A

Project Report

On

"SMART AGRICULTURE USING IoT: ENABLING TECHNOOLOGIES"

A Dissertation Submitted in partial of the Academic Requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION AND ENGINEERING

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CERTIFICATE

This is to certify that the entitled **"SMART AGRICULTURE USING IoT:ENABLING TECHNOGIES"** that is being submitted by the following B.TECH IV year ECE, In partial fulfillment for the award of degree of **BACHELOR OF TECHNOLOGY** in **ELECTRONICS AND COMMUNICATION ENGINEERING** to the **Jawaharlal Nehru Technological University**, is a record of bonafide work carried out by them under guidance and supervision during the year **2018-2019**.

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ACKNOWLEDGMENT

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Finally, we express our gratitude to all other members who are involved either directly or indirectly for the completion of this project.

DECLARATION

We hereby declare that the project work entitled **“SMART AGRICULTURE USING IoT:ENABLING TECHNOGIES”** is a record of an original work done by us under the guidance of **Mr. A. Ganesh** Assistant Professor, Department of Electronics and Communication Engineering, **SWAMI VIVEKANANDA INSITUTE OF TECHNOLOGY**, and this project work has not formed for the basis of any degree or diploma/associate ship/fellowship and any similar titles if any.

ABSTRACT

Despite the perception people may have regarding the agricultural process, the reality is that today's agriculture industry is data-centered, precise, and smarter than ever. The rapid emergence of the Internet-of-Things (IoT) based technologies redesigned almost every industry including ―smart agriculture‖ which moved the industry from statistical to quantitative approaches. Such revolutionary changes are shaking the existing agriculture methods and creating new opportunities along a range of challenges. This article highlights the potential of wireless sensors and IoT in agriculture, as well as the challenges expected to be faced when integrating this technology with the traditional farming practices.

IoT devices and communication techniques associated with wireless sensors encountered in agriculture applications are analyzed in detail. What sensors are available for specific agriculture application, like soil preparation, crop status, irrigation, insect and pest detection are listed. How this technology helping the growers throughout the crop stages, from sowing until harvesting, packing and transportation is explained. Furthermore, the use of unmanned aerial vehicles for crop surveillance and other favorable applications such as optimizing crop yield is considered in this article. State-of-the-art IoT-based architectures and platforms used in agriculture are also highlighted wherever suitable. Finally, based on this thorough review, we identify current and future trends of IoT in agriculture and highlight potential research challenges.

SMART AGRICULTURE USING IoT:ENABLING TECHNOGIES

INDEX

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

To improve the agricultural yield with fewer resources and labor efforts, substantial innovations have been made throughout human history. Nevertheless, the high population rate never let the demand and supply match during all these times. According to the forecasted figures, in 2050, the world population is expected to touch 9.8 billion, an increase of approximately 25% from the current figure. Almost the entire mentioned rise of population is forecasted to occur among the developing countries .

On the other side, the trend of urbanization is forecasted to continue at an accelerated pace, with about 70% of the world‘s population predicted to be urban until 2050 (currently 49%) . Furthermore, income levels will be multiples of what they are now, which will drive the food demand further, especially in developing countries

As a result, these nations will be more careful about their diet and food quality; hence, consumer preferences can move from wheat and grains to legumes and, later, to meat. In order to feed this larger, more urban, and richer population, food production should double by 2050 [4, 5]. Particularly, the current figure of 2.1 billion tons of annual cereal production should touch approximately 3 billion tons, and the annual meat production should increase by more than 200 million tons to fulfill the demand of 470 million tons

Not only for food, but crop production is becoming equally critical for industry; indeed crops like cotton, rubber, and gum are playing important roles in the economies of many nations. Furthermore, the food-crops-based bioenergy market started to increase recently. Even before a decade, only the production of ethanol utilized 110 million tons of coarse grains (approximately 10% of the world production) .

Due to the rising utilization of food crops for bio-fuel production, bio-energy, and other industrial usages, food security is at stake. These demands are resulting in a further increase of the pressure on already scarce agricultural resources.

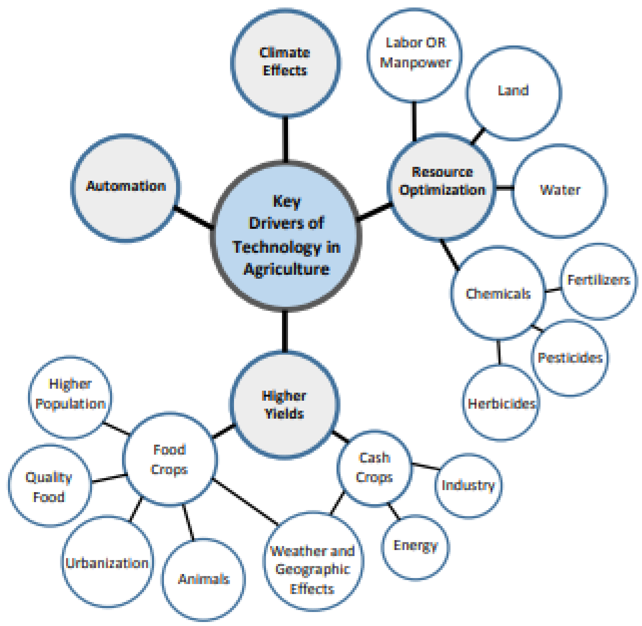

Fig 1.1 Key Drivers of Technology in Agriculture Industry

Unfortunately, only a limited portion of the earth‘s surface is suitable for agriculture uses due to various limitations, like temperature, climate, topography, and soil quality, and even most of the suitable areas are not homogenous. When zooming the versatilities of landscapes and plant types, many new differences start to emerge that can be difficult to quantify. Moreover, the available agricultural land is further shaped by political and economic factors, like land and climate patterns and population density, while rapid urbanization is constantly posing threats to the availability of arable land. Over the past decades, the total agriculture land utilized for food production has experienced a decline [9]. In 1991, the total arable area for food production was 19.5 million square miles (39.47% of the world‘s land area), which was reduced to approximately 18.6 million square miles (37.73% of the world‘s land area) in 2013 [10]. As such, the gap between demand and supply of food is becoming more significant and alarming with the passage of time.

Further examination showed that every crop field has different characteristics that can be measured separately in terms of both quality and quantity. Critical characteristics, like soil type, nutrient presence, flow of irrigation, pest resistance, etc., define its suitability and capability for a specific crop. In most of situations, the differentiations of characteristics can exist within a single crop field, even if the same crop is being cultivated in entire farm; hence, sitespecific analyses are required for optimal yield production. Further, adding the dimension of time, specific crops in the same field rotate season-to-season and biologically reach different stages of their cycle within a year in areas where locational and temporal differences result in specific growth requirements to optimize the crop production. To respond to these demands with a range of issues, farmers need new technology-based methods to produce more from less land and with fewer hands.

Considering the standard farming procedures, farmers need to visit the agriculture sites frequently throughout the crop life to have a better idea about the crop conditions. For this, the need of smart agriculture arises, as 70% of farming time is spent monitoring and understanding the crop states instead of doing actual field work [11]. Considering the vastness of the agriculture industry, it incredibly demands for technological and precise solutions with the aim of sustainability while leaving minimum environmental impact. Recent sensing and communication technologies provide a true remote ―eye in the field‖ ability in which farmers can observe happenings in the field without being in the field. Wireless sensors are facilitating the monitoring of crops constantly with higher accuracy and are able to, most importantly, detect early stages of unwanted state. This is the reason why modern agriculture involves the usage of smart tools and kits, from sowing to crop harvesting and even during storage and transportation. Timely reporting using a range of sensors makes the entire operation not only smart but also cost effective due to its precise monitoring capabilities. Variety of autonomous tractors, harvesters, robotic weeders, drones, and satellites currently complement agriculture equipment. Sensors can be installed and start collecting data in a short time, which is then available online for further analyses nearly immediately. Sensor technology offers crop and sitespecific agriculture, as it supports precise data collection of every site.

Recently, the Internet-of-Things (IoT) is beginning to impact a wide array of sectors and industries, ranging from manufacturing, health, communications, and energy to the agriculture industry, in order to reduce inefficiencies and improve the performance across all markets [12-16]. If looking closely, one feels that the current applications are only scratching the surface and that the real impact of IoT and its uses are not yet witnessed. Still, considering this progress, especially in the near past, we can predict that IoT technologies are going to play a key role in various applications of the agriculture sector. This is because of the capabilities offered by IoT, including the basic communication infrastructure (used to connect the smart objects—from sensors, vehicles, to user mobile devices— using the Internet) and range of services, such as local or remote data acquisition, cloud-based intelligent information analysis and decision making, user interfacing, and agriculture operation automation. Such capabilities can revolutionize the agriculture industry which probably one of most inefficient sectors of our economic value chain today. To summarize this discussion, figure 1 provides the main drivers of technology, while figure 2 highlights the major hurdles of technology implementation in smart agriculture

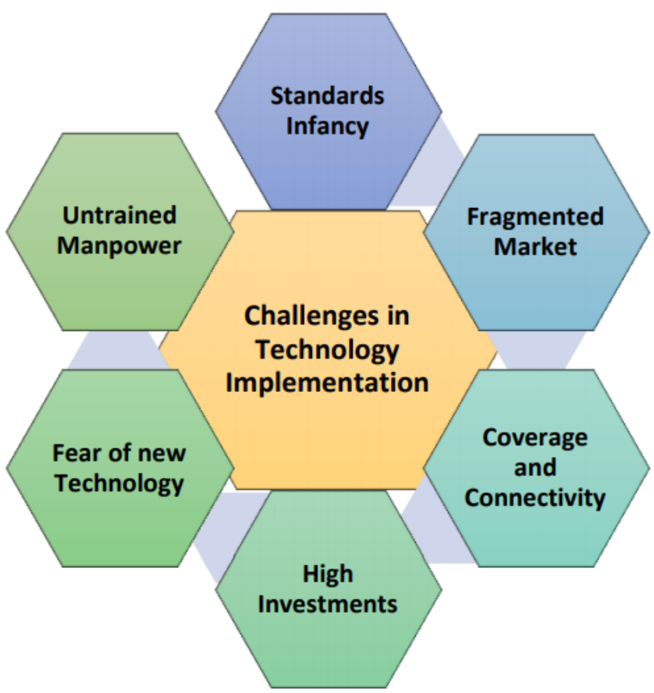

Fig1.2 Major Hurdle's in Technology Implementation for Smart Agriculture

Researchers and engineers around the globe are proposing different methods and architectures and based on that suggesting a variety of equipment to monitor and fetch the information regarding crop status during different stages, considering numerous crop and field types. Focusing on the market demand, many leading manufactures are providing a range of sensors, unmanned aerial vehicles (UAVs), robots, communication devices, and other heavy machinery to deliver the sensed data. In addition, various commissions, food and agriculture organizations, and government bodies are developing polices and guidelines to observe and regulate the use of these technologies in order to maintain food and environment safety [17-20]. There are reasonable efforts that highlight the role of the IoT in the agriculture industry, but most of the published work focuses only on applications [10, 21, 22]. Most of the existing articles either provide no insight or show limited focus on the various IoT-based architectures, prototypes, advanced methods, the use of IoT for food quality, and other future issues considering the latest facts and figures. This manuscript examines the trends in IoT-based agriculture research and reveals numerous key issues that must be addressed in order to transform the agriculture industry by utilizing the recent IoT developments

The major contribution of this article is to provide real insight regarding:

- Expectations of the world from the agriculture industry
- Very recent developments in IoT, both scholarly and in industry are highlighted and how these developments are helping to provide solutions to the agriculture industry.
- Limitations, the agriculture industry is facing.
- Role of IoT to cope these limitations and other issues like resources shortage and their precise use, food spoilage, climate changes, environmental pollution, and urbanization.
- Strategies and policies that need to be considered when implementing IoT-based technologies • Critical issues that are left to solve and possible solutions that are further required, while suggestions are provided considering these challenges.

This article is a compendium of knowledge that can help the researchers and agriculture engineers implementing the IoT-based technologies to achieve the desired smart agriculture. The rest of this document is organized as follows. Section II provides a deep overview of major applications of IoT in agriculture and what we can achieve by utilizing these technologies. Section III gives insight regarding the role of IoT in advanced agriculture practices, like vertical farming (VF), hydroponics, and phenotyping, to manage the issues of increased urban population. Section IV highlights various technologies and equipment, like sensors, robots, tractors, and communication devices, being used to implement IoT in this industry. Accepting the worth of UAVs in precision agriculture, Section V caters application achievements that are not possible even using other latest technologies. Food safety and transportation are other critical areas requiring focus to overcome the hunger issues which did not get the attention of researchers as it deserves. Section VI supplies the role of the IoT to ensure food quality for longer periods and to deliver to remote areas. Section VII identifies current and future trends of this technology in the crop industry by highlighting potential research challenges. Finally, Section VIII concludes this article.

1.2 Major Applications

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1. **SOIL SAMPLING AND MAPPING**

Soil is the ―stomach‖ of plants, and its sampling is the first step of examination to obtain field-specific information, which is then further used to make various critical decisions at different stages. The main objective of soil analysis is to determine the nutrient status of a field so that measures can be taken accordingly when nutrient deficiencies are found. Comprehensive soil tests are recommended on an annual basis, ideally in Spring; however, based on soil conditions and weather consents, it may be done in in Fall or Winter . The factors that are critical to analyze the soil nutrient levels include soil type, cropping history, fertilizer application, irrigation level, topography, etc. These factors give insight regarding the chemical, physical, and biological statuses of a soil to identify the limiting factors such that the crops can be dealt accordingly. Soil mapping opens the door to sowing different crop varieties in a specific field to better match soil properties accordingly, like seed suitability, time to sow, and even the planting depth, as some are deep-rooted and others less. Furthermore, growing multiple crops together could also lead to smarter use of agriculture, simply making the best use of resources

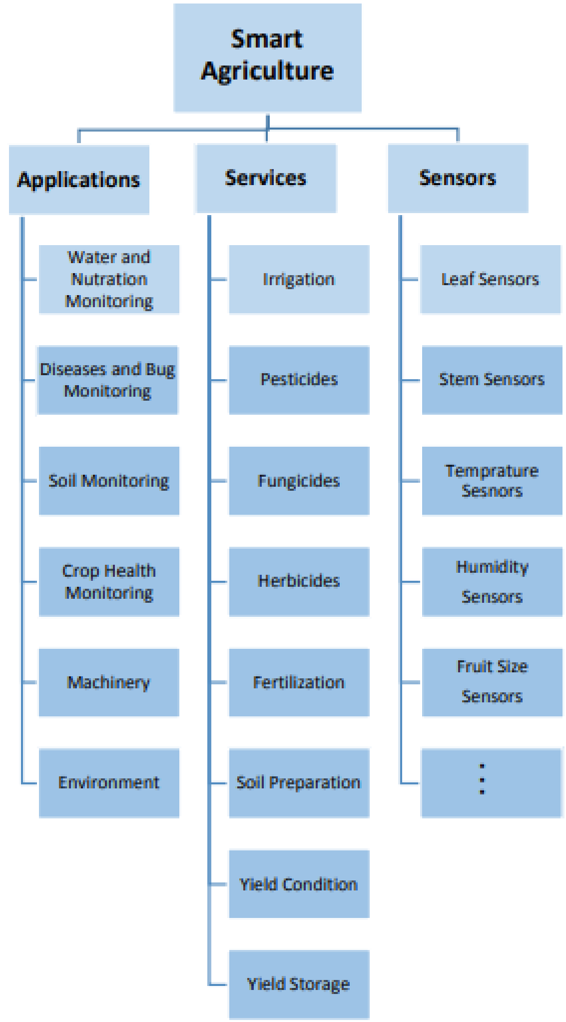

Fig1.3General Hierarchy of Possible Applications, Services and Sensors for Smart Agriculture

Currently, manufacturers are providing a wide range of toolkits and sensors that can assist farmers to track the soil quality and, based on this data, recommend remedies to avoid its degradation. These systems allow for the monitoring of soil properties, such as texture, water-holding capacity, and absorption rate, which ultimately help to minimize erosion, densification, salinization, acidification, and pollution (by avoiding excessive use of fertilizer). Labin-a-Box, a soil testing tool kit developed by AgroCares, is considered a complete laboratory in itself based on its offered services . By using this, any farmer, without having any lab experience, can analyze up to 100 samples per day (overall, more than 22,000 nutrient samples a year) without visiting any lab. Drought is a major concern which limits the productivity of crop yield. Most of the regions around the globe face this issue with various intensities. To deal with this issue, especially in very rural areas, remote sensing is being used to obtain frequent soil moisture data which helps to analyze the agricultural drought in far regions. For this purpose, the Soil Moisture and Ocean Salinity (SMOS) satellite was launched in 2009 which provides global soil moisture maps every, one to two days. Authors in used SMOS L2 to calculate the Soil Water Deficit Index (SWDI) in Spain in 2014. In this effort, they followed different approaches to obtain the soil water parameters in order to compare with the SWDI acquired from in situ data. In authors used the moderate resolution imaging spectroradiometer (MODIS) sensor to map various soil functional properties to estimate the land degradation risk for sub-Saharan Africa. The soil maps and field survey data, which covered all major climate zones on the continent, were used to develop the prediction models. Sensors and vision based technologies are helpful to decide the distance and depth for sowing the seed efficiently. Like in , sensor and vision based autonomous robot called Agribot is developed for sowing seeds. The robot can perform on any agricultural lands on which the selfawareness of the robot‘s placement is ascertained through the global and local maps generated from Global Positioning System (GPS) while the on-board vision system is paired with a personal computer. Advancing further, various non-contact sensing methods are proposed to determine the seed flow rate as in where the sensors are equipped with LEDs; consist of infrared, visible light and laser-LED as well as an element as a radiation receiver. The output voltage varies based on the movement of the seeds through the sensor and band of light rays, and falling of shades on the elements of receiver. The signal information, linked to the passing seeds, is used to measure the seed flow rate.

2. IRRIGATION

About 97% of Earth‘s water is salt-water held by oceans and seas, and only the remaining 3% is fresh water—more than two-third of which is frozen in the forms of glaciers and polar ice caps. Only 0.5% of the unfrozen fresh water is above the ground or in the air, as the rest lies underground .In short, humanity relies on this 0.5% to fulfill all its requirements and to maintain the ecosystem, as enough fresh water must be kept in rivers, lakes, and other similar reservoirs to sustain it. It is worth mentioning that solely the agriculture industry uses approximately 70% of this accessible fresh water . In many countries, situation rises to 75% e.g. Brazil, further in some underdeveloped countries, even it exceeds 80% . The main reason for this high water consumption is the monitoring procedure as even in 2013, crops visual inspection for irrigation decision-making was very common, as nearly 80% of farms in United States were observed by this. According to the UN Convention to Combat Desertification (UNCCD) estimates in 2013 show that there were 168 countries affected by desertification and by 2030, almost half of the world population will be living in areas with high water shortages . Considering the figures of water crises around the globe, same time its increasing demands in agriculture and many other industries, it should be provided to places only where it is needed, most importantly, in required quantities. For this purpose, increased awareness has been implemented to conserve the existing under-stress water resources by employing more efficient irrigation systems.

Various controlled irrigation methods, like drip irrigation and sprinkler irrigation, are being promoted to tackle the water wastage issues, which were also found in traditional methods like flood irrigation and furrow irrigation. Both the crop quality and quantity are badly affected when facing water shortage, as irregular irrigation, even excess, leads to reduced soil nutrients and provokes different microbial infections. It is not a simple task to accurately estimate the water demand of crops, where factors like crop type, irrigation method, soil type, precipitation, crop needs, and soil moisture retention are involved. Considering this fact, a precise soil and air moisture control system using the wireless sensors not only makes an optimal use of water but also leads to better crop health.

3. FERTILIZER

A fertilizer is a natural or chemical substance that can provide important nutrients for the growth and fertility of plants. Plants mainly need three key macronutrients: nitrogen (N) for leaf growth; phosphorus (P) for root, flowers, and fruit development; potassium (K) for stem growth and water movement [38]. Any sort of nutrients deficiency or applying them improperly can be seriously harmful for the plant health. More importantly, excessive use of fertilizer not only results in financial losses but also creates harmful impacts to the soil and environment by depleting the soil quality, poisoning ground water, and contributing to global climate changes. Overall, crops absorb less than half the nitrogen applied as fertilizer, while remaining either emitted to the atmosphere or lost as run off. Unbalanced use of fertilizer leads to an imbalance in both soil nutrient levels and global climate as, reportedly, around 80% of the world‘s deforestation has occurred due to agricultural practices alone [39].

New IoT-based fertilizing approaches help to estimate the spatial patterns of nutrients requirements with a higher accuracy and minimum labor requirements. For example, the Normalized Difference Vegetation Index (NDVI) uses aerial/satellite images to monitor crop nutrient status. Basically, NDVI is based on the reflection of visible and near-infrared light from vegetation and is used to estimate the crop health, vegetation vigor, and density, further contributing to assess the soil nutrient level. Such precise implementation can significantly improve the fertilizer efficiency, simultaneously reducing the side effects to the environment. Many recent enabling technologies, like GPS accuracy, geo mapping, Variable Rate Technology (VRT), and autonomous vehicles, are strongly contributing to IoT-based smart fertilization.

Fig 1.4 Some key inputs, processes involved and possible outputs of smart farming

Fertilization under smart agriculture helps to precisely estimate the required dose of nutrients, ultimately minimize their negative effects on the environment. Fertilization requires site-specific soil nutrient level measurements based on various factors, such as crop type, soil type, soil absorption capability, product yield, fertility type and utilization rate, weather condition, etc. The reason is that the measurement of soil nutrient level is not only expensive but also time consuming, as, typically, investigations of soil samples at each location are required. To better depict this discussion, figure 4, summarizes the major inputs, processes and resultant outputs of smart agriculture.

4. CROP DISEASE AND PEST MANAGEMENT

The Great Famine, also known as the Irish Potato Famine, in which approximately one million Irish people died around 1950, resulted due to crop failure and yield reduction caused by ―potato blight‖ disease . Even today, corn growers in the US and southern Canada are facing an economic loss of approximately one billion USD due to ―southern corn leaf blight‖ disease. The Food and Agriculture Organization (FAO) estimates that 20–40% of global crop yields are lost annually due to pests and diseases. To control such vast production losses, pesticides and other agrochemicals became an important component of the agriculture industry during the last century. It is estimated that, in each year, around half a million tons of pesticide are used in the US alone, while more than two-million tons are used globally.

Recent IoT based intelligent devices, such as wireless sensors, robots and drones are allowing the growers to slash pesticide uses significantly by precisely spotting crop enemies. Compared to traditional calendar or prescription based pest control procedures, modern IoT-based pest management provides real-time monitoring, modeling, disease forecasting, hence proving more effective . Generally, the reliability of crop disease monitoring and pest management depends on three aspects: sensing, evaluating, and treatment. The advanced disease and pest recognition approaches are based on image processing in which raw images are acquired throughout the crop area using field sensors, UAVs, or remote sensing satellites. Usually, remote sensing imagery covers large areas and, hence, offers higher efficiency with lower cost. On the other hand, field sensors are capable to support more functions in collecting data, like environment sampling, plant health, and pest situations, in every corner throughout the crop cycle. For example, IoT-based automated traps [62, 63] can capture, count, and even characterize insect types, further uploading data to the Cloud for detailed analysis, which is not possible through remote sensing.

5. YIELD MONITORING, FORECASTING, AND HARVESTING

Yield monitoring is the mechanism used to analyze various aspects corresponding to agricultural yield, like grain mass flow, moisture content, and harvested grain quantity. It helps to accurately assess by recording the crop yield and moisture level to estimate, how well the crop performed and what to do next. Yield monitoring is considered an essential part of precision farming not only at the time of harvest but even before that, as monitoring the yield quality plays a crucial role. Yield quality depends on many factors, e.g. sufficient pollination with good quality pollen especially when predicting seed yields under changing environmental conditions

Furthermore, analyzing the yield quality and its maturity is another critical factor which enables the determination of the right time for harvesting. This monitoring covers various development stages and uses fruit conditions like its color, size, etc., for this purpose. Predicting the right harvesting time not only helps to maximize the crop quality and production but also provides an opportunity to adjust the management strategy. Although, harvesting is the last stage of this process, proper scheduling can make a clear difference. To obtain the real benefits from crops, farmers need to know when these crops are actually ready to harvest. Figure 5 represents a snapshot of a farm area network (FAN) that can portrait the whole farm to the farmer in real time.

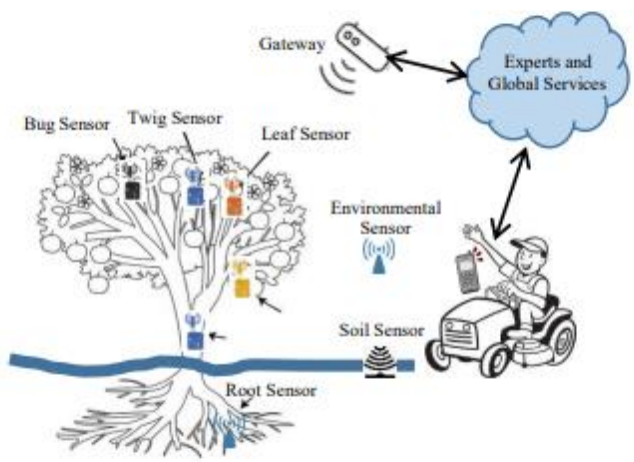

Fig 1.5 An IoT based Farm Area Network (FAN)

CHAPTER 2

BLOCK DIAGRAM AND EXPLANATION

BLOCK DIAGRAM

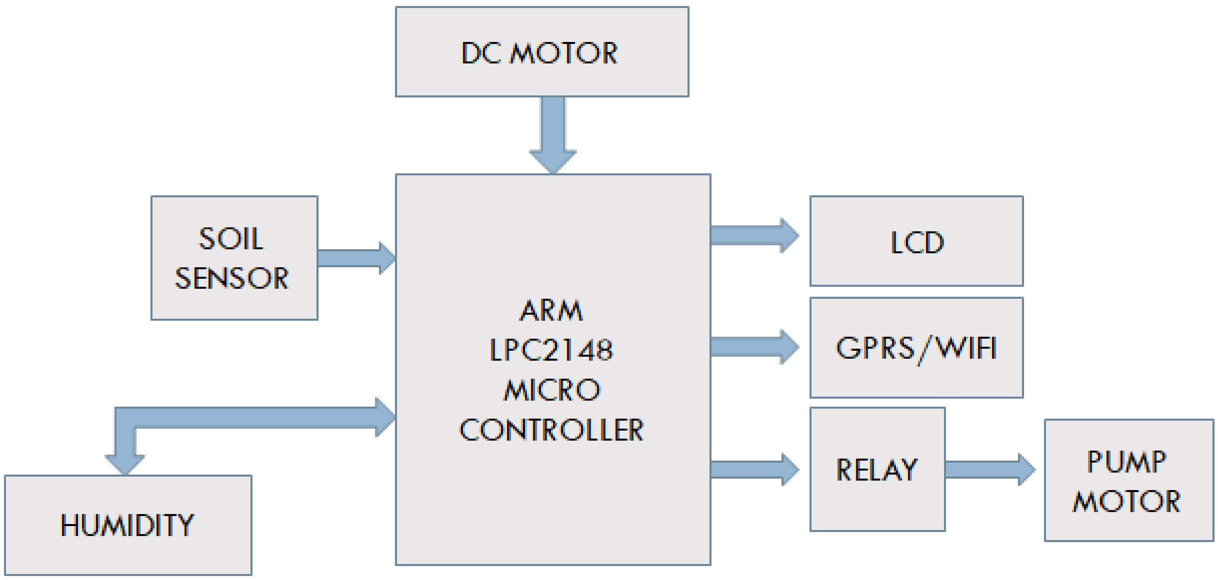

Fig: 2.1 Block Diagram

To get started with RFID-based automatic vehicle parking system ,the vehicle owner has to first register the vehicle with the parking owner and get the RFID tag. When the car has to be parked, the RFID tag is placed near the RFID reader, which is installed near the entry gate of the parking lot. The block diagram consist of following part

2.1 Microcontroller unit

Microcontroller used in the project is PIC 16f877A. This part is the heart of the project. It checks for the entry and exit of the car. It continuously polls the pins from where we receive the signal from the intruder circuits. When it detects the car from the entry gate then it checks whether there is any vacant space in the parking lot. If there is vacant space then it opens the door and increases the over all count in the parking lot by one. And after 3 seconds automatically closes the door. And if it detects the car from the exit gate then it decreases the count by one.

2.2 Relay

Relays are **switches** that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit..

2.3 SOIL MOISTURE SENSOR

The **Soil Moisture sensor** is used to measure the water content(moisture) of soil.when the soil is having water shortage,the module output is at high level, else the output is at low level.This sensor reminds the user to water their plants and also monitors the moisture content of soil.

2.4Display unit (LCD)

LCD makes this instrument user friendly by displaying everything on the display. It is an intelligent LCD module, as it has inbuilt controller which convert the alphabet and digit into its ASCII code and then display it by its own .

2.5 DC MOTOR

Dc motor is used to open and close the door. It is interfaced with microcontroller and takes command from the microcontroller to r

CHAPTER 3

CIRCUIT DIAGRAM AND EXPLANATION

CHAPTER 4

PCB MANUFACTURING

PCB means printed circuit board PCB is one of the most important elements in any electronic system. They accomplish the interconnection the between component mounted on them in particular manner PCB consist of conductive circuit pattern which is applied to one or both sided of an insulating base copper is most widely used for conductor material. Aluminum nickel, silver, brass is used for same special application. The thickness of conducting material depends upon the current carrying capacity of circuit. Thus a thicker conductor layer will have mare current carrying capacity once the PCB is manufactured the current carrying capacity is depends on which of conductor track.

4.1 Functions of PCB

The printed circuit board usually serves there distinct functions are as follows:

• It provides mechanical support for the component mounted on it.

• It provides necessary electrical interconnections.

• It acts as a heat sink i.e. it provides a conduction path leading to removal of most of the heat generate in the circuit.

4.2 ADVANTAGE OF PCB

Over the conventional wire method

: 1. PCB‟s have controllable and predicable electrical mechanical properties.

2. Rapid production is possible.

3. Time is saved since it avoids wiring connections production to another

4. Weight is reduced

5. Soldering is done in one operation instead of individual connection between component and wires.

6. Cost is less

4.3 Types of PCB

Single Sided PCB: This type of PCB consists of a natural coil of a copper on only one side of the base material. This type of PCB frequently used when the manufacturing cost has to be kept at minimum. B) Double Sided PCB: Double sided PCB is used when there is more number of jumpers. This type of PCB has copper fail on both side of base material. The double-sided PCB"s are used when insulation of PCB is very complicated i.e. if jumpers are more in number and when it is difficult to fabricants the PCB ON a single sided PCB.

4.4 Steps in designing PCB

Preparations for the designing the PCB is:

A)Layout planning B) Artwork drawing C) Artwork transforming D) Painting E) Etching F) Drilling G) Mounting of component H) Soldering I) Testing J) Protection

A) Layout planning

For placing the component in the layout all the information about circuit needed for the artwork preparation. The layout should prepare from the component size. Layout planning means planning for the placing of the components and input output connection for a given circuit.

RULES FOR LAYOUT

- First rule is to prepare each and every PCB layout as viewed from the component side or topside.

- Another important rule is not to start the designing of layout unless a clear circuit diagram is available.

• Develop the layout in the direction of the signal flow first and then between this a smaller components larger size components to be place.

• Among the components larger size components should be place first and then in between this smaller components to be place.

• All the components are placed in such a manner that the disordering of the other components is not necessary if they have to be replaced.

• In designing of PCB layout it is very important to divide the circuit into functional submit which helps in testing and serving.

• Mask the input output and power connection of the appropriate point.

• Use two different colors for drawing a layout of double sided PCB

• The rules for the width of the conductor is as follows width of the ground > width of the supply > of the signal.

B) Artwork of PCB

The artwork is use to prepare the all tracks on the board. It is easier and less expensive to draw the artwork, first an sheet or paper because the mistake are easily to correct with an erasing while producing the artwork the first required is the complete circuit diagram. The artwork consists of only the interconnection between the different pins of the components.

RULES FOR DRAWING THE ARTWORK:

• In PCB with higher conductor density is essential in double sided PCB to run the conductor in X direction on one side on the other side in Y direction.

• It is essential to begin and end the conductor length should be minimum.

• The conductor forming the sharp internal angles less than 60˚ must be avoided

• If one or several conductors have to pars between pads or other conductor pattern than the spacing between the conductors should be equally distributed.

• The spacing between the conductors should be minimum the spacing between the conductors depends upon the voltage difference between the conductor increases, which increases the spacing between the conductors.

• As the voltage difference between the conductors increases this increases the spacing between the conductors

C)Painting and Etching

To paint and etching of transferring artwork of given circuit. The apparatus required are paint glass tray etching solution (FECL3) clad. Painting: Cu tracks are filled with paint after and completion of artwork on Cu clad etching is the process of remaining extra unwanted copper from the surface of cu clad warm water is taken in a glass tray and two or three spoon full of Perica Chloride are added to it the copper clad containing the circuit design is emerged in the tray having the ferric chloride solution. After some time the exposed copper gets etched the copper clad is now taken out of the solution and washed with one dried paint on the copper clad can be removed with kerosene or petro

D)Drilling

Is the process of making opening at the proper places where the mounting of components are required it is achieved by using different drill bits or different dimension i.e. 0.5mm, 1m, 15mm drilling is done either by using hand drill or M / L drill.

This is the process of placement of component at proper places. The components a mounted on the opposite side if cu track by checking polarities i.e. +ve or –ve. Before mounting the components the lead so component should be staggered with pliers and cleaned with blade

E) Mounting of Components:

• For Mounting Resister:

• First using mom of cooler code then the leads of resistors bending device checks the value of resistance. The body of resister should touch the PCB surface.

• For Mounting Capacitor:

• First the capacitance value of capacitor is checked it polarities are given then it is mounted is such a manner that the polarity should be correct then the leads are inserted in the hole and bend property. If the length of lead is more then it should be cut for mounting resistor

• For Mounting Transistor:

• The leads of transistor are mounted into the hole for mounting transistor each must have insulating slave because there is less space between the terminals

• For Mounting Diode:

• First the diode is tested then mounted by taking anode and cathode in consideration.

F) Soldering:

To active the moderate joint of the component with PCB the soldering is used. There are two method of soldering

A. IRON SOLDERING

B. MASK SOLDERING

CHAPTER 5

COMPONENT DESCRIPTION

5.1 ARM LPC2148 MICRO CONTROLLER

Fig 5.1 LPC2148

Embedded system and SOC (system on chip) designers choose particular microprocessor cores, libraries, and different tools to develop microprocessor based applications. An ARM processor is one of the best alternatives obtainable for embedded system designers. In the past few years, the ARM architecture has become very popular and these are available from different IC manufacturers. The applications of ARM processors involves in mobile phones, automotive braking systems, etc.

PIN DIAGRAM

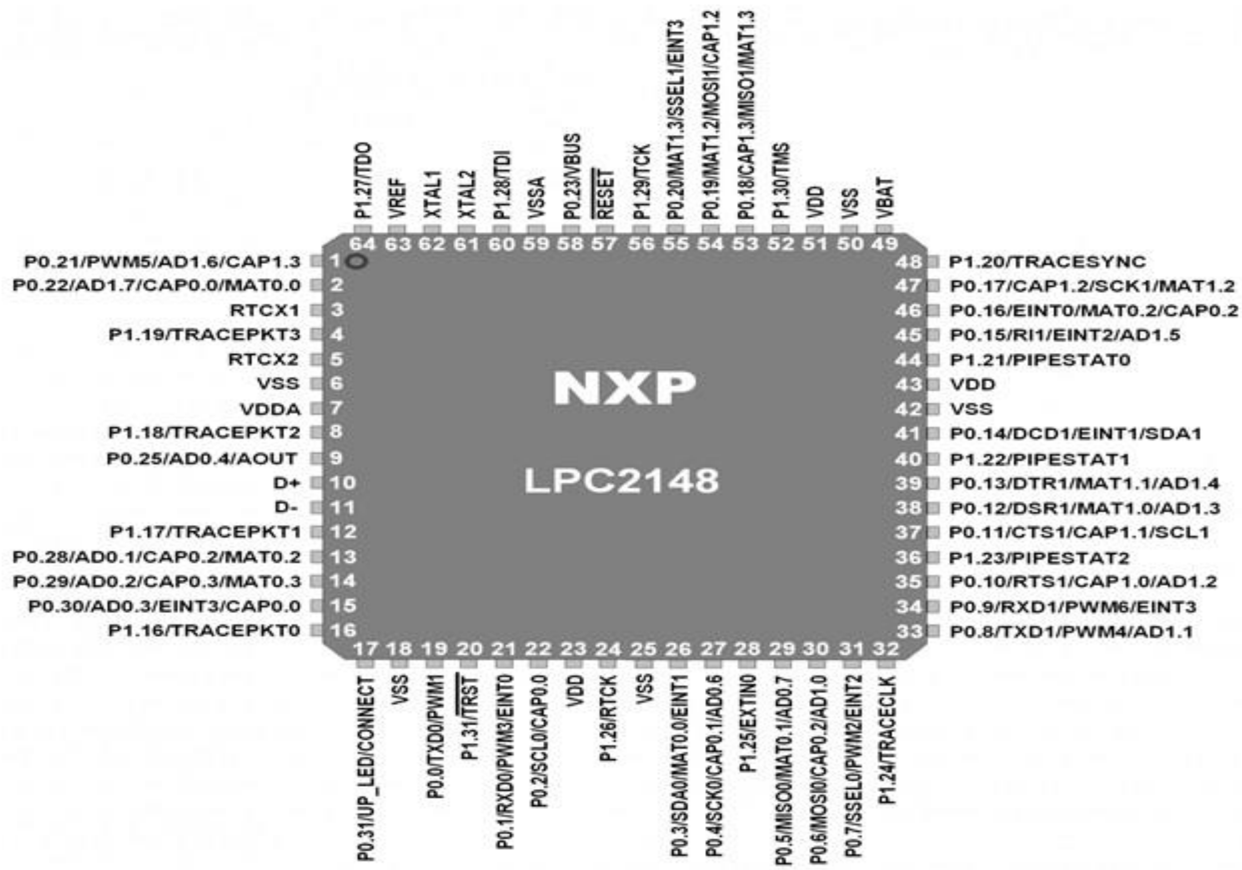

FIGURE: 5.2 Pin Diagram

ARM7 based LPC2148 Microcontroller

The full form of an ARM is an advanced reduced instruction set computer (RISC) machine, and it is a 32-bit processor architecture expanded by ARM holdings. The applications of an ARM processor include several microcontrollers as well as processors. The architecture of an ARM processor was licensed by many corporations for designing ARM processor-based SoC products and CPUs. This allows the corporations to manufacture their products using ARM architecture. Likewise, all main semiconductor companies will make ARM-based SOCs such as Samsung, Atmel, TI etc.

ARM7 Processor:

ARM7 processor is commonly used in embedded system applications. Also, it is a balance among classic as well as new-Cortex sequence. This processor is tremendous in finding the resources existing on the internet with excellence documentation offered by NXP Semiconductors. It suits completely for an apprentice to obtain in detail hardware & software design implementation.

LPC2148 Microcontroller:

The LPC2148 microcontroller is designed by Philips (NXP Semiconductor) with several in-built features & peripherals. Due to these reasons, it will make more reliable as well as the efficient option for an application developer. LPC2148 is a 16-bit or 32-bit microcontroller based on ARM7 family.

5.2 PIN DESCRPTION

- Pin1 (P0.21/PWM5/AD1.6/Cap1.3): It is a general-purpose pin and it could be used for four multiple ways such as it could be as input output data pin, as a pulse width modulation generator, as an analog to digital converter and as a capture input for timer l channel 3.

- Pin 2 (P0.22/AD1.7/CAP0.0/MAT0.0): It could be for used for four purposes. First one P0.21, it could be used for input output data pin, second one AD1.7 , it could be used as analog to digital converter with ADC 1, input 7. Third one CAP0.0,it could be used as a capture input for timer 0 and channel 0. Fourth one MAT 0.0, it could be used as match output for timer 0 and channel 0.

- Pin 3 (RTC X1): Pin3 is used as input pin for RTC oscillator circuit.

- Pin 4 (P1.19/TRACEPKT3): Pin 4 could be as GPIO pin as well as with 3 bit input output pin for inner pull up.

- Pin 5 (RTCX2): Pin 4 is used as output pin for RTC oscillator circuit.

- Pin(6,18,25,42,50): These pins are used as references pins for grounding the microcontroller.

- Pin7(VDDA): This pin is used as voltage source pin with 3.3 Volts. These voltages could be useful for on chip digital to analog converter and analog to digital converter.

- Pin8(P1.18/TRACEPKT2): This pin is used as GPIO pin and 2 bit input output pin for inner pull up.

- Pin9(P0.25/AD0.4/AOUT): This pin is used as GPIO pin, as input 4 for AD0 and as output pin for digital to analog converter.

- Pin(10,11): Pin10 is used for D+ line bidirectional USB. Similarly the pin11 is used for D-line bidirectional USB.

- Pin12(P1.7/TRACEPKT1): This pin is used as a GPIO pin and as a standard input/output port for inner pull up.

- Pin13 (P0.28/AD0.1/CAP0.2/MAT0.2): This pin is used as a GPIO pin, analog to digital converter pin for ADC-0 input 1, capture input pin for timer 0 channel 2 and as a match output pin for timer 2 channel 1.

- Pin14(P0.29/AD0.2/CAP0.3/MAT0.3): This pin could be used as a GPIO pin, converter input pin for ADC-0 input 2,capature input for timer 0 channel 3 and as a match output pin for timer 0 channel 3.

- Pin15(P0.30/AD0.3/CAP0.3/EINT3/CAP0.0): This pin could be used as GPIO pin, converter pin for ADC-0 timer input 3,external interrupt with input 3 and as capture input pin for timer 0 channel 0.

- Pin16(P1.16/ TRACEPKT0): This pin could be used as a trace packet pin as well as GPIO pin.

- Pin(17,19,20,21): All these pins are used as GPIO pins. Pin17 is used as UP_LED pin, means it is used as indicator pin. Pin19 is used as a transmitter output for UART0 and as a pulse width modulator for output 1. Pin20 is used as a reset pin for JATG interface. Similarly the pin21is uses as receiver input for UART0,as PWM generator for output 3 and as external interrupt with input 0.

- Pin(22,24,26,27,28,29,30): These are GPIO pins. Pin22 is used as clock input output and capture input pin, pin 24 is used as CLK output during JATG interface. Pin 26 is used as matched output for timer 0 channel 0 and as external interrupt for input1.Pin 27 is used as a serial clock for transferring data from master bus to slave bus and as a digital converter ADC-0.6 for input 6. Pin 28 could be used as external trigger input with inner pullup. Pin 29 is used as MISO for transferring data form mater to slave bus and used as a converter ADC-0 with input 7.Pin 30 is also used as MISO output and as a capture input for timer 0 channel 2.

- Pin(23,43,51): These pins are used for suppling input voltages to internal core and input output ports.

- Pin(31,32,33): These pins are used as GPIO pins. Pin 31 is used as SSEL0,PWM2 and as external interrupt for input 2.Pin 32 is used as a trace CLK for standard input output port with inner pull up. Similarly, pin 33 is used as transmitter TXD1 for UART1 and as a pulse width modulator PWM4

- Pin(34,35,36,37): Pin 34,35,36 and 37 are GPIO pins. Pin 34 could be used as input receiver such as RDX1 for UART1, as output pulse modulator such as PWM6 for output 6.,as an external interrupt pin for input 3.Pin 35 could be used as a request pin for sending request to UART1 , as a capture input pin for timer 1 channel 1,as an anlage to digital converter ADC-1 for input 1.Pin 36 could be used as a 2-bit pipe line status pin for standard input output port. Pin 37 could be used as a clear input pin for UART1,as a capture pin for timer 1 channel and as a clear output input pin for 12C bus observer.

- Pin(38,39,40,41): Pin 38,39,40 and 41 could be used as GPIO pin. Pin 38 could be used as an output data terminal ready pin for UART1,as match output pin for timer 1 channel 0 and as an analog to digital converter ADC-1 for input1.Pin 39 could be used as an input data terminal ready pin for UART1, as an output match pin for terminal 1 channel 1 and as a converter ADC-1 for input 4.Pin 40 could be used a bit-1 pipe line status pin for standard input output port. Pin 41 could be used as input data carrier detector pin for UART1,as an external interrupt pin for input 1 and as an input output open drain pin for 12C bus observer.

- Pin(44,45,46,47): These pins are also used as GPIO pin. Pin 44 could be used as a bit-0 pipe line pin for standard input output port. Pin 45 could be used as an input ring pointer pin for UART1, as an external interrupt pin for input 2 and as a pulse width modulator generator ADC-1.5 for input 5.Pin 46 could be used as external interrupt pin for input 0, as a match output pin for timer 0 channel 2 and as a capture input pin for timer 0 channel 2. Pin 47 could be used as capture input pin for timer 1 channel 2,as a serial CLK pin for sending output from master but to slave bus.

5.3 Microcontroller features

- The LPC2148 is a 16 bit or 32 bit ARM7 family based microcontroller and available in a small LQFP64 package.
- ISP (in system programming) or IAP (in application programming) using on-chip boot loader software.
- On-chip static RAM is 8 kB-40 kB, on-chip flash memory is 32 kB-512 kB, the wide interface is 128 bit, or accelerator allows 60 MHz high-speed operation.
- It takes 400 milliseconds time for erasing the data in full chip and 1 millisecond time for 256 bytes of programming.
- Embedded Trace interfaces and Embedded ICE RT offers real-time debugging with high-speed tracing of instruction execution and on-chip Real Monitor software.
- It has 2 kB of endpoint RAM and USB 2.0 full speed device controller. Furthermore, this microcontroller offers 8kB on-chip RAM nearby to USB with DMA.
- One or two 10-bit ADCs offer 6 or 14 analogs i/ps with low conversion time as 2.44 μs/ channel.
- Only 10 bit DAC offers changeable analog o/p.
- External event counter/32 bit timers-2, PWM unit, & watchdog.
- Low power RTC (real time clock) & 32 kHz clock input.
- Several serial interfaces like two 16C550 UARTs, two I2C-buses with 400 kbit/s speed.
- volts tolerant quick general purpose Input/output pins in a small LQFP64 package.
- Outside interrupt pins-21.

- 60 MHz of utmost CPU CLK-clock obtainable from the programmable-on-chip phase locked loop by resolving time is 100 μs.
- The incorporated oscillator on the chip will work by an exterior crystal that ranges from 1 MHz-25 MHz
- The modes for power-conserving mainly comprise idle & power down.
- For extra power optimization, there are individual enable or disable of peripheral functions and peripheral CLK scaling.

Supply Voltage

Most microcontrollers operate with the standard logic voltage of _5V. A voltage regulator circuit is usually used to obtain the required power supply voltage when the device is to be operated from a mains adaptor or batteries.

Fig 5.3 DC VOLTAGE SUPPLY

SOIL MOISTURE SENSOR

Soil moisture sensors measure the volumetric water content in soil.[1] Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

WORKING OF SENSOR

- The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value.
- When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower.
- This sensor can be connected in two modes; Analog mode and digital mode. First, we will connect it in Analog mode and then we will use it in Digital mode.

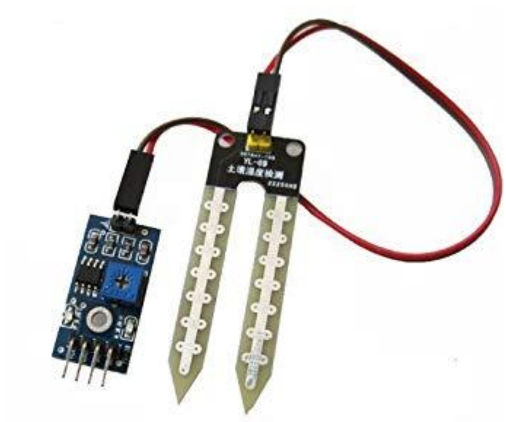

Fig 5.4 Soil Moisture Sensor

RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power

Fig5.5 Relay Circuit

GPRS

- General Packet Radio Service (GPRS) is a packet oriented mobile data standard on the 2G and 3G cellular communication network's global system for mobile communications (GSM). GPRS was established by European Telecommunications Standards Institute (ETSI) in response to the earlier CDPD and i-mode packet-switched cellular technologies. It is now maintained by the 3rd Generation Partnership Project (3GPP).
- GPRS is typically sold according to the total volume of data transferred during the billing cycle, in contrast with circuit switched data, which is usually billed per minute of connection time, or sometimes by one-third minute increments. Usage above the GPRS bundled data cap may be charged per MB of data, speed limited, or disallowed.
- GPRS is a best-effort service, implying variable throughput and latency that depend on the number of other users sharing the service concurrently, as opposed to circuit switching, where a certain quality of service (QoS) is guaranteed during the connection. In 2G systems, GPRS provides data rates of 56–114 kbit/sec.[3] 2G cellular technology combined with GPRS is sometimes described as 2.5G, that is, a

technology between the second (2G) and third (3G) generations of mobile telephony.[4] It provides moderate-speed data transfer, by using unused time division multiple access (TDMA) channels in, for example, the GSM system. GPRS is integrated into GSM Release 97 and newer releases.