IoT PLANT HEALTH MONITORING SYSTEM BASED ON ACOUSTIC SOUND SENSOR

A Project Report Phase-II

Submitted in partial fulfilment of requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Jangiti Sathwik (39130178) and A.Umesh Chandra (39130018) who carried out the project entitled "**IoT PLANT HEALTH MONITORING SYSTEM BASED ON ACOUSTIC SOUND SENSOR**" under our supervision from Aug 2022 to Apr 2023.

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DECLARATION

We, **Jangiti Sathwik (39130178)** and **A.Umesh Chandra (39130018)** hereby declare that the Project Report entitled **" IoT PLANT BASED HEALTH MONITORING SYSTEM BASED ON ACOUSTIC SOUND SENSOR"** done by us under the guidance of **Dr.A.Aranganathan, M.Tech., 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.

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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

Only 0.01% of water is available on the earth's surface. 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 frame work 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 Arduino 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 Raspberry pi is used wherever a large amount of processing is required and Arduino 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 in Sri Lanka, 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 in Sri Lanka. 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.

CHAPTER -2

LITERATURE SURVEY

2.1 "Sensor Based Smart Agriculture with IoT Technologies" A Review Dr.M.Pyingkodi1 , Dr.K.Thenmozhi2, K.Nanthini1 , M.Karthikeyan1 , Dr.Suresh Palarima IEEE 2020

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.

2.2 "SMART IRRIGATION SENSOR" Satyendra K. Vishwakarma, Prashant Upadhyaya, Babita Kumari, and Arun Kumar

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.

2.3 Jonathan J. Hull, Berna Erol, Jamey Graham, Qifa Ke, Hidenobu Kishi, Jorge Moraleda, Daniel G. Van Olsth Research Gate “Paper-Based Augmented Reality”, Research Gate Transaction on Camera and Paper documentation, 2007

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.

2.4 11 Smart Agriculture Monitoring System Using Internet of Things (IoT) Dr. Tanuj Manglani Department of EE Arya College of Engineering and Research Centre, Jaipur, Rajasthan, India Aman Vaishnav Department of CSE Arya College of Engineering and Research Centre. IEEE 2021

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.

2.5 Subramani Roy Chowdhary, A. Divija, G. V N Vijayalakshmi, P. Vamsi, JARTMS "TOUCHLESS HOME AUTOMATION USING AUGMENTED REALITY", JARTMS Transactions on Augmented Reality and Web Interface, 2021

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.

2.6 Vikram N, Harish KS, Nihal M S, Raksha Umesh, and, Shetty Ashik Ashok Kumar, "A Low-Cost Home Automation System using Wi-Fi-based Wireless sensor Network incorporating Internet of things", Procedia Computer Science Transactions on Mobile Device, 2019

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.

2.7 Divya J., Divya M.,Janani V. Agriculture is essential to India's economy and people's survival. The purpose of this project is to create an embedded-based soil monitoring and irrigation system that will reduce manual field monitoring and provide information via a mobile app. The method is intended to help farmers increase their agricultural output. A pH sensor, a temperature sensor, and a humidity sensor are among the tools used to examine the soil. Based on the findings, farmers may plant the best crop for the land. The sensor data is sent to the field manager through Wi-Fi, and the crop advice is created with the help of the mobile app. When the soil temperature is high, an automatic watering system is used. The crop image is gathered and forwarded to the field manager for pesticide advice.

CHAPTER 3

AIM AND SCOPE OF THE PROJECT

3.1 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 Oryza (L.) and Trifolium castoreum (Herbst) adults, for example, are more readily detected than intermediate-sized Rhizopathy Dominica (F), while the smaller Cryptolestes ferrugineus (Stephens) and Oryzaephilus surinamensis L. are less readily detected (Haustrum 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 (Haustrum 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 40o C. Stirring of grain containing 4th-instar S. Oryza, for example, reduced sound production for periods of up to 20 minutes (Mankin et al. 1999). Adult T. castoreum sound production increased between 10 and 40o C (Haustrum and Flinn 1993), while C. maculatus larvae decreased their rates of sounds above 38o C in cowpeas (Shade et al. 1990). Sound production of S. Oryza adults in grain decreased above 30 to 35o C, and R. Dominica adult sound production rates plateaued above 30o C (Haustrum 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 oC. The use of radiant or convective heat, to raise the temperature rapidly above 29o C, increased the rate of sounds from internally feeding S. Oryza 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.

3.1.1 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 (Pota mitis 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)

3.1.2 Efficiency and Reliability of Acoustic Detection Devices

The efficiency 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 (Table 1). 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,

3.1.3 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 (Haustrum et al. 1988, 1990, 1991, 1996), and mappings of stored product insect pest distributions (Haustrum 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 (Haustrum et al. 1988) and T. castoreum adults (Haustrum 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 (Haustrum et al. 1988, 1990, 1991, 1996), and mappings of stored product insect pest distributions (Haustrum 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 (Haustrum et al. 1988) and T. castoreum adults (Haustrum 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

3.2 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.

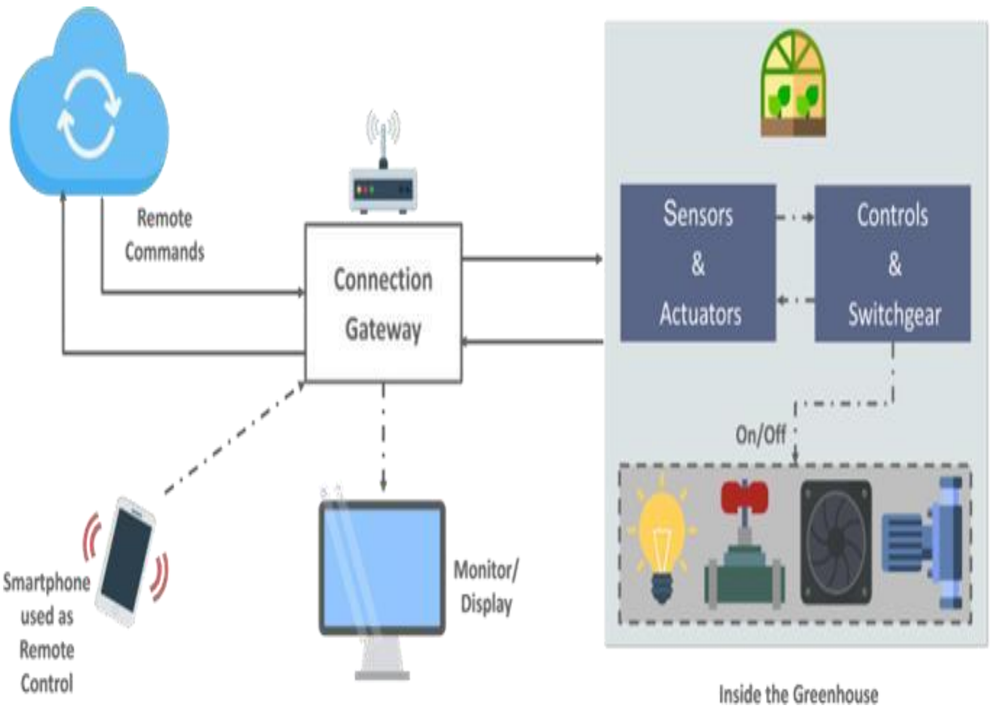

Figure 3.2: IoT Controlled Greenhouse Environment

3.3 Classification of Pests

Contents:

1. Agricultural Pests
2. Household Pests
3. Storage Grain Pests
4. Structural Pests
5. Veterinary Pests
6. Forestry and Nursery Pests

Insect pests are capable of feeding on almost all types of organic matter. The insects can cause damage to crop plants in the field, fruit plants, stored food and even the property. The pests can cause even health problems to man and his animals.

Based on the host which they affect the pests are classified as following:

3.3.1. Agricultural Pests

Each and every agricultural crops are infested by number of pests that cause severe damage. Pest constitute a large number of insects attacking to the various crop plants.

The immature stages or adult insects are either foliage feeders or saps suckers. These insects bear chewing and sucking type of mouth parts.They may be internal feeders or borers or sub-terranean inhabitants.

The important crops like jowar, bajara, wheat, cotton, sugarcane etc. are attacked by pests like stem borer, shoot fly, Deccan wingless grasshopper, army worms, flea beetles, aphids, leafhoppers, mites, jowar midge fly etc.

The cabbage worms, semiloopers, potato beetles, etc., possess chewing type mouth parts. They chew and swallow the external parts of the plants. While some insects i.e. blister beetle feed on pollens and petals of bajara etc. thus causing severe damage.

Sugarcane is an important cash crop cultivated widely in Maharashtra. This single crop is infested by sugarcane stem borer, shoot borer moth, root borer, Pyrilla, mealy bug, scale insects etc.

The cutworms, leafhoppers, potato tuber moth, epilachna beetles, mites, aphids and thrips cause injuries to potato crop and vegetables in field as well as in the storage. The cabbage leaf miner and cabbage caterpillars spoil the cabbage crop seriously.

The Rhinoceros beetle, mango stem borer, brinjal fruit borer, ber fruit borer infesting the variety of fruits in the field as well as in the storage.

The thrips, Aphids, Flea beetles, etc. damage grapes, resulting to great economic loss; if not controlled properly.

The chickoo moth and rhinoceros beetles cause damage to chickoo and coconuts. Thus, large number of pest organisms cause serious damage to many agricultural crop plants if not controlled properly.

Insects of this group, enter into the plant body and cause deformations in the structure and function of different organs of the plants i.e. stem borers enter stem or shoot cause tunnelling inside and swelling.

The leaf roller and leaf cutter cause severe defoliation. Gall insect cause swelling, bark feeder destroy surface of stem.

Example, Bark beetle destroys the timber in the forests; the termites damage the timber logs even after leaving the forest

3.3.2. Household Pests

The insects which cause serious health problems among human population are referred as public health pests. There are number of ways in which insects conflict with man’s comfort and pleasure.These insect pests are annoying by their presence, bad odour, their sounds and tastes of their secretions by crawling over the human body, by getting into the eyes, ears and nose or by laying their eggs on animal bodies.We have experience of flying, buzzing of insects, particularly when we desire to rest or sleep.The diverse environments around us are very attractive to insects, including lawns, flowers, shrubs, parks, industrial complexes and dwellings.Pests that infest dwellings are commonly referred to as household pests (insects). Household insects are direct concern to man, his possessions and his immediate environment. Insects such as cockroaches, crickets, house flies, fruit flies, weevils, ants (red and black), and silver fish etc. which contaminate eatable food and spoil it or transmitting disease causing agents are commonly placed under this group.The insects like cloth moths, carpet beetle, furniture beetles cause damage to property (human-possessions) also belongs to household pets.

Thus, all types of insects which are unwanted guests in the dwellings of man, which cause damage to human holdings and his health, are called as household pests.

The Anopheles mosquitoes spread malaria among human beings, whereas Culex and Aedes spreads filariasis and yellow fever respectively.

Human louse (Pediculus) carries micro-organisms which cause typhus fever, relapsing fever and trench fever.

Housefly is equally important to spreading diseases like typhus fever, cholera, diarrhoea, leprosy, tuberculosis etc.

Rat flea (Xenopsylta) works as vector for Pasteurella pestis cause Bubonic plague, and Tse tse fly (Ghossina palpalis) transmits African sleeping sickness.

3.3.3. Storage Grain Pests

The storage of food grains has been a long practice with cultivators and traders. Considerable losses both in quality and quantity of food grains take place in storage due to number of factors.

Organisms like insects, mites, rodents, fungi and bacteria are directly responsible for causing loss in stored products.

It is estimated that about 7-10% stored grains are lost every year due to stored grain pest in India.

The stored food grains, seeds, fruits, nuts etc. are infected by the internal borer insects in the kothis, godowns and warehouses are most injurious of all insects. The borers can attack them, even during the harvesting stage in the farm land itself.

The grain weevils (pulse beetle, rice weevils), moths, red rust flour beetle, etc. cause a major damage to stored cereals (wheat, rice, bajara, barley, corn, oat, millets etc.) and pulses (lentils, peas, beans, grain etc.) respectively.

Mainly the insects spoil the stored food grains and render them unfit for human consumption, sowing purposes. The stored grain pest can be differentiated into two types viz.(i) Primary type: This group of pests causes damage to intact grains i.e. uncrushed state.(ii) Secondary type: This group of pests feed or attacks the broken or crushed grains.

3.3.4. Structural Pests

Structural pests are those harmful insects which cause damage to wooden frames, doors, furnitures, fencing posts, library books, stored papers, cardboards and all other wooden articles and components of buildings are referred as structural pests.

Structural Pest means any pests which attack and destroy buildings and other structures or which attack clothing, stored food, commodities stored at food manufacturing and processing facilities or manufactured and processed goods.

The termites (i.e. white ants) are colonial and social insects, feed on cellulose, and damage wooden material in variable form.

Silver fishes feed on starch material and ghee, thus damaging book bindings, wall papers, photographs and all kinds of adhesive labels. Cloth moths and carpet beetles can also be damage cloths, carpets as structural pests.

3.3.5. Veterinary Pests

The insects which cause damage to domestic animals like chicken, horses, cattle etc. And blood sucking insects like fleas, lice, bugs, mosquitoes, stable flies as ectoparasites are the examples of domestic animal pests.Pests of veterinary importance are unique in their associations with animals hosts. Unlike the many pests that utilize plants or plant materials for their survival, pests of veterinary importance feed on hosts that can for the most part move from place to place. Thus, the hosts can live in a variety of habitats, move from one habitat to another during a daily cycle, and persist through a variety of climatic conditions during an annual cycle. The host range can be relatively small and associated with a central nest or burrow, or it can be practically endless in the case of herds of range cattle or migratory antelope. Likewise, the range of the pest can be limited geographically to certain locations, climates, or altitudes. Conversely, the pest can be cosmopolitan and affect similar hosts on almost every continent of the planet. Specifically, highly specialized pests can be limited to one or two host species, such as the sheep ked, Melophagus ovinus, a widely distributed parasite of..

A biting lice like Mallophaga cause irritation and loss of flesh in poultry farms.

Tabanid flies, horn flies suck the blood from cattle and horses. Both flies cause serious stomach disturbances in horses.

Grubs of OX-warble flies cause loss of flesh in cattle and can cause damage to the leather by cutting holes in the skin.

3.3.6. Forestry and Nursery Pests

Insects of this group enter into the plant body and cause deformations in the structure and function of different organs of the forest and nursery plants and trees i.e. stem borers enter stem/shoot cause tunneling inside and swelling. This group include a wide variety of leaf feeding beetles belonging to families Melolonithidae, Chrysomelidae and Curculionidae (Coleoptera), leaf feeding caterpillars (Lepidoptera) and grasshoppers (Orthoptera) which cause damage to the foliage of the nursery stock. Among the leaf feeding beetles, important defoliators are species of genera Psiloptera, Sternocera (Buprestidae), Amblyrrhindus, Apoderus, Dereodus and Myllocerus (Currculionidore). The adult beetles are polyphagous feeders of foliage and damage seedlings of many forest species in forest species in forest nurseries and plantations. The infested leaves may dry up and drop.

The lepidopterous leaf feeders include a major group of defoliators. Larvae either devour the entire leaf tissue or skeletonise it. Some times, young larvae prepare a shelter either by binding two or more adjoining leaves or by rolling the leaves and then feeding on the soft green tissues of the leaves. Important species belong to Ascotis, Hyposidra(Geometridoe), Dasychira, Euproctis, Lymantria (Lymantridae), Heliothis and Spodotera (Noctuidae) and Atteva (Yponomeutidae).The leaf roller and leaf cutter cause severe defoliation.

Gall insects cause swelling, bark feeder destroy surface of stem. e.g. Bark beetle destroys the timber in the forests, the termites damage the timber logs even after leaving the forest.

The sap suckers such as plant bugs, Aphids and Thrips suck plant juice of nursery plants which inhibit the photosynthetic activity.

CHAPTER 4

MATERIALS AND METHODS

4.1 ACOUSTIC SOUND SENSOR

An acoustic sensor is an insect pest detection sensor which works by monitoring the noise level of the insect pests. How does it work? Wireless sensor nodes connected to a base station are placed in the field. When the noise level of the pest crosses the threshold, a sensor transmits that information to the control room computer, which then accurately indicates the infestation area. These sensors help detect an infestation at a very early stage, thus greatly reducing crop damage. These are a great tool for the monitoring of large field areas with very low energy consumption.

A variety of different acoustic devices has been commercialized for detection of hidden insect infestations in stored products, trees, and soil, including a recently introduced device demonstrated in this report to successfully detect rice weevil immatures and adults in grain. Several of the systems have incorporated digital signal processing and statistical analyses such as neural networks and machine learning to distinguish targeted pests from each other and from background noise, enabling automated monitoring of the abundance and distribution of pest insects in stored products, and potentially reducing the need for chemical control. Current and previously available devices are reviewed in the context of the extensive research in stored product insect acoustic detection since 2011. It is expected that further development of acoustic technology for detection and management of stored product insect pests will continue, facilitating automation and decreasing detection and management costs.

The activity of insects within a grain bulk produces noises in the audible range of wavelengths, which can be detected by high performance acoustic sensors. A portable probe of 1.4 m length was built up with three levels acoustical sensors coupled to a computer-assisted processing system. The recorded sound signals of the major grain insect species were digitized and stored into a reference database. A classification algorithm was developed for the automatic recognition of recorded insect noise signals by their comparison to the specific spectra of the reference database. The presence of insects will be confirmed by the heat radiated by the insect's body through infrared sensor and the sound generated by the insects detected via ultrasonic sensor. It contains a microphone, power amplifier, and output actuator. The microphone that acts as an input sensor receives the sound signal and converts it into an electrical signal. Then this signal is amplified by the power amplifier and its amplitude is detected by the peak detector. The output actuator, like a loudspeaker, converts this amplified electrical signal into a sound signal for listening.

The sound sensors can detect sound signals in the frequency range of 3kHz to 6kHz and it operates at a DC voltage of 3.3V to 6V. It is a small and cost-effective sensor.

4.1.1 Sound Sensor Working Principle

The sound sensor working principle is simple and very easy. It works like a human ear. The sound sensor module consists of a small circuit board that is a microphone of 50 Hz-10 kHz and operates with the sensor detector module for detection. Other external processing circuitry components convert sound waves into electrical signals. Another important hardware component is the high precision comparator LM393N. This device is mandatory to digitize the electrical signal to the digital output D0. To adjust the sensitivity of the digital output D0, the sound sensor module contains the built-in potentiometer.

The sound sensor contains a microphone called a condenser microphone with 2 charged plates- one is a diaphragm and the other is a backplate. These plates seem like a capacitor. If the sound signals (claps, snaps, knocking, alarms) or audio signals travel through the air and strike the microphone’s diaphragm, then the distance between the 2 charged plates changes due to the vibration of the diaphragm.

Therefore this change in the capacitance between the plates generates the output electrical signal. This output signal is proportional to the input sound signal received by the microphone. Finally, the output signal is amplified by the amplifier and digitized to determine the intensity of the incoming sound signal.

Figure 4.1.1 Acoustic sound sensor

4.2 SOIL MOISTURE SENSOR

The moisture of the soil plays an essential role in the irrigation field as well as in gardens for plants. As nutrients in the soil provide the food to the plants for their growth. Supplying water to the plants is also essential to change the temperature of the plants. The temperature of the plant can be changed with water using the method like transpiration. And plant root systems are also developed better when rising within moist soil. Extreme soil moisture levels can guide to anaerobic situations that can encourage the plant's growth as well as soil pathogens. This article discusses an overview of the soil moisture sensor, working and it's applications.

4.2.1 What is a Soil Moisture Sensor

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content. The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.These sensors normally used to check volumetric water content, and another group of sensors calculates a new property of moisture within soils named water potential. Generally, these sensors are named as soil water potential sensors which include gypsum blocks and tensiometer.

4.2.2 Soil Moisture Sensor Pin Configuration

The FC-28 soil moisture sensor includes 4-pins

soil-moisture-sensor

- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

This module also includes a potentiometer that will fix the threshold value, & the value can be evaluated by the comparator-LM393. The LED will turn on/off based on the threshold value.

4.2.3 Working Principle

This sensor mainly utilizes capacitance to gauge the water content of the soil (dielectric permittivity). The working of this sensor can be done by inserting this sensor into the earth and the status of the water content in the soil can be reported in the form of a percent.

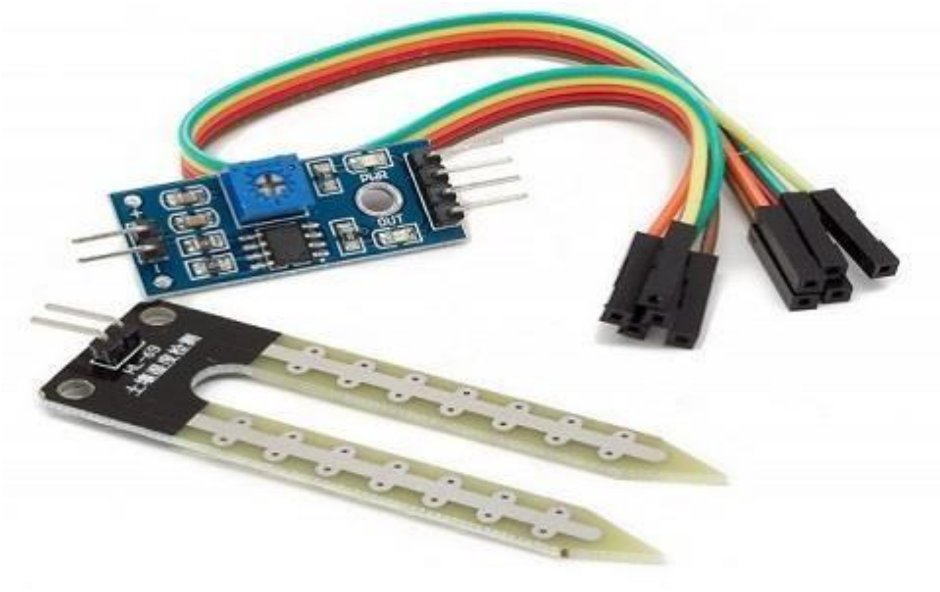

Figure 4.2.3 soil moisture sensor

4.3 DHT11 SENSOR

The DHT-11 Digital Temperature And Humidity Sensor is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin. Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc…

4.3.1 What is a 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 etc… to measure humidity and temperature instantaneously.DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on

LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

4.3.2 Working Principle of DHT11 Sensor

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz, i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller.

Figure 4.3.2 DHT11 sensor

4.4 THING SPEAK

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

The Internet of Things(IoT) is a system of ‘connected things’. The things generally comprise of an embedded operating system and an ability to communicate with the internet or with the neighboring things. One of the key elements of a generic IoT system that bridges the various ‘things’ is an IoT service. An interesting implication from the ‘things’ comprising the IoT systems is that the things by themselves cannot do anything. At a bare minimum, they should have an ability to connect to other ‘things’. But the real power of IoT is harnessed when the things connect to a ‘service’ either directly or via other ‘things’. In such systems, the service plays the role of an invisible manager by providing capabilities ranging from simple data collection and monitoring to complex data analytics. The below diagram illustrates where an IoT service fits in an IoT ecosystem: One such IoT application platform that offers a wide variety of analysis, monitoring and counter-action capabilities is ‘ThingSpeak’. Let us consider ThingSpeak in detail.

Internet of Things (IoT) describes an emerging trend where a large number of embedded devices (things) are connected to the Internet. These connected devices communicate with people and other things and often provide sensor data to cloud storage and cloud computing resources where the data is processed and analyzed to gain important insights. Cheap cloud computing power and increased device connectivity is enabling this trend. IoT solutions are built for many vertical applications such as environmental monitoring and control, health monitoring, vehicle fleet monitoring, industrial monitoring and control, and home automation.

At a high level, many IoT systems can be described using the diagram below:

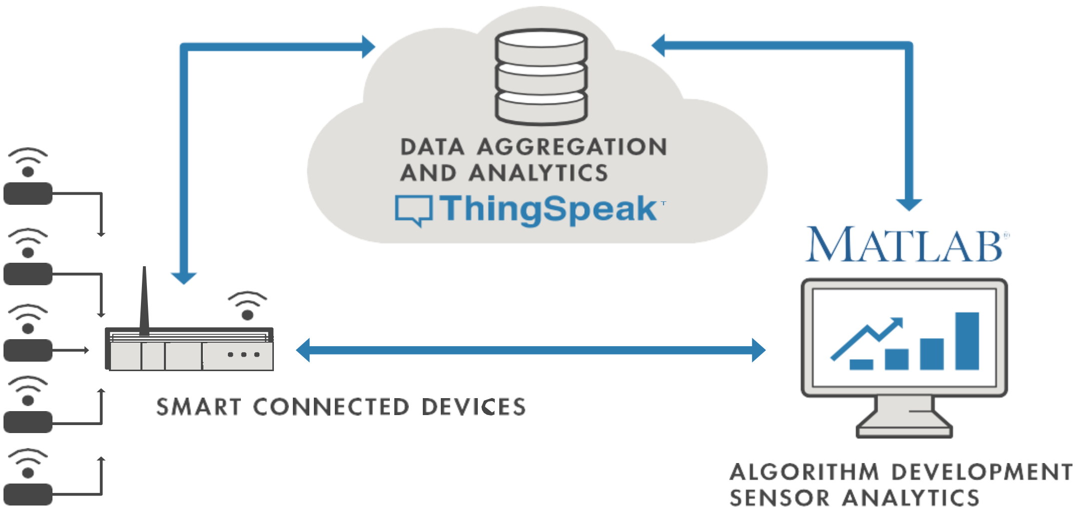

Figure 4.4 Connection diagram

On the left, we have the smart devices (the “things” in IoT) that live at the edge of the network. These devices collect data and include things like wearable devices, wireless temperatures sensors, heart rate monitors, and hydraulic pressure sensors, and machines on the factory floor. In the middle, we have the cloud where data from many sources is aggregated and analyzed in real time, often by an IoT analytics platform designed for this purpose. The right side of the diagram depicts the algorithm development associated with the IoT application. Here an engineer or data scientist tries to gain insight into the collected data by performing historical analysis on the data. In this case, the data is pulled from the IoT platform into a desktop software environment to enable the engineer or scientist to prototype algorithms that may eventually execute in the cloud or on the smart device itself. An IoT system includes all these elements. ThingSpeak fits in the cloud part of the diagram and provides a platform to quickly collect and analyze data from internet connected sensors.

4.4.1 ThingSpeak Key Features

ThingSpeak allows you to aggregate, visualize and analyze live data streams in the cloud. Some of the key capabilities of ThingSpeak include the ability to:

1.Easily configure devices to send data to ThingSpeak using popular IoT protocols.

2.Visualize your sensor data in real-time.

3.Aggregate data on-demand from third-party sources.

4.Use the power of MATLAB to make sense of your IoT data.

5. Run your IoT analytics automatically based on schedules or events.

6. Prototype and build IoT systems without setting up servers or developing web software.

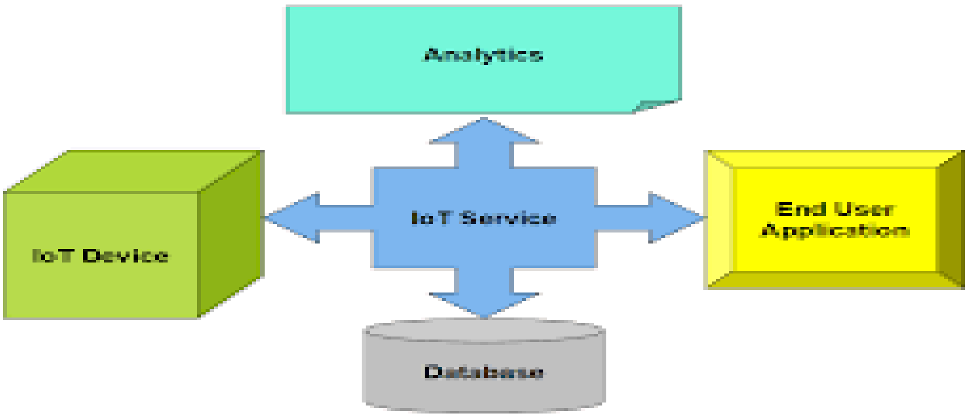

Figure 4.4.1 Server

4.5 ESP8266 Wi-Fi MODULE

In 2014, an ESP8266 Wi-Fi module was introduced and developed by third-party manufacturers like AI thinkers, which is mainly utilized for IoT-based embedded applications development. It is capable of handling various functions of the Wi-Fi network from another application processor. It is a SOC (System On-chip) integrated with a TCP/IP protocol stack, which can provide microcontroller access to any type of Wi-Fi network. This article deals with the pin configuration, specifications, circuit diagram, applications, and alternatives of the ESP8266 Wi-Fi module.

An ESP8266 Wi-Fi module is a SOC microchip mainly used for the development of end-point IoT (Internet of things) applications. It is referred to as a standalone wireless transceiver, available at a very low price. It is used to enable the internet connection to various applications of embedded systems. Express if systems designed the ESP8266 Wi-Fi module to support both the TCP/IP capability and the microcontroller access to any Wi-Fi network. It provides the solutions to meet the requirements of industries of IoT such as cost, power, performance, and design.

It can work as either a slave or a standalone application. If the ESP8266 Wi-Fi runs as a slave to a microcontroller host, then it can be used as a Wi-Fi adaptor to any type of microcontroller using UART or SPI. If the module is used as a standalone application, then it provides the functions of the microcontroller and Wi-Fi network.

The ESP8266 Wi-Fi module is highly integrated with RF balun, power modules, RF transmitter and receiver, analog transmitter and receiver, amplifiers, filters, digital baseband, power modules, external circuitry, and other necessary components. The ESP8266 Wi-Fi module is a microchip shown in the figure below.

A set of AT commands are needed by the microcontroller to communicate with the ESP8266 Wi-Fi module. Hence it is developed with AT commands software to allow the Arduino Wi-Fi functionalities, and also allows loading various software to design the own application on the memory and processor of the module.

The processor of this module is based on the Tensilica Xtensa Diamond Standard 106 micro and operates easily at 80 MHz. There are different types of ESP modules designed by third-party manufacturers.

They are:

ESP8266-01 designed with 8 pins (GPIO pins -2)

ESP8266-02 designed with 8 pins (GPIO pins -3)

ESP8266-03 designed with 14 pins (GPIO pins- 7)

ESP8266-04 designed with 14 pins (GPIO pins- 7)

The ESP8266 Wi-Fi module comes with a boot ROM of 64 KB, user data RAM of 80 KB, and instruction RAM of 32 KB. It can support 802.11 b/g/n Wi-Fi network at 2.4 GHz along with the features of I2C, SPI, I2C interfacing with DMA, and 10-bit ADC. Interfacing this module with the microcontroller can be done easily through a serial port. An external voltage converter is required only if the operating voltage exceeds 3.6 Volts. It is most widely used in robotics and IoT applications due to its low cost and compact size.

The ESP8266-01 Wi-Fi module runs in two modes. They are:

Flash Mode: When GPIO-0 and GPIO-1 pins are active high, then the module runs the program, which is uploaded into it.

UART Mode: When the GPIO-0 is active low and GPIO-1 is active high, then the module works in programming mode with the help of either serial communication or Arduino board.

The applications of the ESP8266 Wi-Fi module are given below:

1.Access points portals

2.IoT projects

3.Wireless data logging

4.Used in learning the networking fundamentals

5.Sockets and smart bulbs

6.Smart home automation systems

The ESP32 is an alternative ESP8266 Wi-Fi module. It is a standalone and most powerful module.

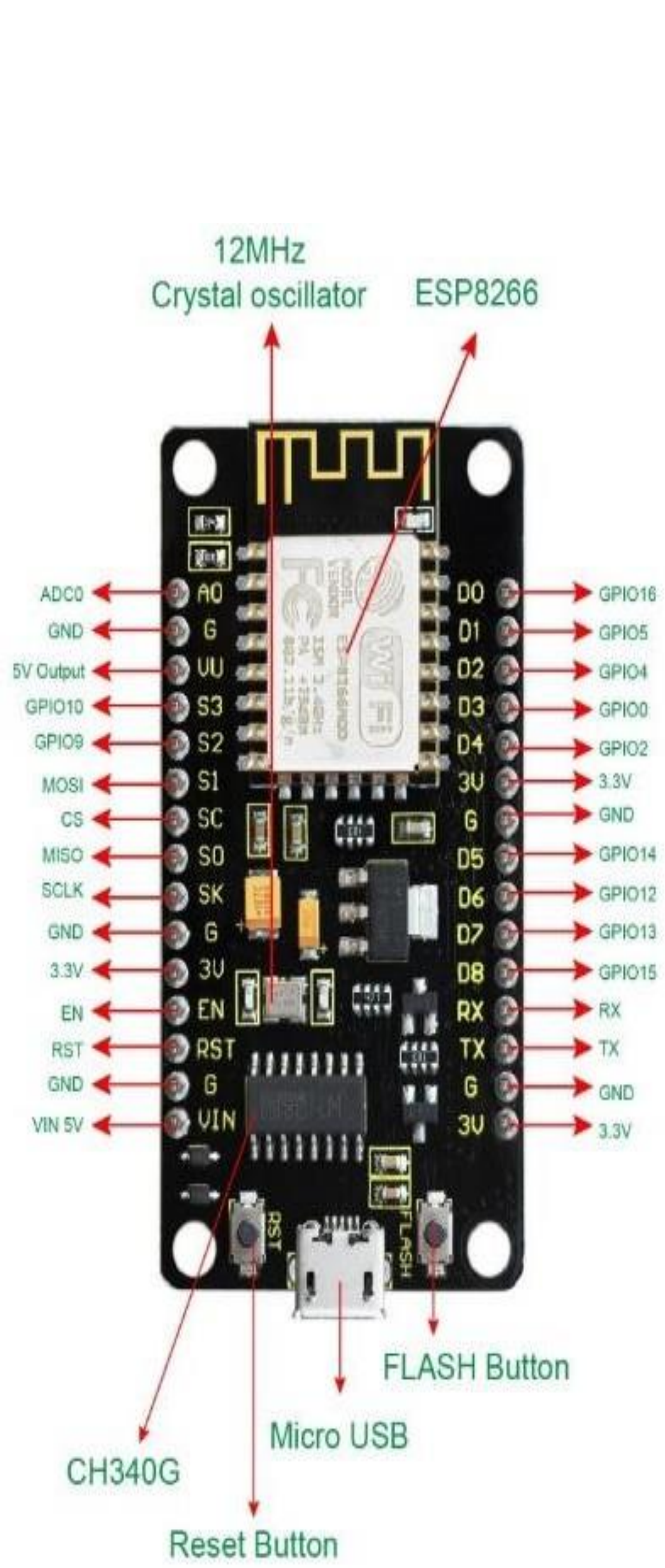

Figure 4.5. ESP8266 Wi-Fi Module

CHAPTER 5

RESULTS AND DISCUSSION

5.1 EXISTING METHODOLOGY

1. There is no proper tracking of water source utility
2. Automatic Pump and Station AMC is not monitored
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

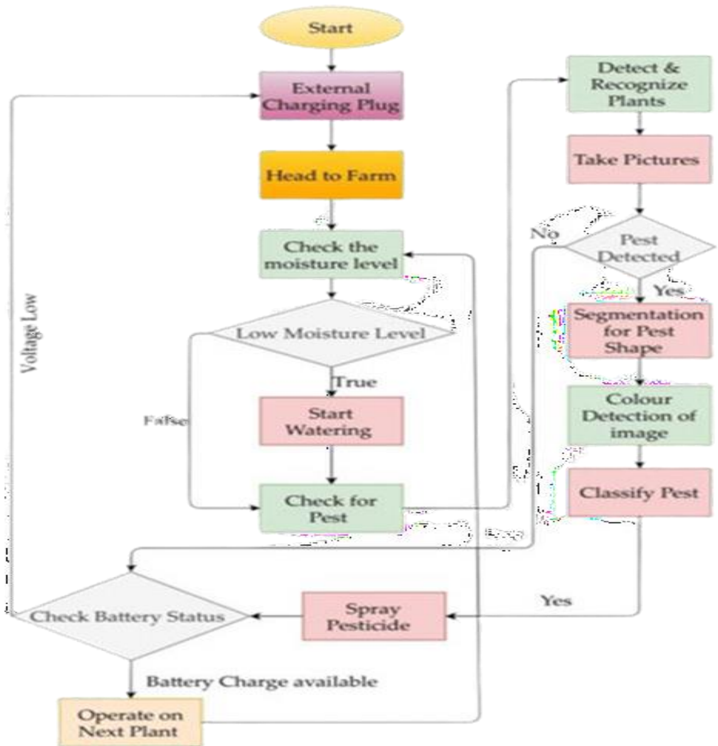

Figure 5.1 Block Diagram

5.2 PROPOSED METHODOLOGY

- The Soil Moisture Sensor, Humidity, Temperature and Acoustic Sensor are connected to ESP8266 NodeMCU Microcontroller
- Then sensors send the data from their respective positions to ESP8266 NodeMCU.
- The received analog data can be processed by the controller and then send to end users like web server, or mobile via MQTT server.
- The Soil Moisture Sensor, Humidity, and Temperature Sensor are connected as inputs to Microcontroller.
- The water pump is connected via Relay. The measured temperature and humidity values send to the end user.
- 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.
- For a better understanding of end users notifications can be sent like " Water deficiency in the soil ON water pump "
- 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.

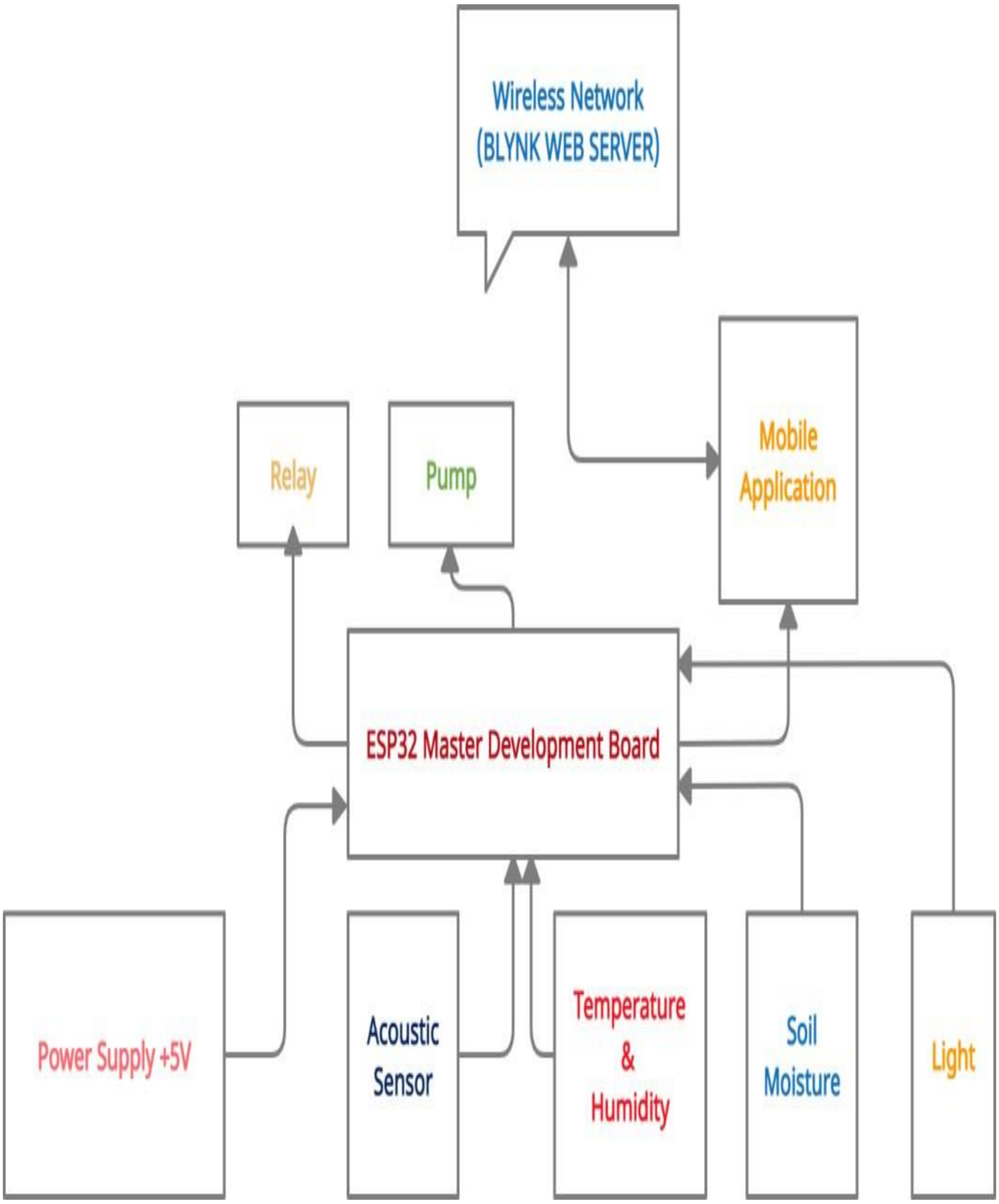

Figure 5.2: Block Diagram for Proposed Methodology

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 CONCLUSION

In normal irrigation systems the farmers control the irrigating land manually. 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. For a plant to survive healthily it needs water continuously, the automatic system helps to get absolute results for this. 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. 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.

6.2 MERITS AND DEMERITS

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%The main disadvantage is the cost factor and its maintenance rate when compared to traditional methods But when compared to the production rate these losses are negotiableIt will reduce the activity of manpower and increase the production.

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APPENDIX

A. SOURCE CODE

```
#include    <ESP8266WiFi.h>;

#include    <WiFiClient.h>;

#include    <ThingSpeak.h>;

#include     "DHT.h”

#define DHTPIN 16
        #define DHTTYPE DHT11

        DHT dht(DHTPIN, DHTTYPE);

            WiFiClient client;

            const char* ssid = "IOT"; //Your Network SSI
const char* password = "IOT@123456789" ;
//Your Network Password

            unsigned long myChannelNumber =
            2060354; //Your Channel Number (Without
            Brackets)

            const char * myWriteAPIKey =
            "Z85EYK6U0MUWCPST";
            //Your Write API Key

            void setup()

            {
Serial.begin(9600);
```

```
dht.begin();

WiFi.begin(ssid, password);

ThingSpeak.begin(client);

pinMode(5,INPUT);
}
void loop()
{
  int SM=digitalRead(5);Serial.print("
S:");Serial.println(SM);

ThingSpeak.writeField(myChannelN umber, 1,SM,
myWriteAPIKey);delay(2000);

float t = dht.readTemperature();
Serial.pri nt("TEMP:");Serial.println(t);

ThingSpeak.writeField(myChannelNumber, 2,t,
myWriteAPIKey);delay(2000);

  float h = dht.readHumidity();
  Serial.print( "HUM:");Serial.println(h);

ThingSpeak.writeField(myChannelNumber, 3,h,
myWriteAPIKey);delay(2000);
int
AQ=analogRead(A0);Serial.print("
AQ:");Serial.println(AQ);

ThingSpeak.writeField(myChannelNumber, 4,AQ,
myWriteAPIKey);delay(2000);
 }
```

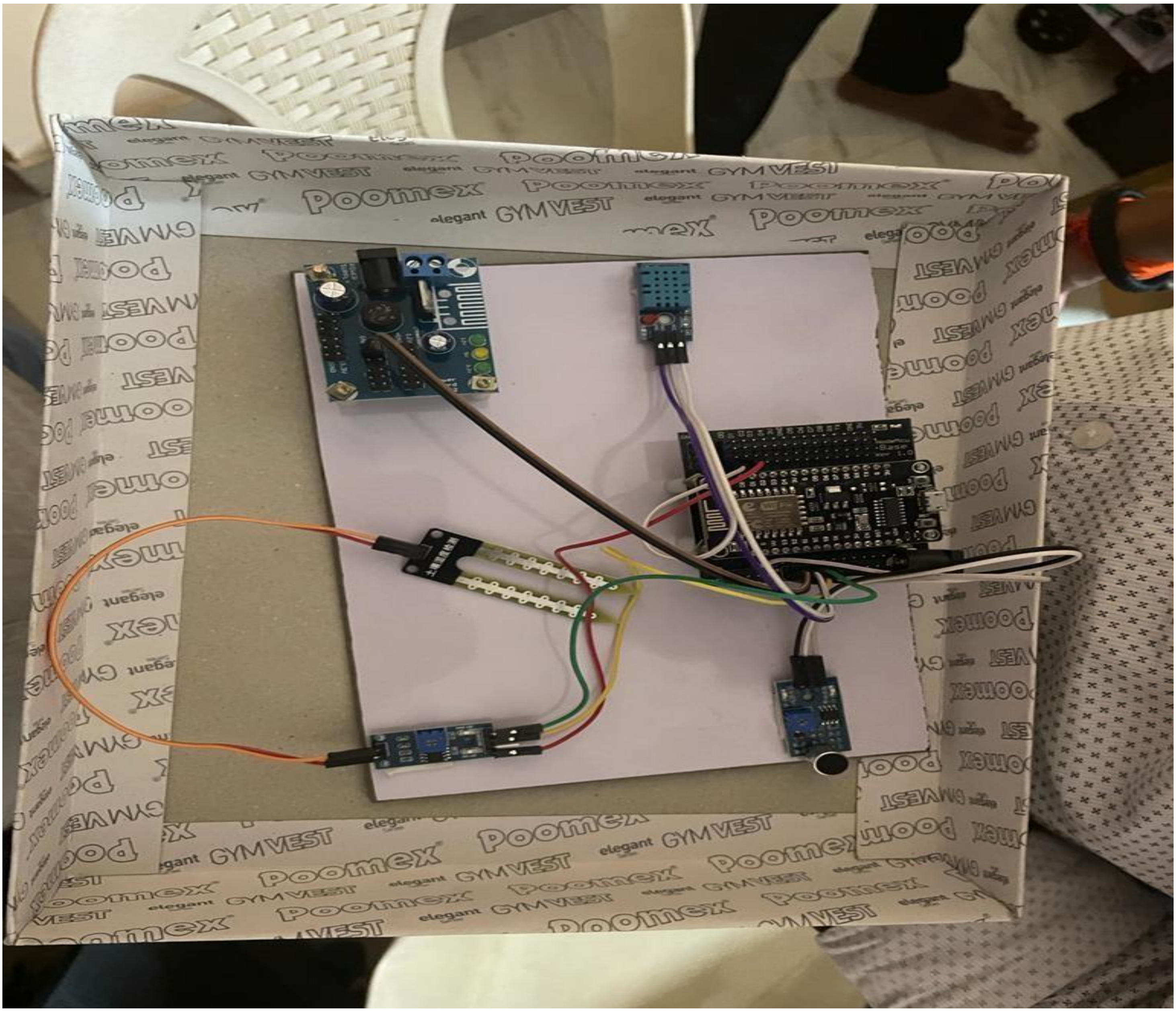

Figure a Deployment Setup

B. SCREEN SHOTS

OUTPUT:

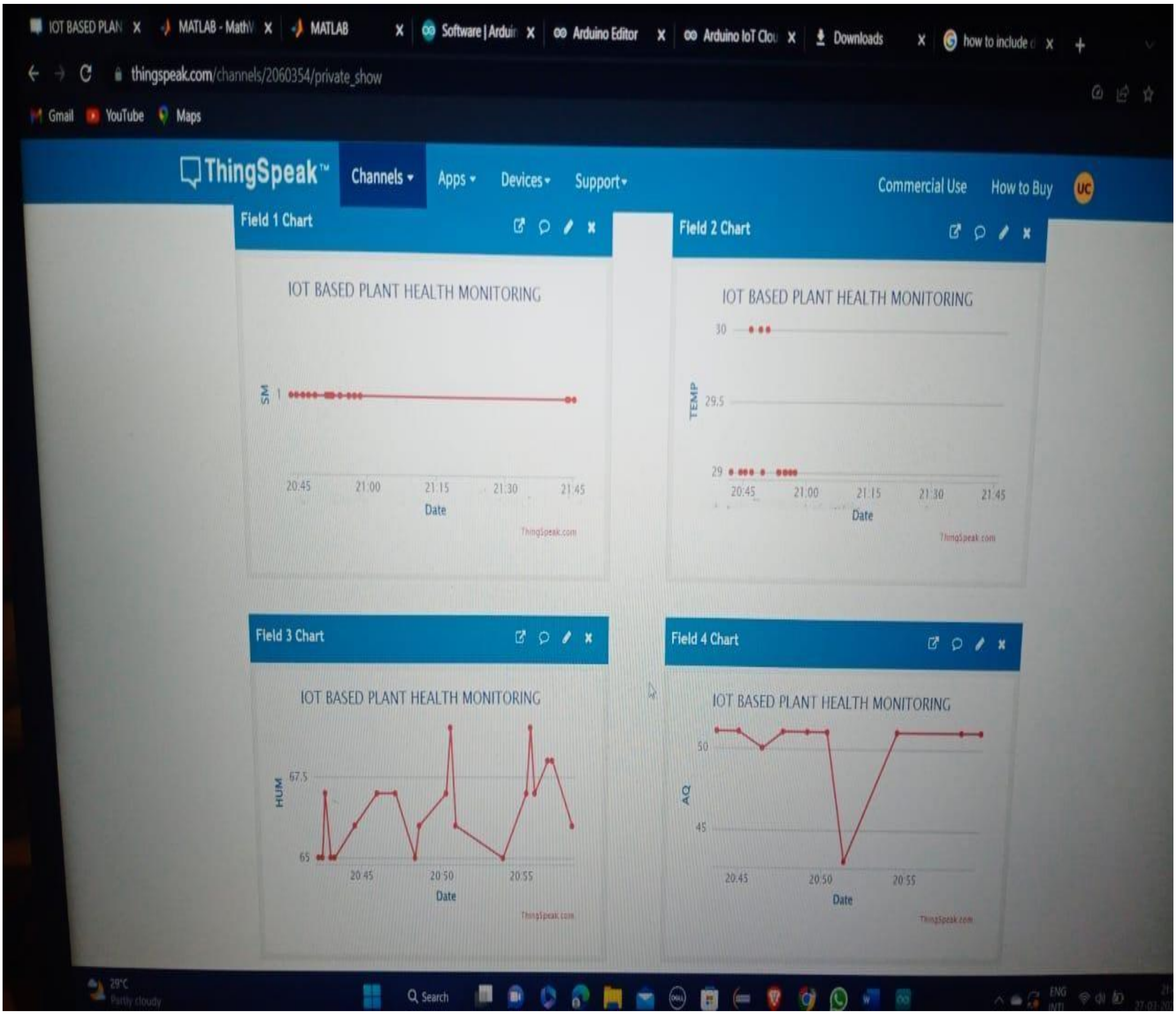

Figure b Output of soil moisture,temperature,humidity and acoustic sound in thingspeak

Figure c Output of temperature,humidity in arduino