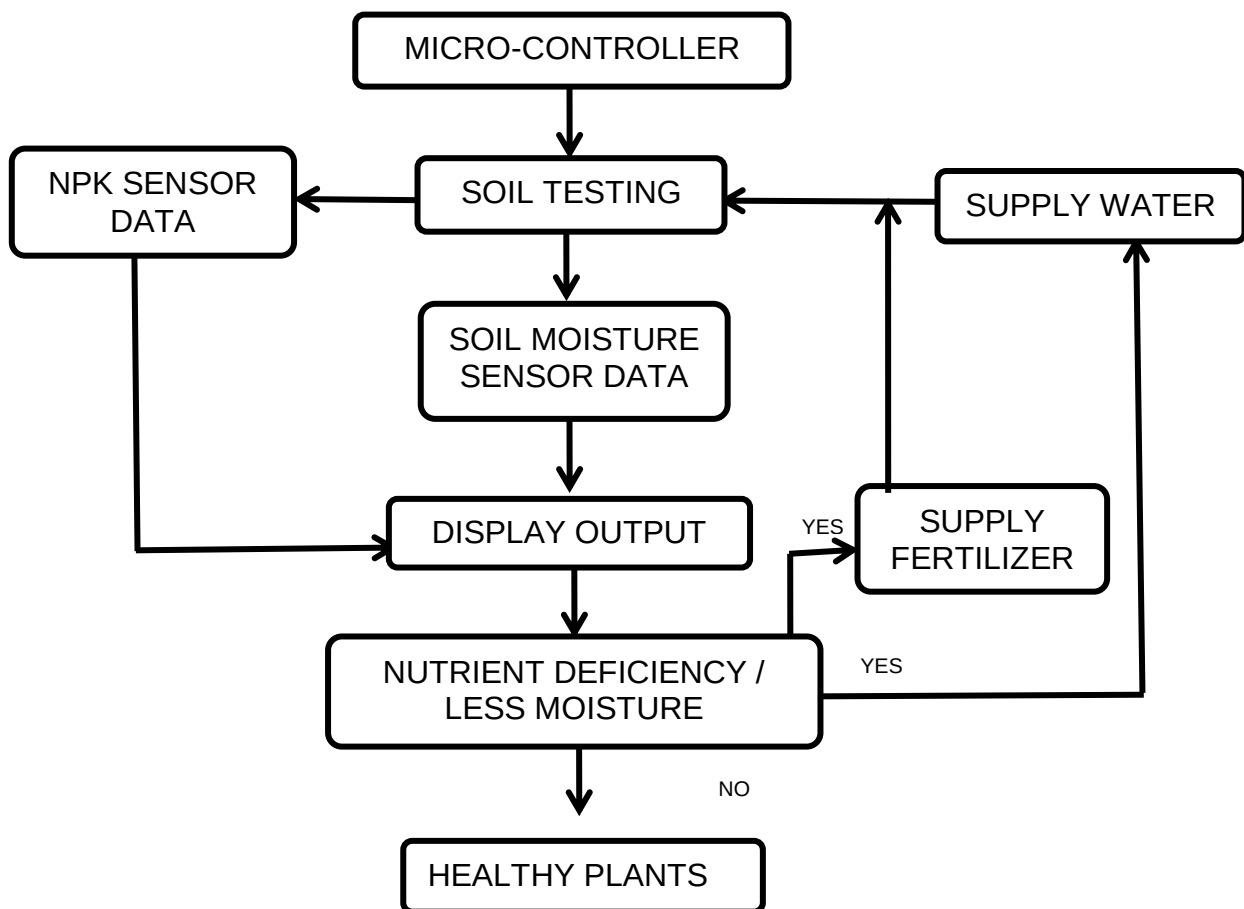


Fig:4.1 : Flow Chart of Proposed System

4.6 EXISTING SYSTEM

4.6.1 Existing System Block Diagram

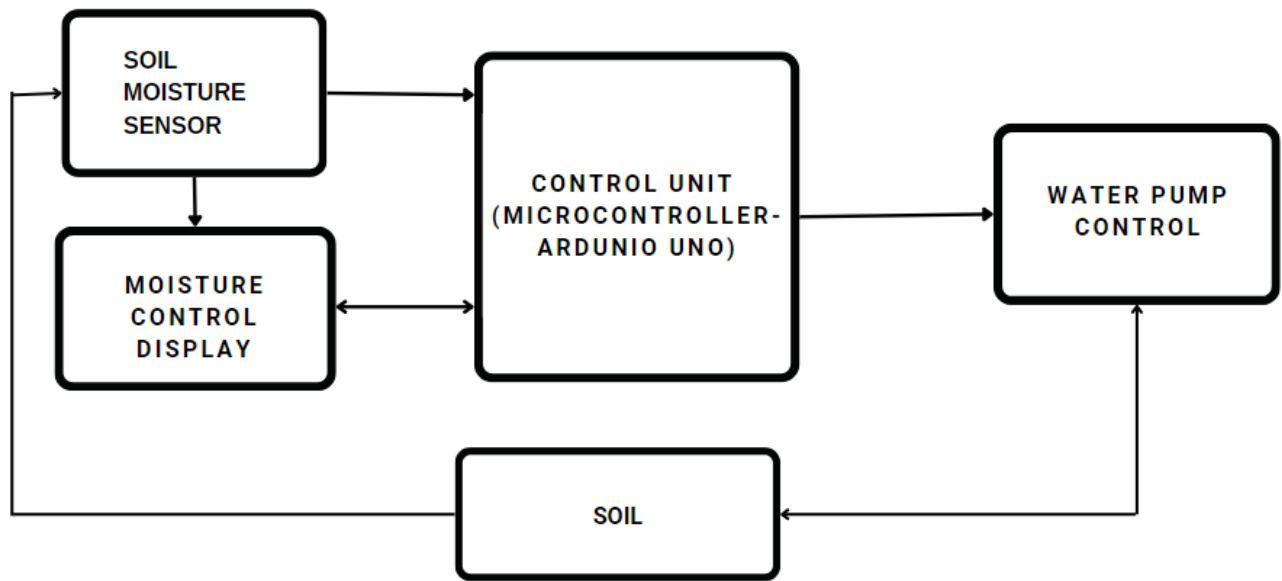


Fig:4.2 : Block Diagram of Existing System

A smart vertical irrigation system without an NPK sensor is a system designed to provide optimized irrigation for plants in a vertical configuration, without the use of NPK sensors for measuring soil nutrient levels. The system incorporates several technologies such as microcontrollers, sensors, and actuators, which work together to automate the irrigation process. Soil moisture sensors are typically used to measure the moisture content of the soil and provide real-time data on the water needs of the plants. The system delivers water evenly to all plants in the vertical configuration, promoting healthy plant growth while minimizing water usage. The use of smart technologies allows for more precise control over the irrigation process, and can help farmers optimize irrigation schedules and reduce water waste. While this type of system does not incorporate NPK sensors for measuring soil nutrient levels, it can still be an effective solution for managing irrigation in a variety of settings. However, it may not be as effective at optimizing fertilization rates as a system that incorporates NPK sensors. Overall, the effectiveness of a smart vertical irrigation system without NPK sensors will depend on a variety of factors, including the type of plants being grown, the specific environmental conditions, and the management practices used.

4.6.2 Explanation Of Smart Vertical Irrigation System

A smart vertical irrigation system is a system designed to provide optimized irrigation for plants grown in a vertical configuration. It incorporates advanced technologies such as micro controllers, sensors, and actuators, which work together to automate the irrigation process. The system typically includes soil moisture sensors, which measure the moisture content of the soil and provide real-time data on the water needs of the plants. This information is used to control the irrigation system, ensuring that plants receive the appropriate amount of water at the right time. Smart vertical irrigation systems can be configured in various ways, such as using a drip irrigation system, a misting system, or a hydroponic system. They can be used to grow a variety of plants, including vegetables, herbs, and flowers. One of the key benefits of a smart vertical irrigation system is its efficiency. By delivering water directly to the plants in a targeted manner, the system reduces water usage and waste, and helps prevent over- or under-watering. The use of smart technologies also allows for more precise control over the irrigation process, enabling farmers to optimize irrigation schedules and reduce water usage.

In addition to improving water efficiency, smart vertical irrigation systems can also promote healthier plant growth. By providing plants with the appropriate amount of water at the right time, the system helps prevent wilting and stress, and promotes optimal nutrient uptake. Overall, smart vertical irrigation systems are a promising solution for improving agricultural productivity and promoting sustainable agriculture practices. They can be used in a variety of settings, from urban agriculture to commercial farming operations, and offer numerous benefits for farmers and consumers alike.

4.6.3 Existing System Dis-Advantages

It cannot monitor the fertilizers supplied to the plant. We cannot check how much fertilizer is required for each crop automatically. So, possibility of loss of fertility of the soil. Requires more maintenance. As there should be someone who have to spray fertilizers to the plant. Overall cost of the system will be more as it requires more maintenance.

CHAPTER 5

SYSTEM DESIGN AND RESULTS

5.1 BLOCK DIAGRAM

The block diagram of the proposed system is shown below.

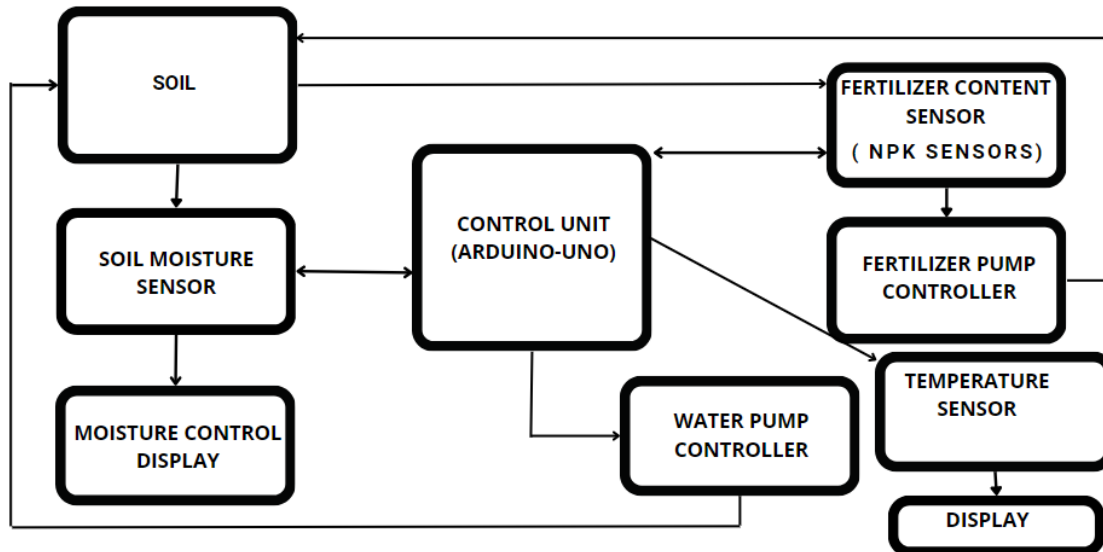


Fig:5.1 : Block Diagram of Proposed System.

5.2 MATERIALS REQUIRED

5.2.1 Soil Moisture Sensor



Fig:5.2 : Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Moisture sensors are placed at the predetermined locations and depths in the field, whereas portable soil moisture probes can measure soil moisture at several locations.

The more water in the soil, the better the conductivity and the lower the resistance. The less water in the soil, the lower the conductivity and thus the higher the resistance.

The specifications are,

1. Power: 9V-24V
2. Measuring Range: 0-1999 mg/kg (mg/l)
3. Operating Temperature: 5-45 °C
4. Resolution: 1mg/kg
5. Precision: $\pm 2\%$ F.S.
6. Output Signal: RS485
7. Baud Rate: 2400/4800/9600
8. Protection Class: IP68

PIN	DISCRIPTION
VCC	The vcc pin powers the module with typically +5v
GND	Power supply ground
AO	Analog output pin for analog output
DO	Digital output pin for digital output

5.2.2 NPK Sensor

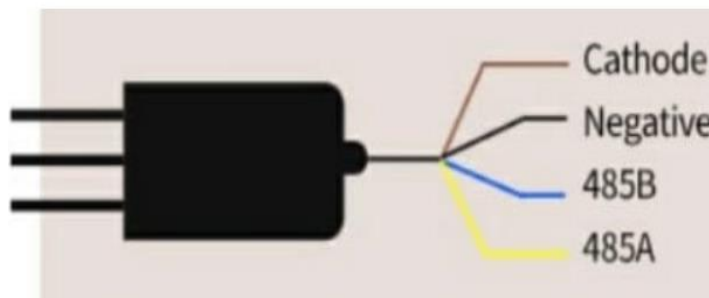


Fig:5.3 : NPK Sensor Pin Diagram

The letters NPK stand for the three major nutrients that plants require to grow and thrive: nitrogen, phosphorus, and potassium. Nitrogen is responsible for the growth and greenness of plant leaves. Phosphorus helps the plant grow strong roots, fruit, and flowers. Potassium improves the overall health and hardiness of a plant. The soil NPK sensor can detect the levels of nitrogen, phosphorus, and potassium in the soil (not in water). It helps determine soil fertility, allowing for a more systematic assessment of soil condition.

Giving excess amount of NPK causes:

- Nitrogen: Over growth with decrease in ability to fruit and flowers, attracts insects and reduces the strength of stem.
- Phosphorus: Reduces ability to absorb Zinc and Iron and few micronutrients even though they are present in soil.
- Potassium: Leads to inability to absorb major nutrients like nitrogen, magnesium and calcium which leads to their deficiency.



Fig:5.4 : NPK Sensor

The specifications of NPK Sensor are,

1. Voltage: 9-24Volts
2. Power consumption: <0.15 Watts
3. Working temperature: 5-45 Celsius(41-113 F)
4. Baud rates: 2400, 4800, and 9600.
5. Measuring Resolution: 1mg/kg(kg/l)
6. Measuring range: 0-1999mg/kg
7. Accuracy: $\pm 2\%$
8. Communication mode: Modbus RS485

5.2.3 LCD Display

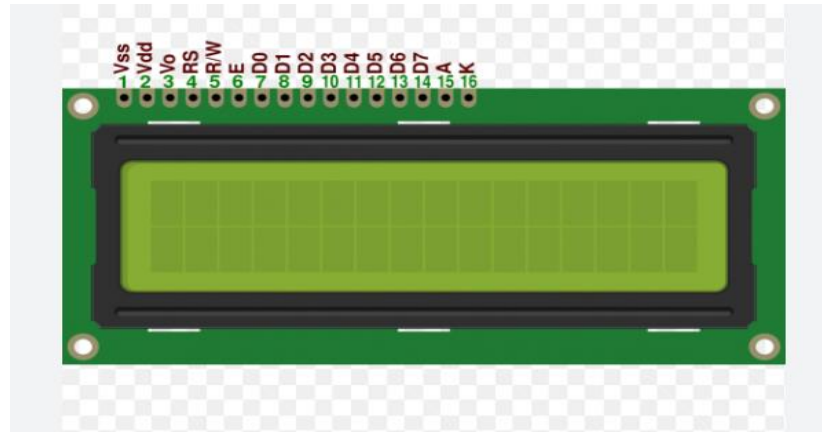


Fig:5.5 : LCD Display

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

5.2.4 Submersible Pump

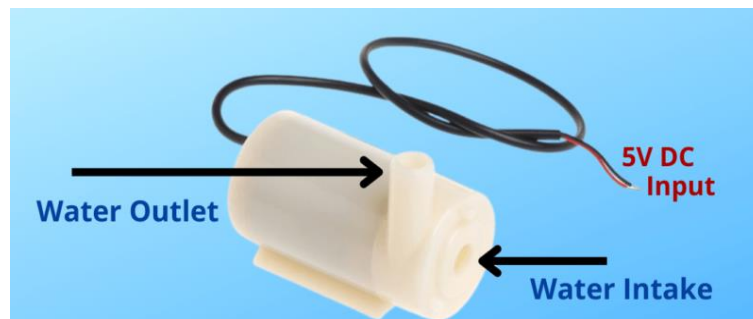


Fig:5.6 : Water Pump

The water pump can be defined as a pump which uses the principles like mechanical as well as hydraulic throughout a piping system and to make sufficient force for its future use. They have been approximately in one structure otherwise another because of early civilization. At present these pumps are utilized within a wide range of housing, farming, municipal, and manufacturing applications.

5.2.5 Arduino Uno

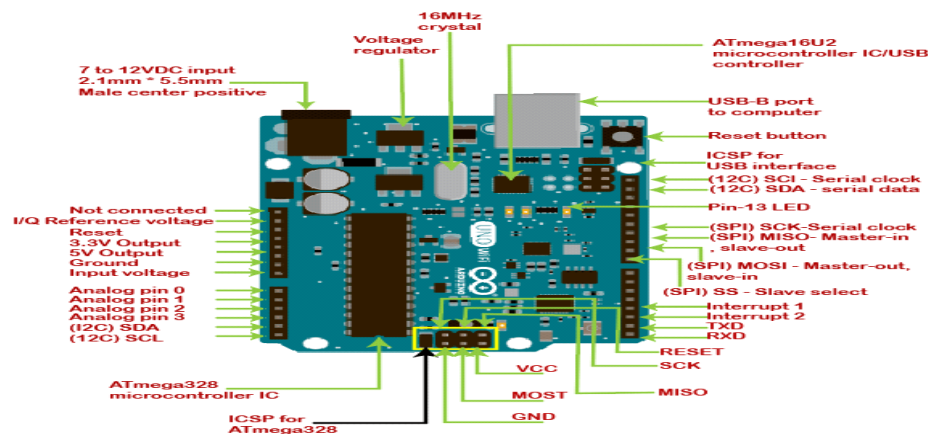


Fig:5.7 : Arduino-Uno

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), an USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the micro controller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

5.2.6 DHT11 Sensor

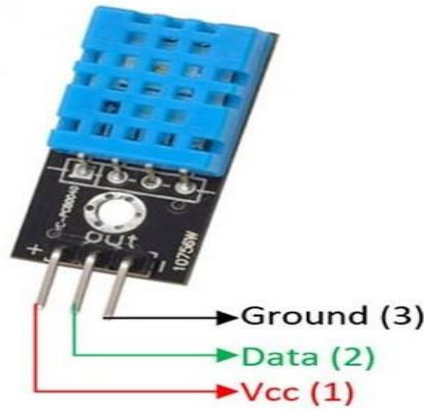


Fig:5.8 : DHT11 Sensor

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

DHT11 Specifications are,

1. Operating Voltage: 3.5V to 5.5V
2. Operating current: 0.3mA (measuring) 60uA (standby)
3. Output: Serial data
4. Temperature Range: 0°C to 50°C
5. Humidity Range: 20% to 90%
6. Resolution: Temperature and Humidity both are 16-bit

5.2.7 MAX485 TTL To RS485 Converter Module



Fig:5.9 : MAX485 TTL to RS485 Converter Module

This converter lets you send and receive data using the RS485 network from your Arduino/microcontroller. MAX485V converter board, serial data can be transmitted in both directions at a data rate up to 2.5Mbps. RS485 to TTL converter module is also possible to connect multiple modules together for communication between 2 or more devices. Each module contains one driver and one receiver.

The specifications are,

1. Operating voltage: 5v
2. Speed: upto 2.5Mbit/Sec
3. Multi drop supports: Up to 32 devices on the same bus
4. Power LED: Red

5.2.8 OLED LCD Display



Fig:5.10 : OLED LCD Display

The full form of OLED is "Organic Light Emitting Diode". It is a type of display technology that uses organic materials to emit light when an electric current is passed through them. OLED displays are known for their high contrast, vibrant colors, and wide viewing angles. The organic materials are sandwiched between two electrodes, and each pixel can be controlled individually to produce the desired color and brightness. The specifications are,

1. Driver IC: SSH1106 or SSD1306.
2. Viewing angle: >160
3. Voltage: DC 3V-5V
4. Work temp: -30c-70c

5. Font Color: Blue

5.2.9 Arduino Nano Cable



Fig:5.11 : Arduino Nano Cable

The Cable for Arduino Nano (USB 2.0 A to USB 2.0 Mini B) 30cm connects speed-critical devices. It is constructed with corrosion-resistant, gold-plated connectors for optimal signal clarity and shielding to minimize interference and it is compatible with Arduino Nano Board.

5.2.10 Arduino Nano

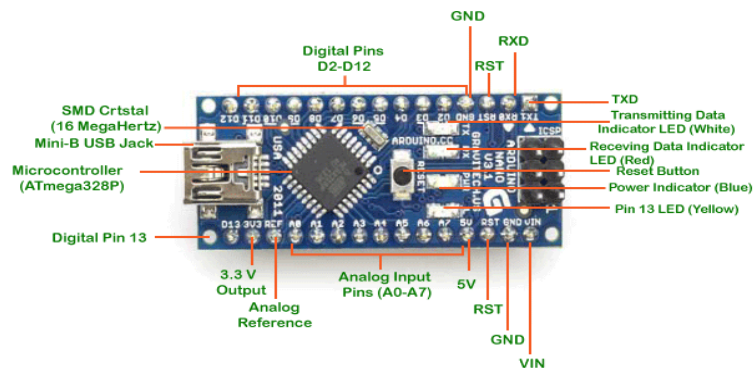


Fig:5.12 : Arduino Nano

The Nano board is defined as a sustainable, small, consistent, and flexible microcontroller board. It is small in size compared to the UNO board. The Arduino Nano is organized using the Arduino (IDE), which can run on various platforms. Here, IDE stands for Integrated Development Environment. This Nano board is different in packaging. It doesn't have any DC jack so that the power supply can be given using a small USB port otherwise straightly connected to the pins like VCC & GND. This board can be supplied with 6 to 20volts using a mini USB port on the board. The specifications are,

1. Operating Voltage : 5V
2. Input Voltage : 7V – 12 V
3. Clock Speed : 16 MHz
4. Flash Memory : 32 KB
5. SRAM : 2KB
6. EEPROM : 1 KB
7. Digital IO Pins : 22 Pins
8. Analog Input Pins : 8
9. Communication : IIC, SPI, USART
10. Serial : Tx, Rx

5.3 PROPOSED SYSTEM SIMULATION

The simulation of the proposed system is done using Proteus software. All the components are assembled and validated by testing the output under different simulation conditions.

This simulation includes Arduino Uno, 2*16 LCD Display, Temperature sensor, Soil moisture sensor and dc motor. Moisture sensor senses the moisture level in the soil and which is given as a signal to the Arduino. If the moisture level is less than predetermined value then Arduino outputs the signal to the motor and the pump is turned on.

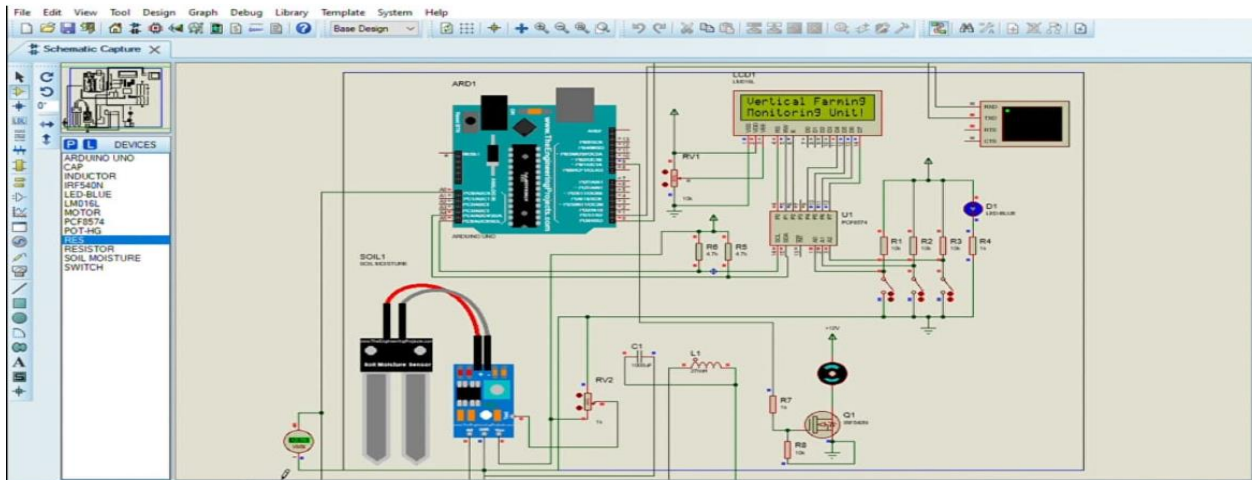


Fig:5.13 : Proposed System Simulation Pic when the Kit is Turned On

This is the simulation of the proposed system when the moisture level is less than the predetermined value. The predetermined value is 25%. If the moisture value is less than 25% then the water pump turn on. This figure represents the moisture value as 24%. It is less than the predetermined value. The moisture sensor output is displayed in LCD display.

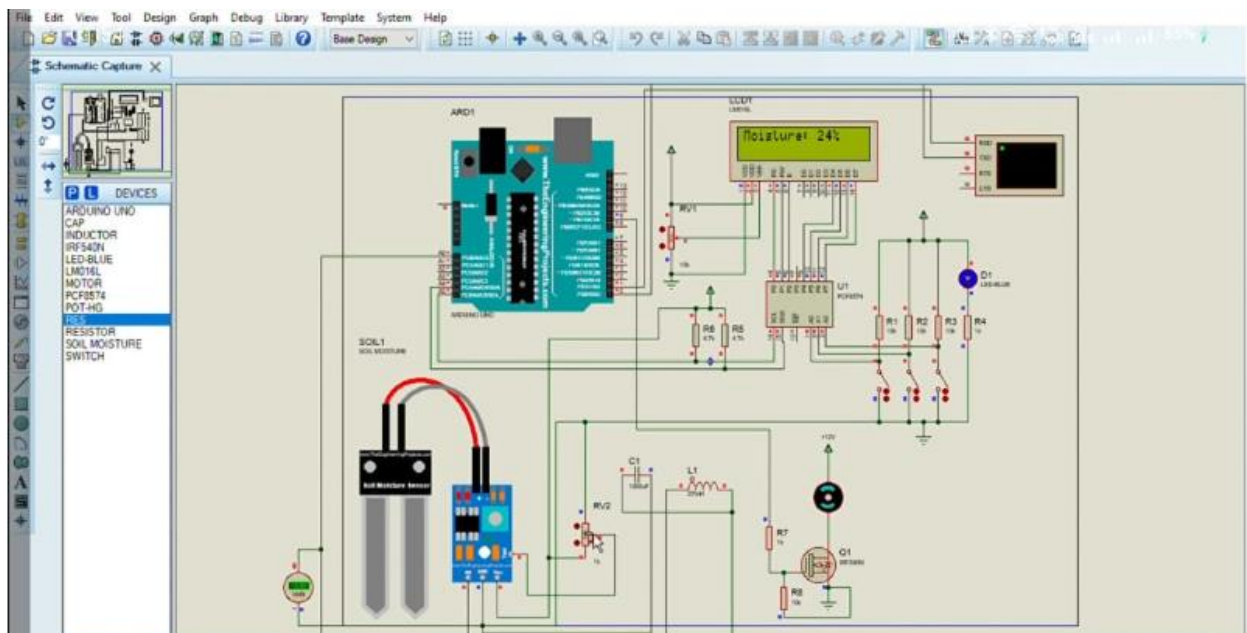


Fig:5.14 : Proposed System Moisture Level Output

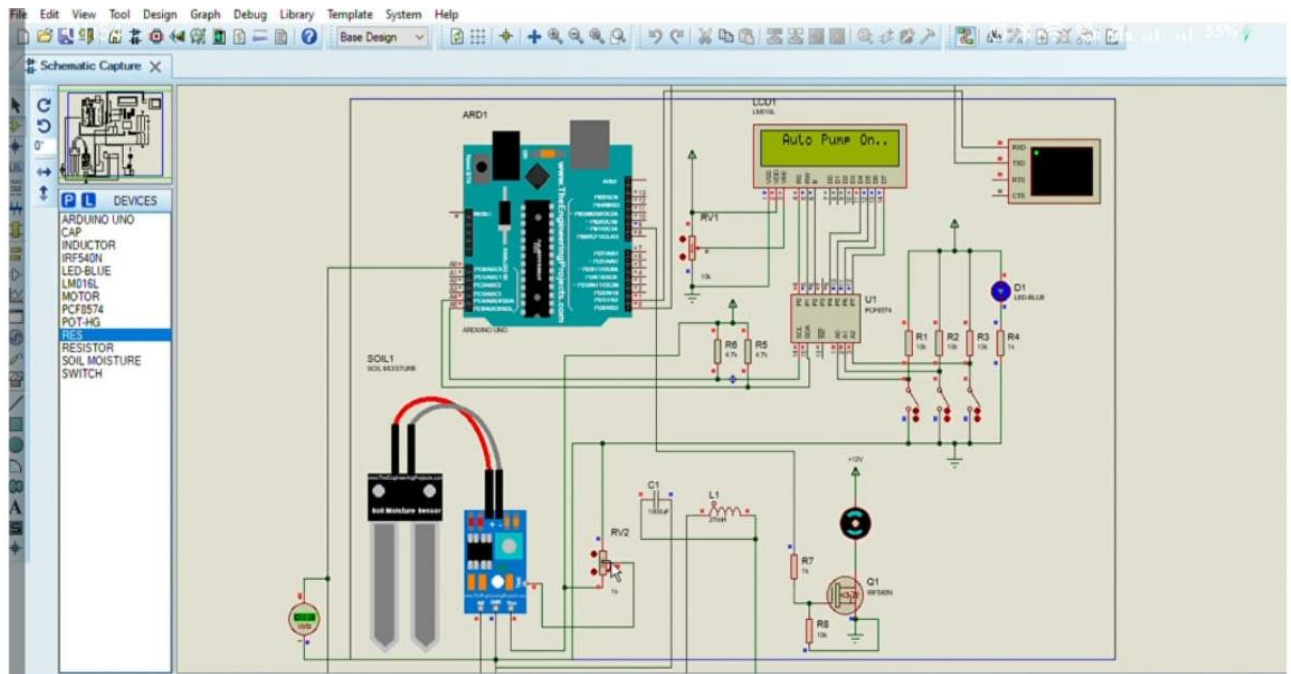


Fig:5.15 : Simulation of the Proposed System when the Pump will Turn On.

The moisture level 24%. So, motor turned on to reach predetermined value of moisture level. Soil moisture sensor senses the moisture level again and it will give the signal to the Arduino. When the moisture level reaches the per-determined value (above 25%) then the motor will TURN OFF automatically. LCD display displays the output as Auto Pump off.

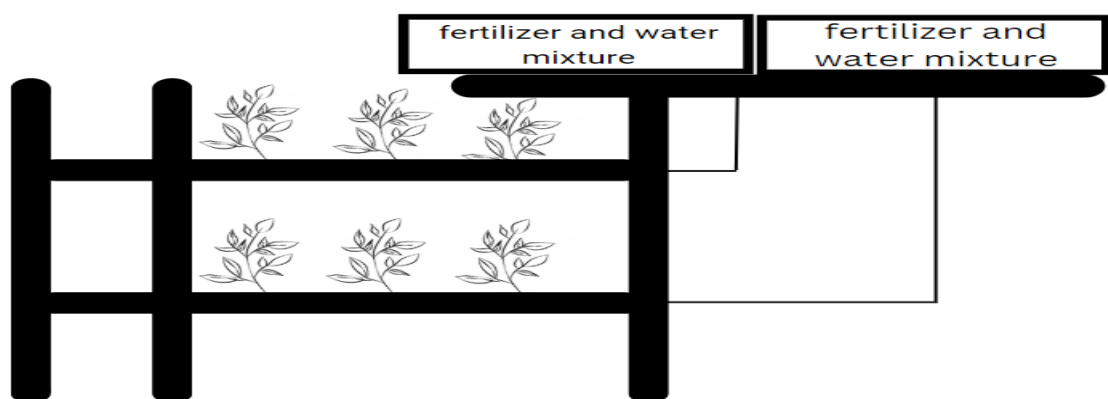


Fig:5.16 : Model Diagram of the Proposed System.

The assumed construction of the proposed system is shown above. Pipes, plants, water tank (which contains fertilizer and water mixture) are used to build a proposed project.

5.4 HARDWARE WORKING



Fig:5.17 : Hardware kit.

The hardware and plant setup in the vertical irrigation method which includes a soil moisture sensor, NPK sensor, Temperature sensor, water pump controller and dc motor are assembled in Fig.



Fig:5.18 : Plant Setup in Vertical Manner

An automatic fertilized vertical irrigation system using an NPK sensor is a smart irrigation system that combines the use of sensors, fertilizers, and water to provide optimal growing conditions for plants. The system is designed to provide plants with the right amount of nutrients and water at the right time, to maximize growth and productivity. The system typically consists of several components, including NPK sensors, soil moisture sensors, a fertilization mechanism, an irrigation system, and a control unit. The NPK sensors measure the levels of nitrogen, phosphorus, and potassium in the soil, while the soil moisture sensors measure the moisture content in the soil. The control unit processes the data from the sensors and determines the optimal irrigation and fertilization requirements for the plants. If the moisture content in the soil is low, the irrigation system is activated to provide water to the plants. If the nutrient levels in the soil are low, the fertilization mechanism is activated to provide the necessary nutrients to the plants.

The system can be programmed to provide a specific amount of water and nutrients based on the needs of the plants at different stages of growth. This ensures that the plants receive the appropriate amount of water and nutrients to promote healthy growth and development. Overall, an automatic fertilized vertical irrigation system using an NPK sensor is an efficient and effective way to manage plant growth, reduce waste, and increase productivity. It provides a precise and automated way to deliver water and nutrients to plants, resulting in healthier and more productive crops.

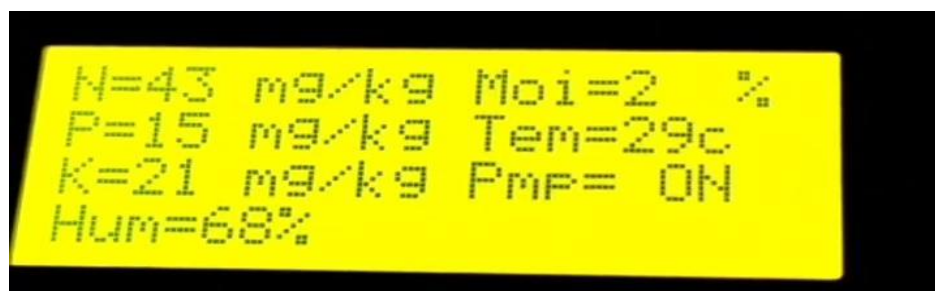


Fig:5.19 : LCD display when the Moisture Level is Less than the Predetermined Value

When moisture level is decreased below the predetermined value the LCD display will show like above figure 5.19 and moisture level sensor will give signal to the Arduino and the motor will turn on from the signal given by the Arduino to reach predetermined moisture value.

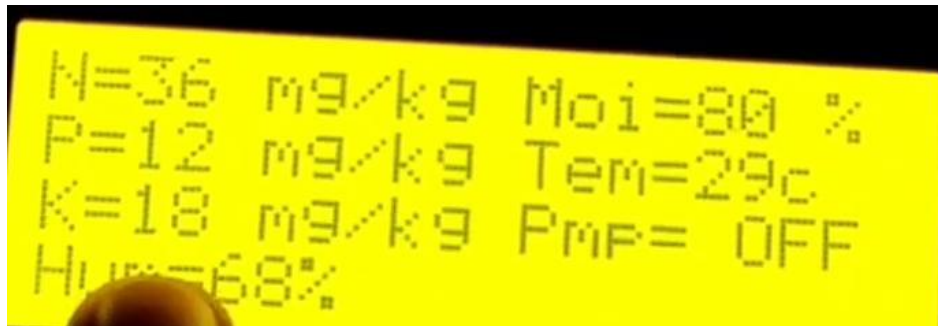


Fig:5.20 : Moisture Level Reaches the Predetermined Value.

When the moisture level reached predetermined value, the motor will turn OFF and the LCD display will show like fig 5.20

When Npk values less than the predetermined value it will Show in the LCD display. The NPK sensor will give signal to the Arduino and motor will turn on according to the signal given by the Arduino and motor will supply fertilizer to the plants according to the need of the plants.

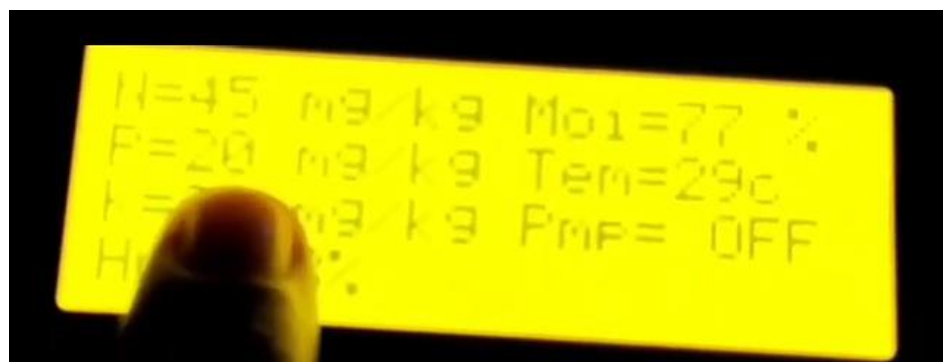


Fig:5.21 : NPK Values Reaches the Predetermined Value.

5.4.1 Advantages of Proposed System

The advantages of an automatic fertilized vertical irrigation system using an NPK sensor include:

1. Improved plant growth: By providing the plants with the appropriate amounts of water and nutrients, the system can improve plant growth and increase yields.
2. Reduced water and fertilizer waste: The system can significantly reduce water and fertilizer waste by delivering only the required amount of water and nutrients to the plants. This reduces costs and environmental impact.
3. Increased efficiency: The system can operate autonomously, reducing the need for manual intervention and increasing the efficiency of the irrigation and fertilization process.
4. Precise nutrient management: By using an NPK sensor, the system can precisely monitor the nutrient levels in the soil and apply fertilizers accordingly, avoiding over- or under-fertilization.
5. Water conservation: By using soil moisture sensors to determine the appropriate irrigation needs of the plants, the system can help conserve water by avoiding unnecessary watering.
6. Real-time monitoring: The system can provide real-time data on soil moisture and nutrient levels, allowing for quick adjustments to the irrigation and fertilization process.
7. Improved crop quality: The system can improve crop quality by ensuring that the plants receive the appropriate nutrients and moisture, leading to healthier and more robust plants.

Overall, an automatic fertilized vertical irrigation system using an NPK sensor can significantly improve the efficiency and effectiveness of crop management, resulting in increased yields and reduced environmental impact.

CHAPTER 6

FUTURE SCOPE

6.1 SUMMARY

A smart automatic fertilized vertical irrigation system using NPK sensors is a system designed to optimize plant growth and reduce water and fertilizer usage by automatically adjusting the flow rate of fertilizer based on real-time measurements of soil nutrient levels. The system typically involves suspending plants in a vertical configuration and using pumps, pipes, and drip emitters to deliver water and fertilizer evenly to all plants. The NPK sensors are integrated into the system to measure soil nutrient levels, and the data is transmitted to a central controller for analysis. Automated system adjusts the flow rate of fertilizer in response to changes in soil nutrient levels. This ensures that plants receive the optimal amount of fertilizer, while minimizing waste and reducing the risk of over-fertilization.

The smart automatic fertilized vertical irrigation system using NPK sensors can help promote healthy plant growth and reduce the environmental impact of agriculture by reducing water and fertilizer usage. The system can also improve efficiency and reduce labour costs by automating the fertilizer application process. Overall, this system represents a significant advancement in the field of agriculture, and has the potential to revolutionize the way we grow crops and manage irrigation systems in the future.

6.2 FUTURE EXTENSION

The future scope of the automatic fertilized vertical irrigation system using NPK sensor project is quite promising, and there are several potential avenues for further research and development. Some of the key areas of future scope for this project include:

1. Improved sensor technology: While NPK sensors are already highly accurate and reliable, there is still room for improvement in sensor technology. Future research could focus on developing even more precise and sensitive sensors that can measure soil nutrient levels with even greater accuracy.

2. Optimization of fertilizer application rates: While the automatic fertilized vertical irrigation system using NPK sensors is already highly efficient, there may be opportunities to further optimize fertilizer application rates. Future research could focus on developing more advanced algorithms or decision-making models that can adjust fertilizer application rates in real-time based on a wider range of factors.
3. Integration with other technologies: The automatic fertilized vertical irrigation system using NPK sensors could be further enhanced by integrating with other technologies such as weather sensors, drones, and remote sensing technologies. This could help improve irrigation scheduling and further reduce water waste.
4. Application in different environments: While the automatic fertilized vertical irrigation system using NPK sensors is well-suited to certain types of crops and environments, there may be opportunities to apply this technology in other contexts. Future research could explore the potential for using this system in greenhouse environments, hydroponic systems, and other controlled environments.
5. Scaling up for commercial use: While the automatic fertilized vertical irrigation system using NPK sensors has the potential to improve agricultural productivity and efficiency, there may be challenges to scaling up this technology for commercial use. Future research could focus on developing strategies for overcoming these challenges and implementing this technology at scale.

Overall, the automatic fertilized vertical irrigation system using NPK sensors represents a promising area of research and development for improving agricultural practices and promoting sustainable agriculture. With continued research and development, this technology has the potential to revolutionize the way we grow crops and manage irrigation systems in the future.

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APPENDIX

PROGRAM FOR ARDUINO UNO

```
#define Soil 14
#define Motor 9
int Moisture;
int Moisture_Percentage;
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);
void setup()
{
  pinMode(Soil, INPUT);
  pinMode(Motor, OUTPUT);
  digitalWrite(Motor, LOW);
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0,0);
  lcd.print("Vertical Farming");
  lcd.setCursor(0,1);
  lcd.print("Monitoring Unit!");
  delay(3000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Calibrating...");
  delay(3000);
  lcd.clear();
  lcd.setCursor(6,0);
  lcd.print("Data");
  lcd.setCursor(1,1);
  lcd.print("Extraction...!");
  delay(3000);
  lcd.clear();
  Serial.begin(9600);
```

```

}
void loop()
{
  Moisture = analogRead(Soil);
  Moisture_Percentage = ( 100 - ( Moisture / 1023.00 ) * 100 );
  Water();
  if(Moisture_Percentage <= 25)
  {
    lcd.clear();
    lcd.setCursor(2,0);
    lcd.print("Auto Pump On...!");
    delay(1000);
    digitalWrite(Motor, HIGH);
    lcd.clear();
  }

  else
  {
    digitalWrite(Motor, LOW);
  }
}
void Water()
{
  lcd.clear();
  Moisture = analogRead(Soil);
  Moisture_Percentage = ( 100 - ( Moisture / 1023.00 ) * 100 );
  Serial.print("Moisture Percentage = ");
  Serial.print(Moisture_Percentage);
  Serial.print("%");
  Serial.println();
  lcd.setCursor(0,0);
  lcd.print("Moisture: ");
  lcd.print(Moisture_Percentage);
  lcd.print("%");

```

..

```
    delay(1000);  
    lcd.clear();  
}
```