

PLANT HEALTH MONITORING SYSTEM
BASED ON ACOUSTIC SOUND SENSOR MACHINE LEARNING
Submitted in partial fulfilment of requirements for the award of
Bachelor of Engineering
in
Electronics and Communication Engineering

By

O.AFRID BASHA (40130268)

K.CHANDRA SAI KUMAR (40130275)



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A++” by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI,

CHENNAI – 60011

APRIL-2024



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited "A++" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **O.AFRID BASHA(40130268)** and **K. CHANDRA SAI KUMAR (40130275)** who carried out the project entitled "**PLANT HEALTH MONITORING SYSTEM BASED ON ACOUSTIC SOUND SENSOR MACHINE LEARNING**" under my supervision from December 2024 to April 2024

Internal Guide

Dr.T.BERNATIN M.E.,Ph.D.

Head of the Department

Dr.T.RAVI M.E., Ph.D.

Submitted for Viva voce Examination held on 18/4/24

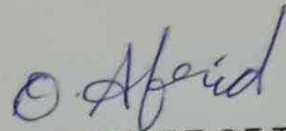
Internal Examiner
External Examiner

DECLARATION

We, O.AFRID BASHA 40130268) and K.CHANDRA SAI KUMAR (40130275) here by declare that the Project Report entitled "PLANT BASED HEALTH MONITORING SYSTEM BASED ON ACOUSTIC SOUND SENSOR MACHINE LEARNING" done by us under the guidance of Dr.T.BERNATIN M.E.,Ph.D. Associate Professor is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering

DATE: 18.04.2024

PLACE: Chennai: Chennai



SIGNATURE OF THE THECANDIDATE

DECLARATION

We, O.AFRID BASHA 40130268) and K.CHANDRA SAI KUMAR (40130275) here by declare that the Project Report entitled "PLANT BASED HEALTH MONITORING SYSTEM BASED ON ACOUSTIC SOUND SENSOR MACHINE LEARNING" done by us under the guidance of Dr.T.BERNATIN M.E.,Ph.D. Associate Professor is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering

DATE: 18-04-2024

PLACE: Chennai : chenni

K.Chandrasaikumar

SIGNATURE OF THE THECANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge our sincere thanks to **Board of Management of SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N.M. NANDHITHA M.E., Ph.D.**, Dean, School of Electronics and Communication Engineering and **Dr. T. RAVI M.E., Ph.D.** Head of the Department, Department of Electronics and Communication Engineering for providing me necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **Dr. T. BERNATIN M.E., Ph.D.** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

I wish to express our thanks to all Teaching and Non-teaching staff members of the Department of **Electronics and Communication Engineering** who were helpful in many ways for the completion of the project.

TABLE OF CONTENTS

TITLE	Page No.
ABSTRACT	6
LIST OF FIGURES	
1 INTRODUCTION	7
2 LITERATURE SURVEY	15
2.1 Inferences from Literature Survey	
2.2 Open problems in Existing System	
3 REQUIREMENTS ANALYSIS	
3.1 Feasibility Studies/Risk Analysis of the Project	
3.2 Software Requirements Specification Document	
3.3 System Use case	
4 DESCRIPTION OF PROPOSED SYSTEM	19
4.1 Selected Methodology or process model	
4.2 Architecture / Overall Design of Proposed System	
4.3 Description of Software for Implementation and Testing plan of the Proposed Model/System	
4.4 Project Management Plan	
4.5 Financial report on estimated costing	
4.6 Transition/ Software to Operations Plan	
5 IMPLEMENTATION DETAILS	26
5.1 Development and Deployment Setup	
5.2 Algorithms	
5.3 Testing	
6 RESULTS AND DISCUSSION	
7 CONCLUSION	30
7.1 Conclusion	
7.2 Future work	
7.3 Research Issues	
7.4 Implementation Issues	
REFERENCE	31

APPENDIX

A.SOURCE CODE

B.SCREENSHOT

C.RESEARCH PAPER

ABSTRACT

Automatic pest classification is a very important step to protect the agricultural crops against the attack of pest. This helps to increase the crop yield by reducing the pests that affect agricultural productivity. In addition, automatic irrigation systems aid in the enhancement of agricultural land productivity by computing optimal amount of water required by the plants. In this research, we proposed a new technique called IoT-based pest classification and automatic irrigation algorithm (IPCAI) using wireless sensor networks. In this technique, sensors like moisture sensor, temperature sensor and integrated to Arduino Microcontroller module. The data acquired by these sensors are processed using ESP 8266 Express If Systems WI-FI Development Board that is connected to the cloud. The proposed IPCAI machine learning algorithm is embedded into the ESP 8266 Express If Systems WI-FI Development Board that classifies the type of pest and also computes the optimal amount of water required by the crops. Based on the type of pest being detected, suitable pesticide is sprayed to the crops to improve the crop yield. This helps in the prevention of spreading of pests. It was found that the proposed algorithm classifies 40 different type of pest with very high accuracy. In addition, the proposed automatic irrigation system helps to conserve enormous quantities of water. The IoT-module connected to the ESP 8266 Express If Systems WI-FI Development Board helps to upload the data collected by the sensors, pest classification result, and water requirement result to the cloud. From the cloud, the data is transmitted to the farmer's mobile, using which the famers can continuously monitor the crop land from remote locations. The proposed pest classification algorithm achieved high specificity of 95.86% with a precision rate of 96.69%.

CHAPTER 1

INTRODUCTION

Water availability on earth surface is only 0.01%. So water is a rare resource and irrigation systems also face problems with water scarcity. Therefore it is necessary to have a smart irrigation system where the water is precisely used.

The requirement of water in the irrigation system is very crucial, so the new irrigation methods should implement in such a manner that requires less water consumption when compared to old technologies. Our Proposed model can control water waste up to 95% whereas the traditional methods result in around 20% to 70% Our prototype is designed for continuously monitoring the weather conditions, the water level in the reservoir, and soil moisture, and then supplying water depending on the requirement Based on the Buzzing Sound notification from the data through the Acoustic sensors . we can automate the pesticide sprayer. This will increase the probability of anti deflecting rate caused by bugs and insects. Thus growth of the plant will be in an effective manner which could help the farmers to yield more profits with good stuffs.

Plant plays a vital role in maintaining the ecological cycle and forms the foundation of a food chain pyramid and thus to maintain the plant's proper growth and health adequate monitoring is required. Hence the aim at making plant monitoring system smart is using automation and Internet of Things (IOT) technology. This topic highlights various features such as smart decision making based on soil moisture real time data.

The computerized water system framework with IOT is practically and financially sufficient for planning water resources for plantation (group of a plant). Adopting the automatic water system framework we can demonstrate that the utilization of water can be decreased for various plantations (group of plants) usages. The system framework has an appropriated microwaves (wireless) chain of moisture content in the soil through soil moisture sensor, humidity and temperature sensor set in the root zone of the plants and level of water (ultrasonic) sensor is set in tank for checking the water level in tank. The data will gather from the sensors and send to the web server (cloud).

The background of chapter highlights the study of IOT in the field of agriculture. This shows how we can implement the IOT technology to make our planting smart and reliable with the real time updated data. This chapter also helps the beginners to implement the IOT technology and learn the basics of this technology.

Internet of Things (IoT) plays an important role in most of the fields. The use of IoT increased because of the various advantages we can get from that. The agriculture is the area where a lot of improvement is needed because that is one of the essential needs and a large sector of people is involved in that. Most of the area the major problem is the water scarcity because of low rainfall and even though there is rainfall the water is wasted because of no proper arrangement for the storage of water. Many techniques are proposed in IoT in terms of providing a better irrigation to the crop. The IoT devices can also be used in home for monitoring the garden real time.

The Raspberry and Arduinio plays an important role in processing the information that is received from various sensors. The cost of these devices will be affordable and the major issue is the usage of large amount of sensors and other devices. Much research focus is on finding the effect of these devices in the environment, if it causes any side effects to the humans. The Rapberry pi is used wherever a large amount of processing is required and Arduinio in terms of interconnecting certain hardware devices and performs a little amount of processing. The installation of the sensors for finding the humidity level is one major factor to avoid the wastage of water.

Since governments throughout the world implemented lockdowns to combat the spread of COVID-19, there has been a surge in interest in home gardening. Most families nowadays begin gardening during this season since they may grow whatever veggies, fruits, or other plants they desire in their daily lives. As a result, they will be able to make it through this period without having to spend money on online grocery shopping for fruits and vegetables. Due to the epidemic home gardening has been popular in recent months. Most of the households were attempting to grow for their purposes. However, the government is currently attempting to lift such limitations to allow people to return to regular work . People are starting to do their jobs because of this scenario, and they do not have time to continue planting in their gardens. We discussed the issue and attempted

to develop a solution that would allow them to continue working while doing so. The main issue is that individuals cannot constantly watch their plants to safeguard their gardens. As a result, we decided to automate the garden labor. Gardeners may use our innovative solution to monitor critical parameters such as plant health and illness, soil moisture level, air humidity level, and surrounding temperature, as well as water their garden from anywhere in the globe at any time. The current approach is based on observation with the naked eye, which is a time-consuming process. To detect plant disease at an early stage, automatic detection of plant disease can be used. Farmers have utilized a variety of disease control techniques daily to prevent plant illnesses.

1. 1 Low-Cost Wireless Sensor IoT Network Design

The Internet-of-Things (IoT) comprises a network of embedded networked computers (implanted into everyday ‘things’) that are able to sense the environment, as well as communicate and interact with people and each other . The falling costs of embedded devices and advanced networking has led to a proliferation of IoT applications in industries, cities, homes, and the natural world, all of which enhance people’s lives . Consequently, the ‘assisted living’ community are investing much ongoing research and development into the use of IoT. For example, an important area of IoT research needed to realise the ‘assisted living’ vision is inter-device communication,

especially that relating to the development of the wireless sensor network (WSN). WSNs are networks that consist of multiple sensor nodes, with a gateway and a wireless transmission path. Generally, node communication is supported by technologies such as Wi-Fi, Low Energy Bluetooth, ZigBee, 6LoWPAN, and 4/5G.

We live in a world where everything can be controlled and operated automatically, but there are still a few important sectors in our country where automation has not been adopted or not been put to a full-fledged use, perhaps because of several reasons one such reason is cost. One such field is that of agriculture. Agriculture has been one of the primary occupations of man since early civilizations and even today manual interventions in farming are inevitable. Plant monitoring form an important part of the agriculture and

horticulture sectors in our country as they can be used to grow plants under controlled climatic conditions for optimum produce. Automating a plant monitoring and controlling of the climatic parameters which directly or indirectly govern the plant growth and hence their produce. Automation is process control of industrial machinery and processes, thereby replacing human operators. In this paper the presented plant monitoring system technology to provide feedback to the user through smart phone. The automated system will reduce the need of manpower, hence reducing the error. for a largescale area, it is quite impossible for a farmer to monitor the efficiency of the system by implementing this technology, the farmers can easily monitor the system using their smart phone. Also due to busy life these days we are not able to keep proper care of plants such as watering plant, to check whether plant is getting sufficient sunlight etc. To easy this we are making an IOT based automation system in which user can monitor plant parameters such as temperature, humidity, moisture and can also water them.

Agriculture represents one of the important roles in the life and well-being of people; it is a food production process and a source of food for both the population and domestic animals. Over time, the climate has undergone changes to which people have had to adapt and implicitly adapt the solutions used to ensure the quality of food or water, both for irrigation and for daily use. The health of soils and crops is very important, since it affects the quality and quantity of agricultural products. In the agricultural area, crops must be watered whenever necessary and only with the amount of water needed at that particular time of irrigation. Precision agriculture (AP) aims to support and improve farm management by automating agricultural tasks.

1.2 Insect Sound-Production Variability

Adult and immature stages of stored product insect pests vary considerably in size and in the amplitudes and rates of sounds they produce (Arnett 1968, Mankin et al. 1997a). Relatively large *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst) adults, for example, are more readily detected than intermediate-sized *Rhyzopertha dominica* while the smaller *Cryptolestes ferrugineus* and *Oryzaephilus surinamensis*

L. are less readily detected (Hagstrum and Flinn 1993). Some insects become quiet when they are disturbed, and the time needed for them to return to normal activity after a

disturbance must be taken into account when they are monitored (Arnett 1968, Mankin et al. 2011). The rate of sound production also is affected by external factors such as temperature and disturbance levels. Vick et al. (1988a) determined that *S. oryzae* larvae in grain can be detected from distances up to 10 to 15 cm. *Tribolium castaneum* adults were detected up to 18.5 cm (Hagstrum et al. 1991). On average the sound production rate of immature stored product insects tends to increase with instar, as was found for *S. oryzae* larvae in grain (Pittendrigh et al. 1997, Hickling et al. 2000) and *Callosobruchus maculatus* (F.) larvae in cowpeas, *Vigna unguiculata* (L.) Walp., (Shade et al. 1990). Also, externally moving adults often produce sounds at considerably higher rates than internally feeding larvae, up to 37 times higher for *R. dominica* (Hagstrum et al. 1990), and 80 times higher for *T. castaneum* (Hagstrum et al. 1991). It should be noted, however, that because sound levels attenuate with increasing distances from a sensor, a small larva in a nearby grain kernel might be detected at the same time that signals from a much larger adult outside the 15 to 20 cm active space might fall below background noise levels. In addition, a small adult insect like *C. ferrugineus* will move through the interstices between grains easily and produce fewer sounds than larger adults such as *R. dominica*. Disturbance can enhance or reduce detectability of stored product insect pests, depending on the species, and increases in temperature usually result in increased rates of sound production until temperatures exceed 30 to 40°C. Stirring of grain containing 4th-instar *S. oryzae*, for example, reduced sound production for periods of up to 20 minutes (Mankin et al. 1999). Adult *T. castaneum* sound production increased between 10 and 40°C (Hagstrum and Flinn 1993), while *C. maculatus* larvae decreased their rates of sounds above 38°C in cowpeas (Shade et al. 1990). Sound production of *S. oryzae* adults in grain decreased above 30 to 35°C, and *R. dominica* adult sound production rates plateaued above 30°C (Hagstrum and Flinn 1993). Rapid heating has been tested to increase the detectability of adults and internally feeding larvae in stored grain initially at low Temperatures below 20 °C. The use of radiant or convective heat, to raise the temperature rapidly above 29°C, increased the rate of sounds from internally feeding *S. oryzae* larvae by a factor of 2 to 5 (Mankin et al. 1999). A patent was issued in France for heating grain to increase insect sound production (Mihaly 1973). Under conditions of low disturbance and optimal temperatures, monitoring times of 180 seconds are adequate to

reliably detect many stored product insects. The minimum monitoring interval depends on the fraction of time the insects are active.

Acoustic Signatures and Temporal Patterns of Insect-Produced Signals

Problems in distinguishing sounds produced by target species from background noise and sounds from other insects have hindered usage of acoustic devices, but new devices and signal processing methods have greatly increased detection reliability. One new method considers spectral and temporal pattern features that prominently appear in insect sounds but not in background noise, and vice versa. Insect chewing and movement sounds usually have acoustic signatures (high-frequency components containing few harmonics) and they occur in bursts of short, 3 to 10 millisecond impulses (Potamitis et al. 2009, Mankin et al. 2010, Mankin and Moore 2010). Listeners or scouts can readily identify many distinguishing characteristics in the sounds produced by a target species after about an hour of training (Mankin and Moore 2010). Better understanding of these signal characteristics has led to improved capabilities for automated insect detection and monitoring (Mankin et al. (2010, 2011).

Efficacy and Reliability of Acoustic Detection Devices

The efficacy of acoustic devices depends on many factors, including sensor type and frequency range, substrate structure, interface between sensor and substrate, assessment duration, size and behavior of the insect, and the distance between the insects and the sensors. Larvae and/or adults of 18 species of stored product insect pests have been detected in grain or packaged goods using one or more of six types of acoustic sensors . Considerable success has been achieved in protection against false positives (predicting the presence of a target insect when none is present) and some with false negatives (predicting the absence of insects when one is present) in detecting grain insect pests. For example,

Successful Applications of Acoustic Technology for Stored Product Pest Detection

Acoustic methods have been applied successfully for grain inspection (Vick et al. 1988a, b, Pittendrigh et al. 1997, Shuman et al. 1993, 1997), estimations of population density

(Hagstrum et al. 1988, 1990, 1991, 1996), and mappings of stored product insect pest distributions (Hagstrum et al. 1996). Data collected by acoustic sensors from grain infested with a single species and stage typically provides sampling statistics similar to those estimated from grain samples for *R. dominica* larvae (Hagstrum et al. 1988) and *T. castaneum* adults (Hagstrum et al. 1991). Successful Applications of Acoustic Technology for Stored Product Pest Detection Acoustic methods have been applied successfully for grain inspection (Vick et al. 1988a, b, Pittendrigh et al. 1997, Shuman et al. 1993, 1997), estimations of population density (Hagstrum et al. 1988, 1990, 1991, 1996), and mappings of stored product insect pest distributions (Hagstrum et al. 1996). Data collected by acoustic sensors from grain infested with a single species and stage typically provides sampling statistics similar to those estimated from grain samples for *R. dominica* larvae (Hagstrum et al. 1988) and *T. castaneum* adults (Hagstrum et al. 1991). Finally, networking opportunities provided by modern communication systems could assist in agricultural sourcing and tracing initiative (1998) and permit tracking of insect infestations in grain and other commodities as they move through the marketing system. The capability of acoustic sensor systems to interface directly with intelligent computer networks enables reductions in the labor costs and risks of collecting such information. As reliability and ease of use increase and costs decrease, acoustic devices have considerable future promise as insect detection and monitoring tools

Agriculture:

A greenhouse farming technique enhances the yield of crops by controlling environmental parameters. However, manual handling results in production loss, energy loss, and labor cost, making the process less effective. A greenhouse with embedded devices not only makes it easier to be monitored but also, enables us to control the climate inside it. Sensors measure different parameters according to the plant requirement and send them to the cloud. It, then, processes the data and applies a control action.

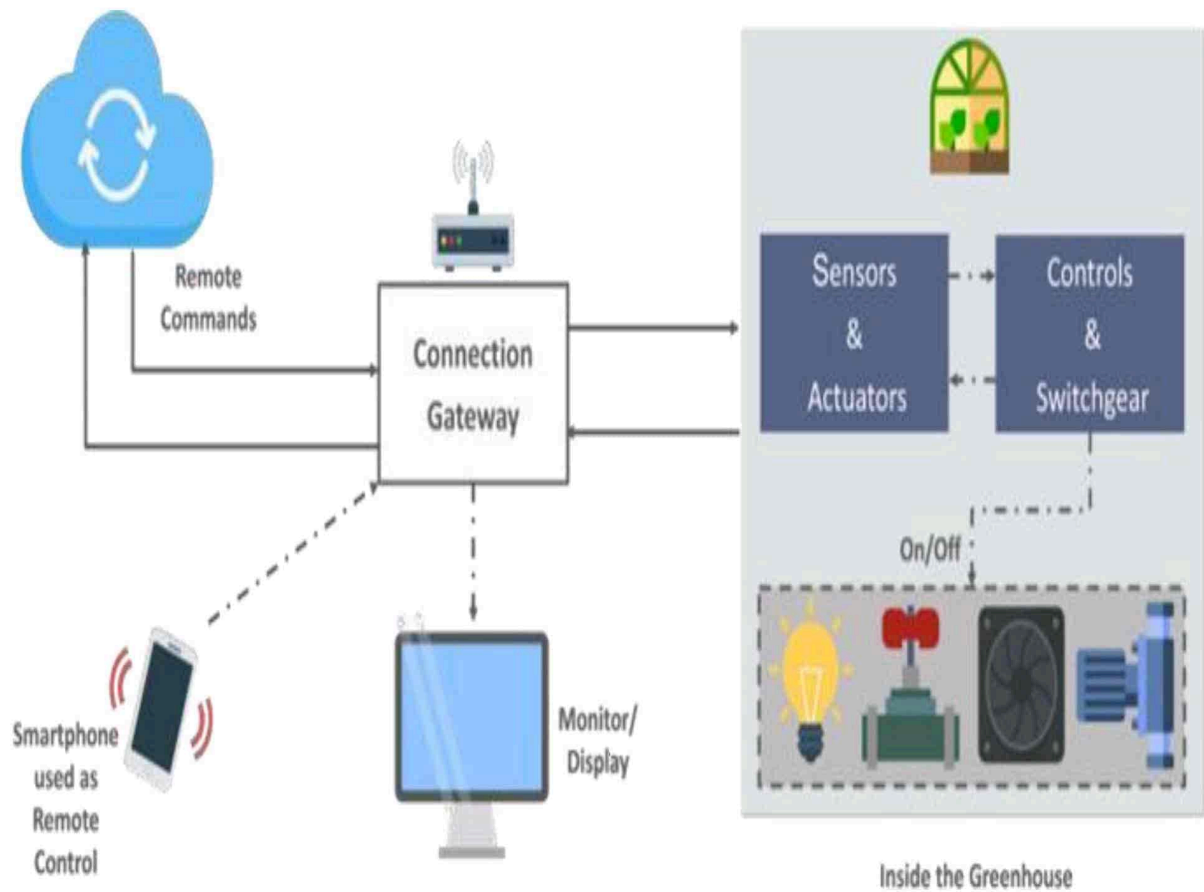


Figure 1.2 : IoT Controlled Greenhouse Environment

LITERATURE SURVEY

IoT sensor-based agriculture is now widely recognized as the new age of farming. It will shortly exchange traditional farming practices also enhance agricultural output [31]. It is already in use in large farms and industrialized nations, but if properly implemented in countries such as India, China, and Africa, it may quickly solve world hunger. This contemporary farming approach has the potential to usher in a new era of green revolution and pave the way for progress in a nation like India, where farming is the major sector and market is based on it. These also demonstrated how variety sorts of sensor based on general research concepts are employed in the Internet of Things. The purpose of this study was to present the Internet of Things (IoT) and how it may be used in agricultural operations. The major goal was to go over the different types of agricultural sensors in depth. These are helped to gather information More commercialized sensors are available here were briefly discussed, as well as their benefits. Agricultural sensors were also discussed in terms of their uses, benefits and drawbacks, and obstacle.

Smartphone irrigation sensor To be used in crops, an automatic irrigation sensor was devised and built. [1] The sensor captures and processes digital pictures of the soil around the crop's root zone with a smartphone and calculates the water content visually. The sensor is housed in a room with regulated lighting and buried at the plant's root level. The smartphone's processing and connection components, such as the digital camera and the Wi- Fi network, were controlled directly by an Android App. The smartphone is activated by the mobile App, which wakes it up according to user-defined settings. Through an anti-reflective glass window, the built-in camera takes a picture of the soil., and an RGB to a gray procedure is used to estimate the ratio between the image's moist and dry areas. Using image processing techniques, to monitor the disease area, a wireless camera is installed in the agricultural field. The technology is low-cost and energy-independent, making it ideal for water-scarce and geographically isolated locations.

A new method for augmenting paper documents with electronic information is described that does not modify the format of the paper document in any way. Applicable to both commercially printed documents as well as documents that are output from PC's, the technique we call Paper-Based Augmented Reality substantially improves the utility of paper. We describe the recognition technology that makes this possible as well as several applications. An implementation on a camera phone is discussed that lets users retrieve data and access links from paper documents to electronic data. Recognition is performed at 4 frames per second on a Treo 700w and support is provided for several user applications, including "clickable paper" – printed web pages whose appearance is unchanged but that can be navigated with a camera phone. Linking patches of text will increase a lot of security reasons.

In this paper presented the smart agriculture monitoring system using internet of things (IoT). The proposed model is implemented with the help of different sensors and IoT equipments. This proposed design helps the farmer to continuously monitor the crop to increase the production of the crops in the land. Presently assuming the framework mode set into manual mode, microcontroller unit will send the information to the android gadget. From the client's android cell phone client at that point get a pop-up message from the framework. What's more, in that notice client will see the sensor information. In the wake of checking the current condition, the client will at that point make an appropriate move. In another manner on the off chance that the client set the activity mode programmed, the framework will take sensors information and figure them. In the event that the worth decided a best for water system, water pump will be turned on. Then again, assuming the worth isn't ideal for water system, the framework turned off. For IoT-based control of agricultural advancement conditions, sensor centers that can exist in various zones, entryways that can connect with the web, or little terminals that interlock with their frames through network interfaces.

As human life is heading towards a busy schedule it becomes necessary to automate our home appliances. Human error is something that cannot be completely erased. With the busy schedule in hand, there is defiantly a possibility of missing something that may be trivial to us but can result in a catastrophe. For these reasons, Our Project home

automation can increase efficiency, security, and reliability. AR has recently evolved for the automation of various electrical appliances by popping virtual objects into the real world.

This paper illustrates a methodology to provide a low-cost Home Automation System (HAS) using Wireless Fidelity (Wi-Fi). This crystallizes the concept of internetworking of smart devices. A Wi-Fi-based Wireless Sensor Network (WSN) is designed for the purpose of monitoring and controlling the environmental, safety, and electrical parameters of a smart interconnected home. The different sections of the HAS are; the temperature and humidity sensor, gas leakage warning system, fire alarm system, burglar alarm system, rain-sensing, switching and regulation of load & voltage, and current sensing. The primary requirement of HAS to monitor and control devices is accomplished using a Smartphone application. The application is developed using Android Studio based on the JAVA platform and the User Interface is exemplified. The primary focus of the paper is to develop a solution cost- effective and flexible in the control of devices and implements a wide range of sensors to capture various parameters.

EXISTING METHODOLOGY

1. Automatic Pump and Station AMC is not monitored
2. There is no proper tracking of water source utility
3. Physical emergency overflow cutoff is still in practice
4. Unwanted distribution of water flow is not monitored
5. Terrain distribution of water sources is not precise
6. Bug Control mechanisms and effective methodologies are not properly discussed
7. Lots of unwanted pesticide automatic sprayers were implemented which is much harmful
8. There is no proper data maintained during pesticide spray.

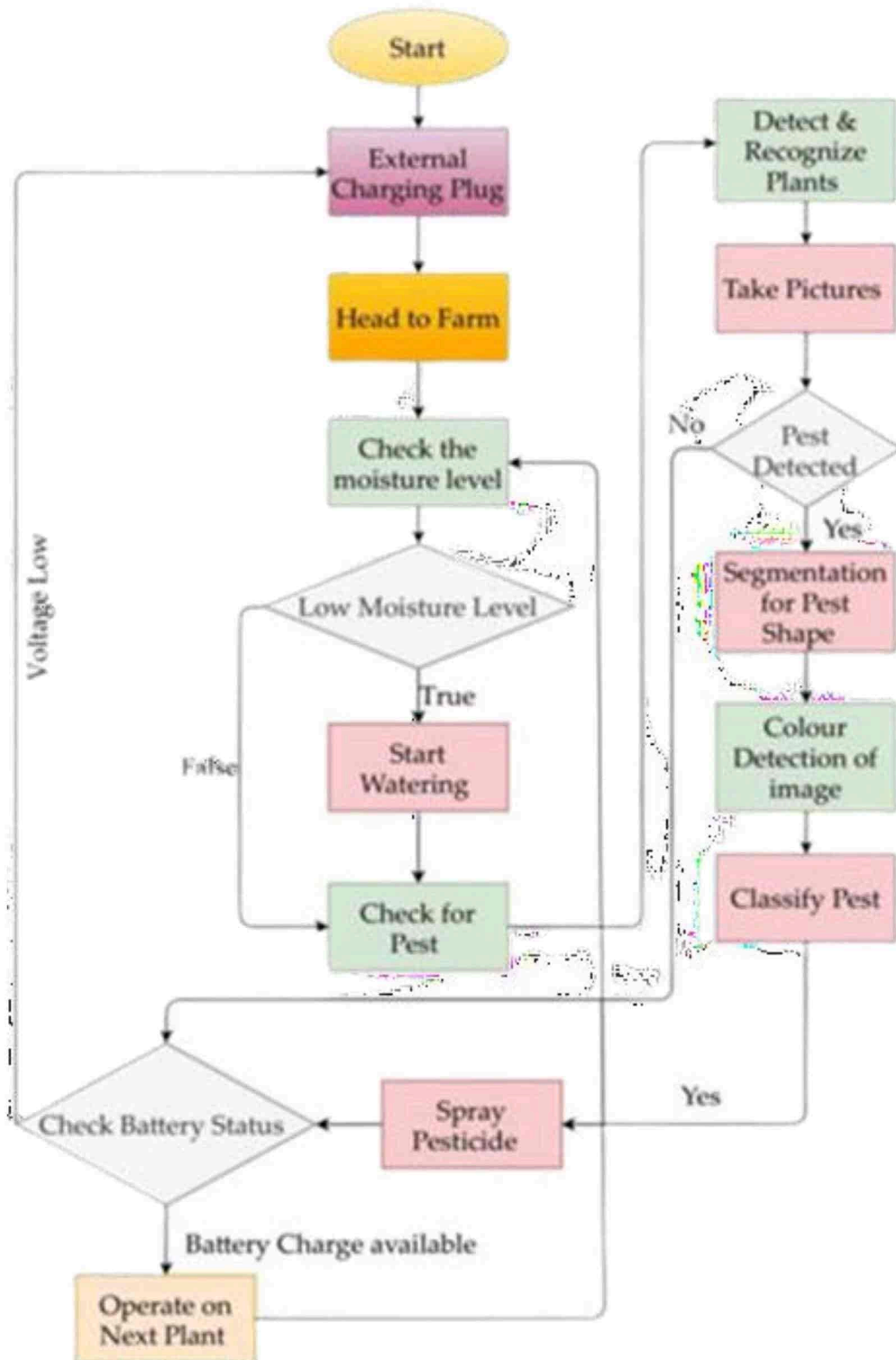


Fig.1.3. Flow chart

4.1 .PROPOSED SYSTEM

1. The Soil Moisture Sensor, Humidity, Temperature and Acoustic Sensor are connected to ESP8266 Node MCU Microcontroller
2. Then sensors send the data from their respective positions to ESP8266 Node MCU.
3. The received analog data can be processed by the controller and then send to end users like web server, or mobile via MQTT server.
4. The Soil Moisture Sensor, Humidity, and Temperature Sensor are connected as inputs to Microcontroller.
5. The water pump is connected via Relay. The measured temperature and humidity values send to the end user.
6. The moisture sensor senses the water quantity in the soil and the water pump will supply it whenever the quantity of water in the soil is reduced.
7. For a better understanding of end users' notifications can be sent like "Water deficiency in the soil ON water pump"
8. The water level in a reservoir continuously survey by the sensor and alerts the customer with notifications like the height of the water level from the top view, and the current percentage of water present in the reservoir at that moment.

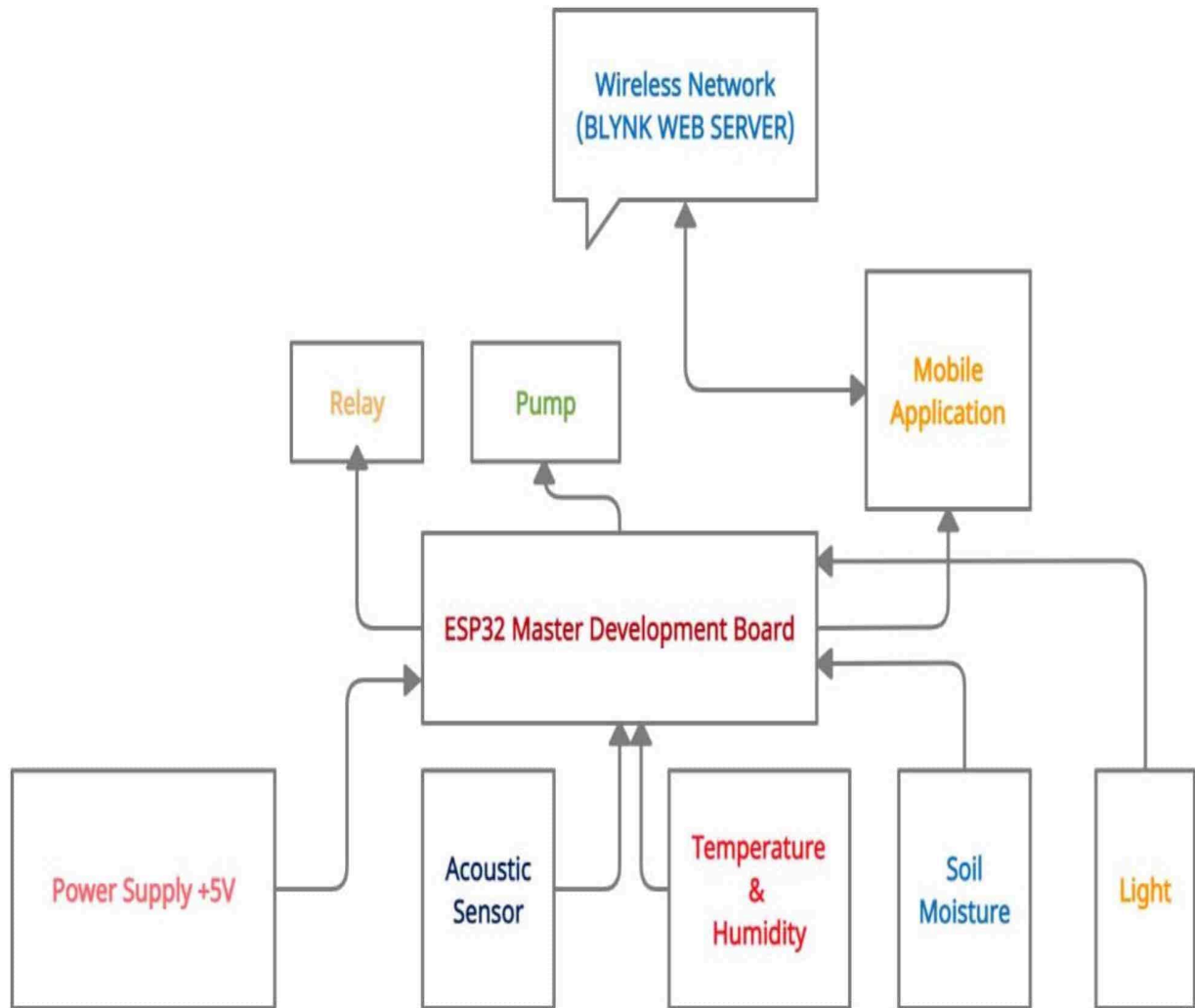


Figure 4.1: Block diagram for proposed methodology

Introduction to Internet of Things (IoT)

IoT stands for Internet of Things. It refers to the interconnectedness of physical devices, such as appliances and vehicles, that are embedded with software, sensors, and connectivity which enables these objects to connect and exchange data. This technology allows for the collection and sharing of data from a vast network of devices, creating opportunities for more efficient and automated systems.

Internet of Things (IoT) is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment. In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a few of the categorical examples where IoT is strongly established.

IOT is a system of interrelated things, computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers. And the ability to transfer the data over a network requiring human-to-human or human-to-computer interaction.

History of IOT

Here you will get to know about how IOT is involved and also from the explanation of each will let you know how IOT plays a role in this innovations !

1982 – Vending machine: The first glimpse of IoT emerged as a vending machine at Carnegie Mellon University was connected to the internet to report its inventory and status, paving the way for remote monitoring.

- 1990 – Toaster: Early IoT innovation saw a toaster connected to the internet, allowing users to control it remotely, foreshadowing the convenience of smart home devices.
- 1999 – IoT Coined (Kevin Ashton): Kevin Ashton coined the term “Internet of Things” to describe the interconnected network of devices communicating and sharing data, laying the foundation for a new era of connectivity.
- 2000 – LG Smart Fridge: The LG Smart Fridge marked a breakthrough, enabling users to check and manage refrigerator contents remotely, showcasing the potential of IoT in daily life.
- 2004 – Smart Watch: The advent of smartwatches introduced IoT to the wearable tech realm, offering fitness tracking and notifications on-the-go.

- 2007 – Smart iPhone: Apple's iPhone became a game-changer, integrating IoT capabilities with apps that connected users to a myriad of services and devices, transforming smartphones into hubs.
- 2009 – Car Testing: IoT entered the automotive industry, enhancing vehicles with sensors for real-time diagnostics, performance monitoring, and remote testing.
- 2011 – Smart TV: The introduction of Smart TVs brought IoT to the living room, enabling internet connectivity for streaming, app usage, and interactive content.
- 2013 – Google Lens: Google Lens showcased IoT's potential in image recognition, allowing smartphones to provide information about objects in the physical world.
- 2014 – Echo: Amazon's Echo, equipped with the virtual assistant Alexa, demonstrated the power of voice-activated IoT, making smart homes more intuitive and responsive.
- 2015 – Tesla Autopilot: Tesla's Autopilot system exemplified IoT in automobiles, introducing semi-autonomous driving capabilities through interconnected sensors and software.

Four Key Components of IOT

Device or sensor

Connectivity

Data processing

Interface

IoT is network of interconnected computing devices which are embedded in everyday objects, enabling them to send and receive data.

Over 9 billion 'Things' (physical objects) are currently connected to the Internet, as of now. In the near future, this number is expected to rise to a whopping 20 billion.

Main Components Used in IoT

Low-power embedded systems: Less battery consumption, high performance are the inverse factors that play a significant role during the design of electronic systems.

Sensors: Sensors are the major part of any IoT application. It is a physical device that measures and detects certain physical quantities and converts it into signal which can be provided as an input to processing or control unit for analysis purpose.

Different types of Sensors

Temperature Sensors

Image Sensors

Gyro Sensors

Obstacle Sensors

RF Sensor

IR Sensor

MQ-02/05 Gas Sensor

LDR Sensor

Ultrasonic Distance Sensor

Control Units: It is a unit of small computer on a single integrated circuit containing microprocessor or processing core, memory and programmable input/output devices/peripherals. It is responsible for major processing work of IoT devices and all logical operations are carried out here.

Cloud computing: Data collected through IoT devices is massive, and this data has to be stored on a reliable storage server. This is where cloud computing comes into play. The data is processed and learned, giving more room for us to discover where things like electrical faults/errors are within the system.

Availability of big data: We know that IoT relies heavily on sensors, especially in real-time. As these electronic devices spread throughout every field, their usage is going to trigger a massive flux of big data.

Networking connection: In order to communicate, internet connectivity is a must, where each physical object is represented by an IP address. However, there are only a limited

number of addresses available according to the IP naming. Due to the growing number of devices, this naming system will not be feasible anymore. Therefore, researchers are looking for another alternative naming system to represent each physical object. Ways of Building IOT building IoT: There are two ways of forming a separate internet work including only physical objects. Make the Internet ever more expansive, but this requires hard-core technologies such as rigorous cloud computing and rapid big data storage (expensive). In the near future, IoT will become broader and more complex in terms of scope. It will change the world in terms of “anytime, anyplace, anything in connectivity.”

IoT Enablers

RFIDs: uses radio waves in order to electronically track the tags attached to each physical object.

Sensors: devices that are able to detect changes in an environment (ex: motion detectors).

Nanotechnology: as the name suggests, these are tiny devices with dimensions usually less than a hundred nanometers.

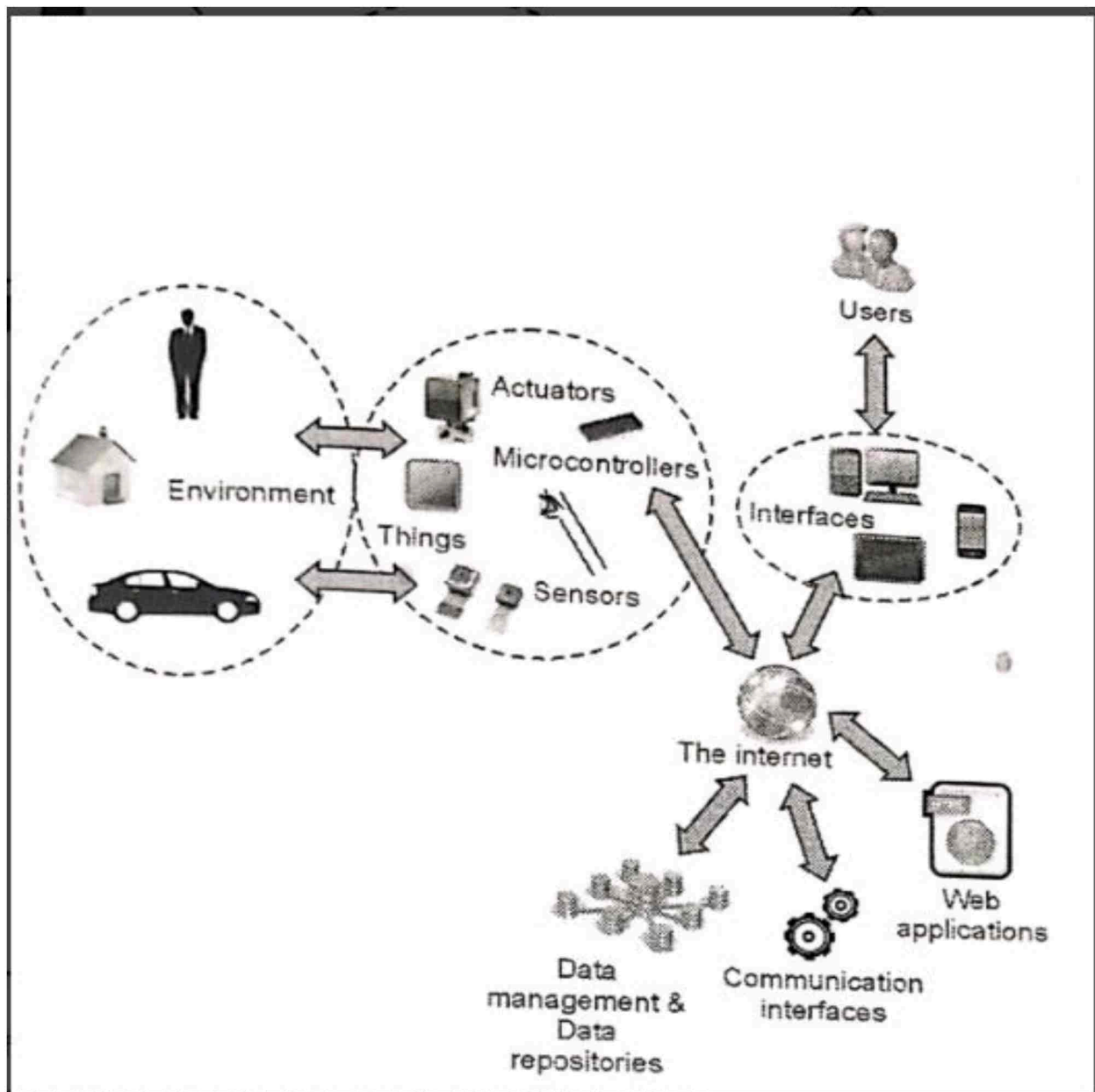
Smart networks: (ex: mesh topology).

Working with IoT Devices

Collect and Transmit Data : For this purpose sensors are widely used they are used as per requirements in different application areas.

Actuate device based on triggers produced by sensors or processing devices: If certain conditions are satisfied or according to user's requirements if certain trigger is activated then which action to perform that is shown by Actuator devices.

Receive Information: From network devices, users or devices can take certain information also for their analysis and processing purposes. Communication Assistance: Communication assistance is the phenomenon of communication between 2 networks or communication between 2 or more IoT devices of same or different networks. This can be achieved by different communication protocols like: MQTT, Constrained Application Protocol, ZigBee, FTP, HTTP etc.



5.1 IMPLEMENTATION DETAILS

Massively scalable and efficient

IP-based addressing will no longer be suitable in the upcoming future.

An abundance of physical objects is present that do not use IP, so IoT is made possible.

Devices typically consume less power. When not in use, they should be automatically programmed to sleep.

A device that is connected to another device right now may not be connected in another instant of time.

Intermittent connectivity – IoT devices aren't always connected. In order to save bandwidth and battery consumption, devices will be powered off periodically when not in use. Otherwise, connections might turn unreliable and thus prove to be inefficient.

Desired Quality of any IoT Application

Interconnectivity

It is the basic first requirement in any IoT infrastructure. Connectivity should be guaranteed from any devices on any network then only devices in a network can communicate with each other.

Heterogeneity

There can be diversity in IoT enabled devices like different hardware and software configuration or different network topologies or connections, but they should connect and interact with each other despite so much heterogeneity.

Dynamic in Nature

IoT devices should dynamically adapt themselves to the changing surroundings like different situations and different prefaces.

Self-adapting and self configuring technology

For example, surveillance camera. It should be flexible to work in different weather conditions and different light situations (morning, afternoon, or night).

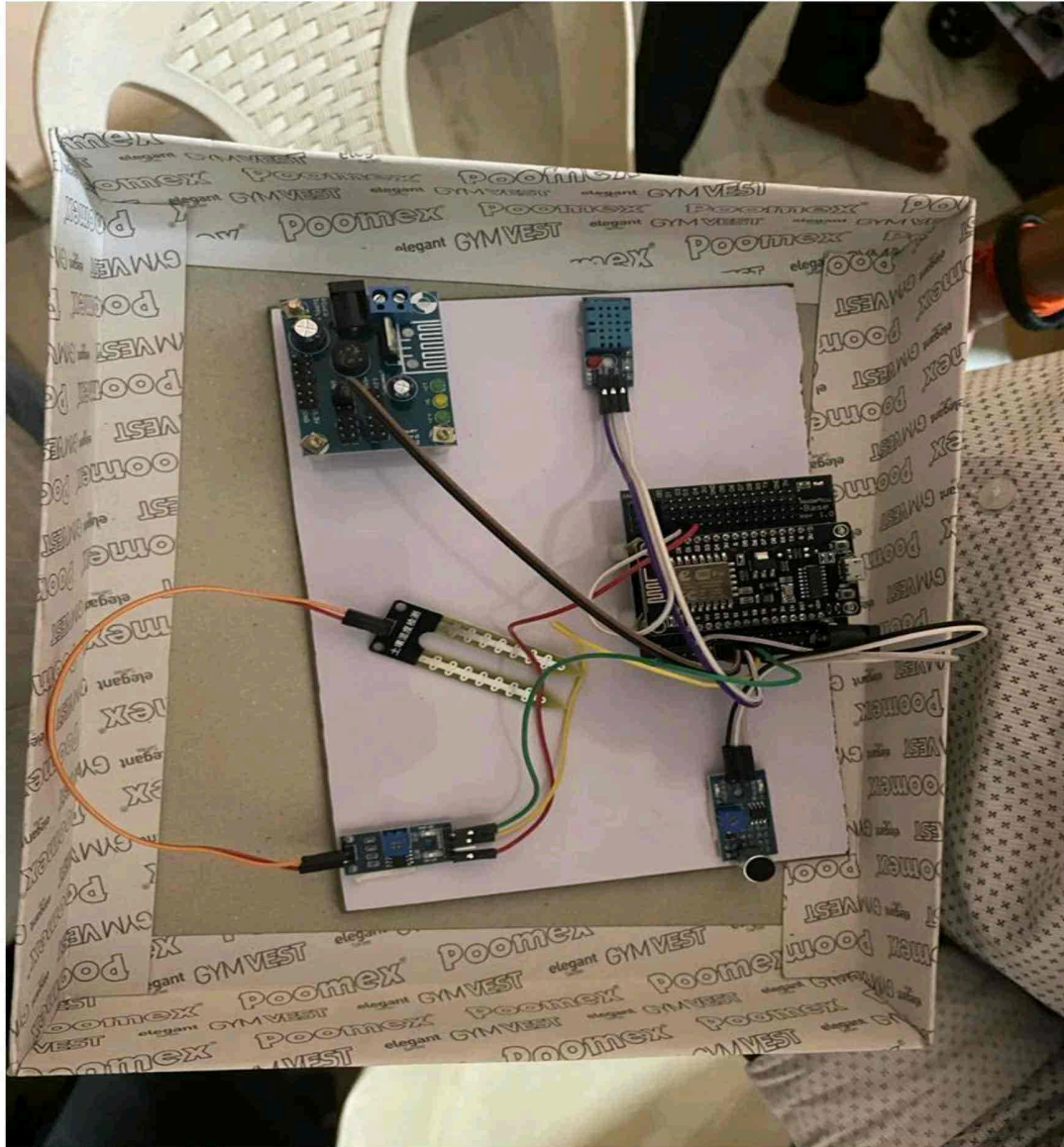


Fig.5.1.Project Implementation

DEPLOYMENT SET-UP

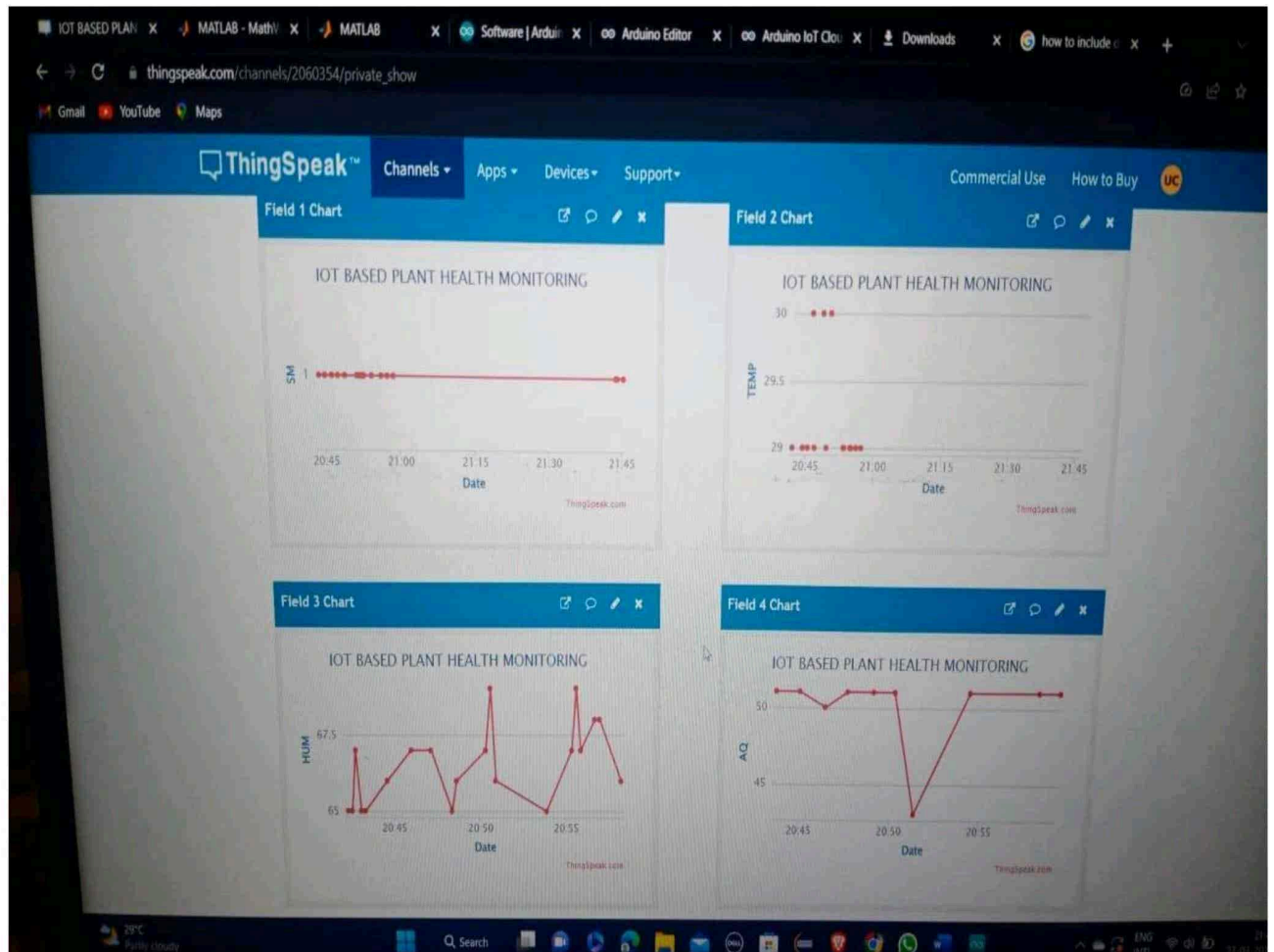


FIG.5.2 RESULT

OUT-PUT GRAPHS

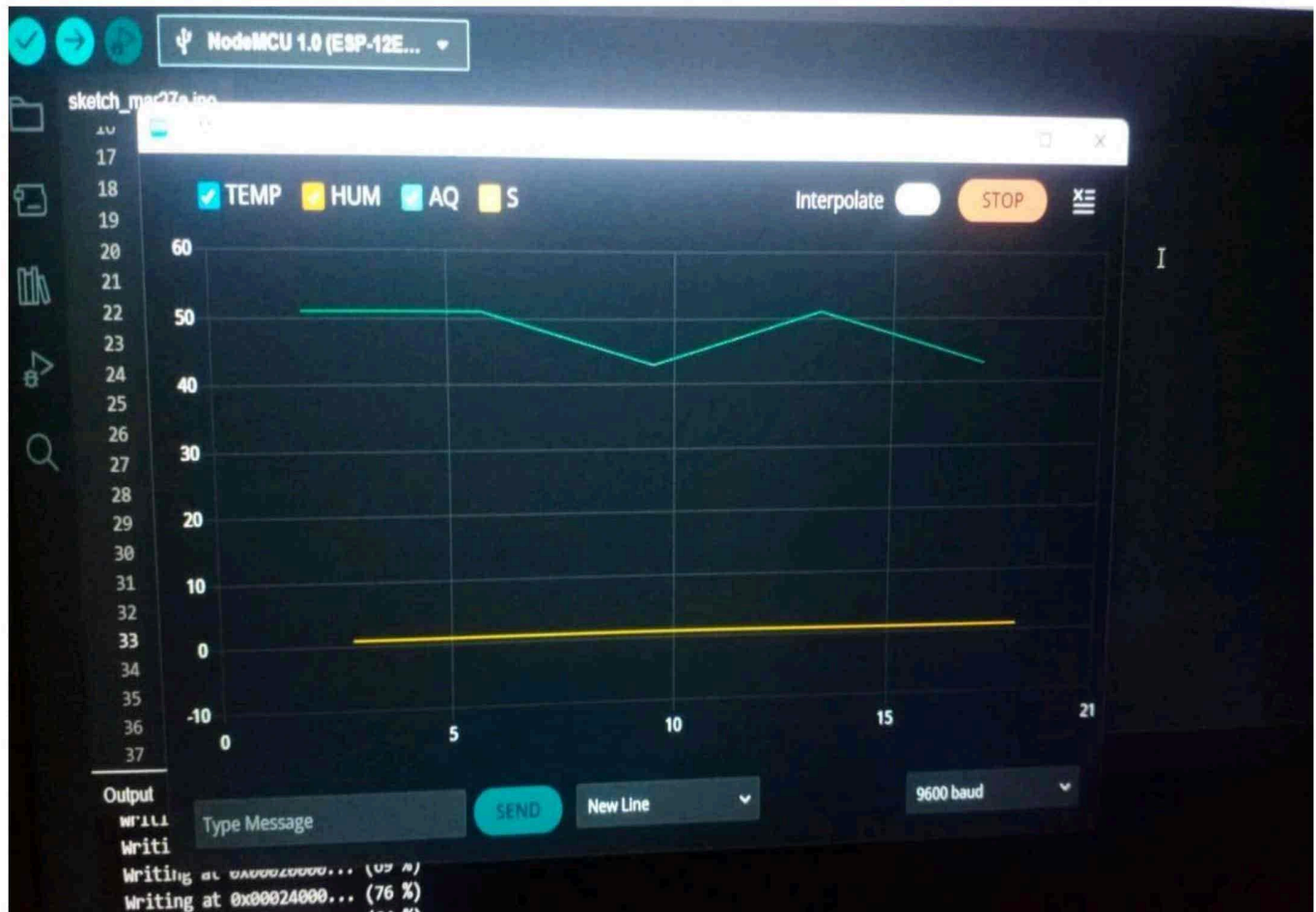


FIG.5.3 RESULT

CONCLUSION

1. In normal irrigation systems the farmers control the irrigating land manually.
2. These techniques take a longer duration and waste the available water at higher rates so it leads to the usage of water more than what is required.
3. For a plant to survive healthily it needs water continuously, the automatic system helps to get absolute results for this.
4. For implementing this kind of irrigation system in agriculture gives more comfort to farmers in terms of time-saving and accurate usage of water without wasting.
5. Moreover the required power for operating the ESP8266 NodeMCU Microcontroller chip and wireless sensors is very less, as well as all these features, are available at a very low cost.

MERITS AND DEMERITS

1. The Main objective of our proposal is to save crops, increase the irrigation rate and produce a healthy outcome We have followed a lot of modern techniques that were discussed in research papers, following these methods will surely increase the existing production rate nearly up to 45%
2. The main disadvantage is the cost factor and its maintenance rate when compared to traditional methods
3. But when compared to the production rate these losses are negotiable
4. It will reduce the activity of manpower and increase the production rate.

REFERENCES

1. Gemmeke, J.F.; Ellis, D.P.W.; Freedman, D.; Jansen, A.; Lawrence, W.; Moore, R.C.; Plakal, M.; Ritter, M. Audio Set: An Ontology and Human-Labeled Dataset for Audio Events. In Proceedings of the 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, LA, USA, 5–9 March 2017; pp. 776–780. [[Google Scholar](#)]
2. Cramer, J.; Wu, H.-H.; Salamon, J.; Bello, J.P. Look, Listen, and Learn More: Design Choices for Deep Audio Embeddings. In Proceedings of the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK, 12–17 May 2019; pp. 3852–3856. [[Google Scholar](#)]
3. Arandjelović, R.; Zisserman, A. Look, Listen and Learn. In Proceedings of the IEEE International Conference on Computer Vision (ICCV), Venice, Italy, 22–29 October 2017. [[Google Scholar](#)]
4. Kong, Q.; Cao, Y.; Iqbal, T.; Wang, Y.; Wang, W.; Plumbley, M. PANNs: Large-Scale Pretrained Audio Neural Networks for Audio Pattern Recognition (Pretrained Models). *IEEE/ACM Trans. Audio Speech Lang. Process.* **2020**, *28*, 2880–2894. [[Google Scholar](#)] [[CrossRef](#)]
5. Hershey, S.; Chaudhuri, S.; Ellis, D.P.W.; Gemmeke, J.F.; Jansen, A.; Moore, R.C.; Plakal, M.; Platt, D.; Saurous, R.A.; Seybold, B.; et al. CNN architectures for large-scale audio classification. In Proceedings of the 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, LA, USA, 5–9 March 2017; pp. 131–135. [[Google Scholar](#)] [[CrossRef](#)] [[Green Version](#)]
6. Gaylard, A.; Meyer, A.; Landy, C. Acoustic Evaluation of Faults in Electrical Machines. In Proceedings of the 1995 Seventh International Conference on Electrical Machines and Drives (Conf. Publ. No. 412), Durham, UK, 11–13 September 1995; pp. 147–150. [[Google Scholar](#)]
7. Kawaguchi, Y.; Endo, T. How Can We Detect Anomalies from Subsampled Audio Signals? In Proceedings of the 2017 IEEE 27th International Workshop on Machine Learning for Signal Processing (MLSP), Tokyo, Japan, 25–28 September 2017; pp. 1–6. [[Google Scholar](#)]
8. Koizumi, Y.; Saito, S.; Uematsu, H.; Harada, N. Optimizing Acoustic Feature Extractor for Anomalous Sound Detection Based on Neyman-Pearson Lemma. In Proceedings of the 2017 25th

- European Signal Processing Conference (EUSIPCO), Kos, Greece, 28 August–2 September 2017; pp. 698–702. [[Google Scholar](#)]
9. Koizumi, Y.; Saito, S.; Uematsu, H.; Harada, N.; Imoto, K. ToyADMOS: A Dataset of Miniature Machine Operating Sounds for Anomalous Sound Detection. In Proceedings of the 2019 IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (WASPAA), New Paltz, NY, USA, 20–23 October 2019; pp. 313–317. [[Google Scholar](#)]
 10. Purohit, H.; Tanabe, R.; Ichige, T.; Endo, T.; Nikaido, Y.; Suefusa, K.; Kawaguchi, Y. MIMII Dataset: Sound Dataset for Malfunctioning Industrial Machine Investigation and Inspection. In Proceedings of the Detection and Classification of Acoustic Scenes and Events 2019 Workshop (DCASE2019), New York, NY, USA, 25–26 October 2019; pp. 209–213. [[Google Scholar](#)]
 11. Kawaguchi, Y.; Imoto, K.; Koizumi, Y.; Harada, N.; Niizumi, D.; Dohi, K.; Tanabe, R.; Purohit, H.; Endo, T. Description and Discussion on DCASE 2021 Challenge Task 2: Unsupervised Anomalous Sound Detection for Machine Condition Monitoring under Domain Shifted Conditions. *arXiv* **2021**, arXiv:2106.04492. [[Google Scholar](#)]
 12. Dohi, K.; Imoto, K.; Harada, N.; Niizumi, D.; Koizumi, Y.; Nishida, T.; Purohit, H.; Endo, T.; Yamamoto, M.; Kawaguchi, Y. Description and Discussion on DCASE 2022 Challenge Task 2: Unsupervised Anomalous Sound Detection for Machine Condition Monitoring Applying Domain Generalization Techniques. *arXiv* **2022**, arXiv:2206.05876. [[Google Scholar](#)]
 13. Koizumi, Y.; Kawaguchi, Y.; Imoto, K.; Nakamura, T.; Nikaido, Y.; Tanabe, R.; Purohit, H.; Suefusa, K.; Endo, T.; Yasuda, M.; et al. Description and Discussion on DCASE2020 Challenge Task2: Unsupervised Anomalous Sound Detection for Machine Condition Monitoring. In Proceedings of the Detection and Classification of Acoustic Scenes and Events 2020 Workshop (DCASE2020), Tokyo, Japan, 2–4 November 2020; pp. 81–85. [[Google Scholar](#)]
 14. Grollmisch, S.; Abeßer, J.; Liebetrau, J.; Lukashevich, H. Sounding Industry: Challenges and Datasets for Industrial Sound Analysis. In Proceedings of the 2019 27th European Signal Processing Conference (EUSIPCO), A Coruña, Spain, 2–6 September 2019; pp. 1–5. [[Google Scholar](#)]
 15. Koizumi, Y.; Saito, S.; Uematsu, H.; Kawachi, Y.; Harada, N. Unsupervised Detection of Anomalous Sound Based on Deep Learning and the Neyman–Pearson Lemma. *IEEE/ACM Trans Audio Speech Lang Process* **2019**, *27*, 212–224. [[Google Scholar](#)] [[CrossRef](#)] [[Green Version](#)]

16. Sharan, R.; Xiong, H.; Berkovsky, S. Benchmarking Audio Signal Representation Techniques for Classification with Convolutional Neural Networks. *Sensors* **2021**, *21*, 3434. [[Google Scholar](#)] [[CrossRef](#)]
17. Roche, F.; Hueber, T.; Limier, S.; Girin, L. Autoencoders for Music Sound Modeling: A Comparison of Linear, Shallow, Deep, Recurrent and Variational Models. In Proceedings of the 16th Sound & Music Computing Conference (SMC 2019), Malaga, Spain, 28–31 May 2019. [[Google Scholar](#)]
18. Bai, J.; Chen, C.; Chen, J. Feature Based Fusion System for Anomalous Sounds Monitoring. In Proceedings of the 5th Workshop on Detection and Classification of Acoustic Scenes and Events (DCASE), Tokyo, Japan, 2–4 November 2020. [[Google Scholar](#)]
19. Ahmed, F.; Nguyen, P.; Courville, A. An Ensemble Approach for Detecting Machine Failure from Sound. In Proceedings of the 5th Workshop on Detection and Classification of Acoustic Scenes and Events (DCASE), Tokyo, Japan, 2–4 November 2020. [[Google Scholar](#)]
20. Alam, J.; Boulianne, G.; Gupta, V.; Fathan, A. An Ensemble Approach to Unsupervised Anomalous Sound Detection. In Proceedings of the 5th Workshop on Detection and Classification of Acoustic Scenes and Events (DCASE), Tokyo, Japan, 2–4 November 2020. [[Google Scholar](#)]