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Automatic Irrigation Implementation

تمثيل نظام الري الألي

A Project Submitted in Partial Fulfillment for The Requirements of the Degree of B.Sc. (Honor) In Electrical Engineering

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بسم الله الرحمن الرحيم

"يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ"

صدق الله العظيم

سورة المجادلة الآية (11)

DEDICATION

Our peace and grace from Allah be upon him.

To the utmost knowledge lighthouse, to our greatest and most honored prophet Mohamed

To the spring that never stops giving, to our mothers. To the big hearts our dear fathers.

To those who have demonstrated to us what is the most beauty of life our brothers.

To the people who paved our way of science and knowledge all our teachers distinguished. To the taste of the most beauty moments with them and our friends.

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Above everything else we thank the Lord for seeing us thus far with all this work. His guidance is something we could not do without.

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Finally, and most importantly, we would like to express our deep appreciation to our beloved families, for all their encouragement, understanding, support, patience and true love throughout the ups and downs.

ABSTRACT

Water is the important source in human life. Around 80 % to 90 % water used in agriculture field. As due to day by day growth in globalization and population water consumption is also increases. There is challenge in front of every country to reduce the farm labor, cost, water consumption and provide fresh and healthy food.

Today automation is one of the important role in human life. The system is not only providing comfort but also reduce energy, efficiency and time saving.

Whenever there is a change in temperature or humidity, the surroundings these sensors sense the change in temperature and humidity and gives an interrupt signal to the NodeMCU witch control pumps and send the data to the farmer in the mobile application.

مستخلص

تعتبر المياه من اهم المصادر الطبيعيه في حياه الانسان حيث تستهلك الزراعه حوالي 80% الي 90% من مصادر المياه العزبه ، يزداد استهلاك المياه مع ازدياد التعداد السكاني العالمي يوما بعد يوم مما يشكل تحديا لكل دوله يتطلب منها تقليل استهلاك المزارع للايدي العامله و المياه و الطاقه و تكلفه الري.

في هذا العصر تشغل الالات حيزا مهما في حياه الانسان.

النظام الالي المستخدم لا يوفر الراحه فقط بل يقلل من استهلاك الطاقه و الوقت و يزيد من الكفاءه.

عندما يحدث تغيير في رطوبه التربه او حراره الجو تقوم المحسسات الحيطه بتحسس هذا التغيير ويرسل اشاره الي المتحكم الذي يقوم بالتحكم بطرمبات المياه بناءا علي القيم المقاسه ويرسل القياسات الي التطبيق الموجود في هاتف المزارع.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
LED	Light Emitter Diode
IOT	Internet Of Things
MQTT	Message Queuing Telemetry Transport
WAN	Wide Area Network
LAN	Local Area Network
IoAG	Internet Of Automatic Irrigation
USB	Universal Serial Bus
CPU	Central Processing Unit

LIST OF SAMPLES

Sample	**Meaning**
V0,1,2,…	Virtual pin 0,1, 2, …
D0,1,2,…	Digital pin 0, 1, 2, …
A0	Analog pin 0
v	Electric voltage
hum	Humidity
C	Celsius
cm	centimeter
Hz	Hertz
b	bit
B	byte

CHAPTER ONE

INTRODUCTION

1.1 Overview

Irrigation is the process of applying water to soil, primarily to meet the water needs of growing plants. approximately 30% of the world's food is grown on irrigated land, which accounts for only about 15% of the world's land used for crop production.

1.2 Problem statement

Irrigation process is one of the important step of agricultural product. Agricultural represents approximately 80% of total of water availability varies drastically from region to region some regions have aplenty of water available and some face scarcity of water also agriculture it need workers that proposed to be used in solving the problems the use of automatic irrigation control system.

1.3 Objective

- Obtaining a high accuracy automatically irrigation, in accordance with the program which mad by the owner.

- Reducing the total cost by aright and accurate irrigation.

- Reducing laborers and their costly.

- Production development.

- Preserving time and water by reducing the lost water and time.

- Preserving the soil elements and protect the soil from erosion.

1.4 Methodology

This project is about a temperature and soil humidity sensing automatic irrigation system under closed environment using Arduino like controller called NodeMCU. Which is plays the role of microcontroller.

This system reads the moisture of the soil using a soil moisture sensor and the temperature using a temperature sensor. When moisture level rises above the set point the system switches off the pump**.**

1.5 Research layout

In general, the thesis will be divided into five chapters.

- Chapter One introduction, stat the problem, proposed solution and methodology.
- Chapter Two describes the irrigation system in general.
- Chapter Three describes the methods used in automation of irrigation.
- Chapter Four provides a step by step implementation of the system.
- Describes and discusses the results obtained from the system.
- Chapter Five outlines the conclusions from this research and identifies possible extensions of this project.

CHAPTER TWO

IRRIGATION SYSTEMS

2.1 Introduction

Irrigation is the process of applying water to soil, primarily to meet the water needs of growing plants. Water from rivers, reservoirs, lakes, or aquifers is pumped or flows by gravity through pipes, canals, ditches, or even natural streams. Applying water to Slope fields enhances the magnitude, quality, and reliability of crop production approximately 30% of the world's food is grown on irrigated land, which accounts for only about 15% of the world's land used for crop production [1].

Various irrigation methods have been developed over time to meet the irrigation needs of certain crops in specific areas. The three main methods of irrigation are surface, sprinkler, and drip or micro-irrigation.

In surface irrigation, water flows over the soil by gravity. Sprinkler irrigation applies water to soil by sprinkling or spraying water droplets from fixed or moving systems. Micro-irrigation applies frequent, small applications by dripping, bubbling, or spraying.

A fourth, and minor, irrigation method is sub-irrigation, where the water table is raised to or held near the plant root zone using ditches or subsurface drains to supply the water.

More than 90% of the approximately 270 Mha of irrigated crop land in the world is surface-irrigated; less than 1% is irrigated by micro-irrigation [2].

2.2 Types of Irrigation

There are three main types of Irrigation system, surface irrigation, sprinkler irrigation and micro irrigation.

2.2.1 Surface irrigation

Surface irrigation entails water flowing by gravity over soil. Water is usually supplied by gravity through canals, pipes, or ditches from the water source to the field. In some locations, however, water may need to be pumped from the source to a field at a higher elevation. Types of surface irrigation systems include furrow, basin, and border irrigation. Surface irrigation systems are typically used for field crops, pastures, and orchards. Efficiency of surface irrigation systems varies tremendously because of variations in soil type, field uniformity, and management. Surface irrigation is often considered less efficient than sprinkler irrigation or micro-irrigation, because soil, not a pipe, is the water-conveyance system for surface irrigation (Table 2.1). However, a well-managed surface irrigation system on a uniform soil with a runoff-reuse system can approach 90% application efficiency [3].

Table 2.1: Application efficiencies for irrigation systems

System type	Application efficiency (%)
Furrow	50-70
Level basin	60-80
Border	60-75
Solid set	60-85
Set move	60-75
Center-pivot, Linear-move	75-95
Traveling gun	55-65
Micro-irrigation	80-95
Subsurface irrigation	50-80

- **Furrow irrigation**

In furrow irrigation, water flows in evenly spaced furrows or corrugates that are typically 0.1-0.3 m wide on fields with slopes of 0.1-3%. Water commonly flows in furrows for 12-24 h during an irrigation, but shorter or longer durations may be used depending on furrow length and soil, water, and management considerations. Inflow rates for individual furrows vary from approximately 10 to 100 l min^{-1}, again depending on soil, slope, field length, and management. Ideally, water should advance across the field in approximately 25% of the total irrigation time to irrigate the field uniformly. Since soil erosion increases as field slope and inflow rate increase, flow rate must be carefully managed on fields with steeper slopes (greater than 1%). Low inflow rates and long irrigation durations may be needed to apply the desired amount of water during an irrigation on soils with low infiltration rate. Conversely, higher inflow rates are often needed on fields with low slopes and/or high infiltration rates in order for the water to flow across the field and uniformly irrigate the upper and lower ends of the field. Inflow to irrigation furrows may be supplied from gated pipes or ditches (earthen or concrete). Siphon tubes are frequently used to convey and regulate water flow from ditches to individual furrows (Figure 2.1).

Figure 2.1: Furrow-irrigated sugar beet field, with water supplied by siphon tubes from a concrete ditch.

By creating a siphon, water flows through the tube, over the ditch bank, and into the furrow, as long as the tube outlet is lower than the water elevation in the ditch. Furrow inflow rate is controlled by tube diameter and the elevation difference between the ditchwater level and tube outlet. Gated pipes distribute water to furrows through evenly spaced outlets on the pipes. With earthen ditches, water can flow through a breach or other opening in the ditch bank to individual furrows or a smaller feed ditch that distributes water to several furrows. It is much more difficult to regulate flow through a breach in an earthen ditch than through siphon tubes or pipe gates. Furrow irrigation requires lower capital investment, less technical knowledge, and greater labor than most other irrigation systems. Fields can be irrigated without leveling or grading, because water flows in furrows.

Furrow irrigation is not well suited to automation, because water flow rate must be adjusted for each furrow for each irrigation [2].

- **Basin and border**

Basin and border irrigation systems are similar in that both involve a uniform sheet of water flowing over the soil. The general difference is that basin irrigation involves applying water to a nearly level field and may include ponding for extended time periods. With border irrigation, water flows between dikes that divide a sloping field into rectangular strips with free drainage at the end (Figure 2.2)

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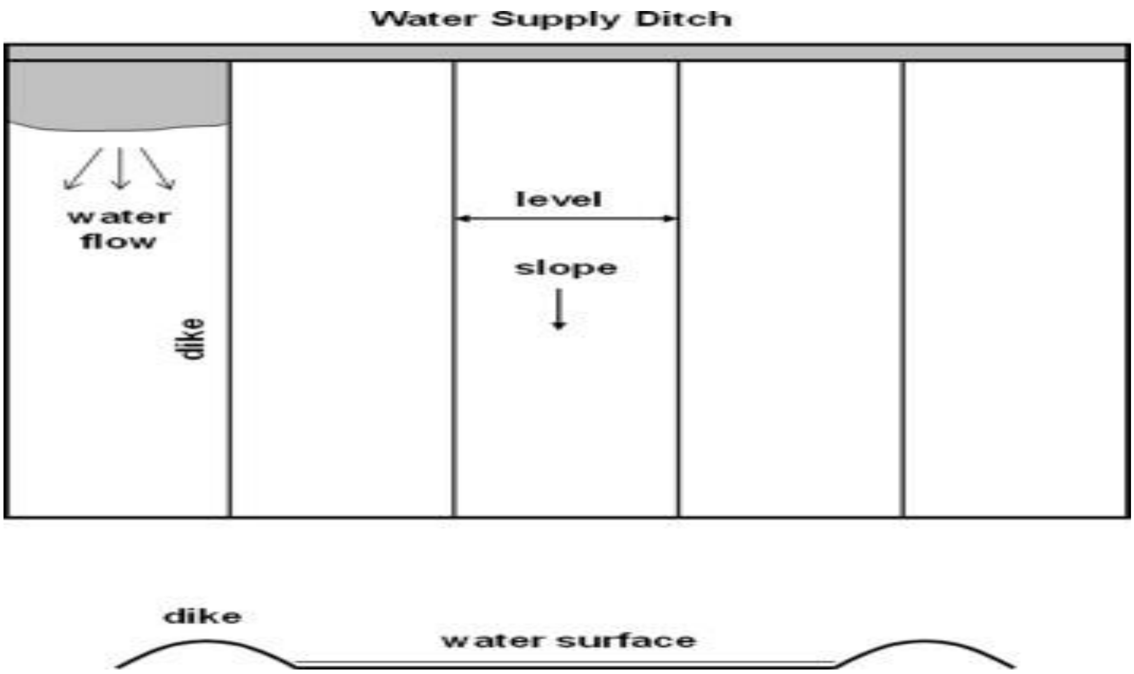

Figure 2.2: Schematic of a border-irrigated field, where a uniform sheet of water flows between dikes.

Basin irrigation is shown in Figure 2.3 blow.

Figure 2.3: Basin irrigation

The purpose of the dikes is to contain water as it flows across the field, unlike basin irrigation where the dikes pond the water.

Basins can be as small as a few square meters for a single tree or as large as several hectares with greater than 1001s-1 inflow rates. Basin size is a balance between soil infiltration rate, slope, and water supply. Water depth in basins varies from approximately 5 to 20 cm, with typical depths of 10-15 cm. Efficient basin irrigation requires a level soil surface with uniform soil texture and adequate water supply so the basin is quickly and uniformly covered with water. If the basin is not level, the higher elevation areas will receive less water than the low areas. If the basin inflow rate is inadequate, water will slowly advance, causing large differences in infiltration opportunity time within the basin.

A special type of basin irrigation is a drain-back level basin. Drain-back level basins have a series of parallel basins that receive inflow from a shallow, 5-10-m-wide ditch. After the first basin is filled, a gate opens to start filling the adjacent basin, which is at a lower elevation. Water near the inflow end of the first basin drains back to the inflow ditch and flows to the next basin. This procedure is repeated until every basin has been irrigated. The drain-back phase improves uniformity by reducing the amount of water that infiltrates near the inflow end and initially increases the inflow rate to the next basin, which increases the advance rate.

Border irrigation systems are better suited for sloping fields than basin systems, because water flows between dikes rather than ponds within basins. The irrigated areas between dikes can be 3-30 m wide and up to 400 m long. The field slope between dikes (perpendicular to water flow direction) should be nearly level so water flows uniformly down the field. The slope along the dikes can be similar to furrow irrigation, but border systems often have slopes of less than 0.5%. Water can be supplied to borders and basins from open ditches with gates, breaches, or siphon tubes or from above- or belowground pipes. Typical inflow rates vary from 10 to 1001 s -1, but vary widely depending on the size of basin or border, soil texture, and slope. Border and basin irrigation require less labor than furrow irrigation because water is supplied to a larger area with a single outlet [4].

2.2.2 Sprinkler irrigation

Sprinkler irrigation applies water to soil by spraying or sprinkling water through the air on to the soil surface. Water is pressurized and delivered to the irrigation system by a mainline pipe, which is often buried so it does not interfere with farming operations.

Three main categories of sprinkler irrigation systems are solid-set, set-move, and moving. Sprinkler irrigation is used for a wide variety of plants, including field crops, orchard trees, turf, and pasture. Sprinkler systems are also installed for applying wastewater and protecting plants from frost. Solid-set systems may be installed for a single season for certain field crops or permanently for turf, orchards, or permanent crops. Set-move systems are manually or mechanically moved to another part of the field after the irrigation set is complete in the present location. Moving systems such as center pivots or traveling guns apply water as the system slowly travels through the field.

Sprinkler irrigation is often more efficient than surface irrigation, because water application is more controlled (Table 2.1) [2]. In hot and/or windy areas, however, sprinkler irrigation can have significant losses to evaporation and wind drift. Maintenance is also important for efficient sprinkler irrigation. Worn nozzles and leaking pipe connections reduce application uniformity and system efficiency.

- **Solid-set sprinkler systems**

  Most solid-set sprinkler irrigation systems are designed to apply frequent, small amounts of water to meet plant water needs (e.g., daily). Water application rates can vary from approximately 4-6 mm 11-1 for field crops to 5-30 mm h-1 for turf applications. Overhead costs are greater for solid-set systems than other sprinkler systems, because the entire irrigated area must be equipped with sprinklers and pipe. However, permanently installed systems can be automated to reduce labor and allow irrigation at any hour of the day, which reduces the opportunity for plants to be stressed. When properly designed, solid-set systems have high application uniformity. While solid-set systems are most commonly used with turf, and landscape and permanent crops, these systems are also used for some high-value annual crops with low tolerance for water stress. Solid-set system designs are as varied as the applications: small sprinklers may irrigate 20 m 2, or large, gun-type sprinklers may be spaced 50 m apart. Plastic pipe is frequently used for buried applications, but it is also used in some aboveground applications. Momentum pipe (50-100 mm in diameter) is often used for field crops when the system is installed after planting and removed before harvest. Most systems are divided into zones so a portion of the area is irrigated at one time. Solid-set systems used for frost control, however, must be designed to water the entire area simultaneously [2]. (Figure 2.4) shows the solid-set sprinkler irrigation system.

Figure 2.4: Solid-Set sprinkler irrigation

- **Set-Move Sprinkler Systems**

Set-move sprinkler irrigation systems are designed to apply water slowly during the irrigation set (e.g., 4-6 mm h-1), which often lasts 8-24 h. After completing the irrigation set, the sprinkler system is moved to an adjacent area for the next set (Figure 4). Adequate water has to be applied during an irrigation set to meet the crop's water needs until the system is moved back to the area, often in 7-10 days.

The common types of set-move irrigation systems are hand-move and side-roll systems. Hand-move systems can be a single sprinkler or a line of sprinklers. A line of hand-move sprinklers, sometimes called “hand-lines” is typically composed of 9- or 12-m long pieces of 75- or 100-mm-diameter aluminum pipe with a sprinkler mounted on one end or in the center. Individual pipes are connected to form an irrigation line, usually not more than 400 m long.

After an irrigation set is completed, the line is disconnected, and each piece is moved by hand 10-20 m to the next set. A slight variation to the hand-line is the dragline or end-pull system. These systems, which are less common, have special connections between sprinkler pipes that allow the irrigation line to be pulled by a tractor to the next set. Side-roll systems, also called wheel lines, are similar in principle to hand-lines except a large-diameter wheel (1.5-3 m in diameter) is mounted in the center or on the end of each piece of aluminum pipe (100-125 mm in diameter) to elevate the sprinkler. The sprinkler pipe is the axle for the side-roll. When an irrigation set is completed and the pipe has drained, the wheel line, powered by an engine, is rolled to the next position. Self-leveling sprinklers are used so the side-roll does not have to be exactly positioned for the sprinklers to operate correctly [2].

Hand-move sprinkler system is shown in (Figure 2.5).

Figure 2.5: Hand-move sprinkler system

As for Side-Roll sprinkler irrigation is in (Figure 2.6).

Figure 2.6: Side-Roll sprinkler irrigation

- **Center pivot**

The center pivot has a stationary pivot point so the towers move in a circle (Figure 2.7). Water and power are supplied to the system through the pivot point.

A typical center pivot has eight spans, a total length of approximately 400 m, and irrigates 50-60 ha. Center pivots are extremely popular, because water is uniformly applied to a large area with little labor. Furthermore, once a circular field has been irrigated, the center pivot is in position to start the next irrigation. System cost per irrigated area is reduced by increasing the total length of a center pivot, because irrigated area per unit length increases with distance from the pivot point. Consequently, water application rate increases with distance from the pivot point, because each span must irrigate a larger area per revolution (a 50-m span at the pivot point irrigates 0.8 ha, while a 50-m span that is 350 m from the pivot point irrigates 12 ha). Application rates often exceed the infiltration rate of the soil under the outer spans of center pivots. Thus, the opportunity for unoff increases as center-pivot length increases. Center pivots can also irrigate fields with rolling terrain are difficult or impossible to irrigate by surface- irrigation methods; however, these conditions can create additional management challenges [2].

Figure 2.7 Center-Pivot irrigation system

- **Linear move**

have a control unit on one end, or in the center on longer systems, that moves the towers in a straight line to irrigate rectangular shaped fields. Power is supplied by an electrical drag cord or by an engine-powered generator mounted on the control unit. Water is typically supplied to the drive unit by a drag hose connected to a buried or aboveground pipe. Drive units can be equipped with a pump so water can be supplied from an open ditch flowing parallel to the travel direction, but this is not commonly used, because it requires a nearly level ditch. System cost per irrigated area is reduced by increasing the distance the system travels. Since hose length is limited to approximately 150 m, the system can move 300 m before the hose is connected to the next riser. Similar to 'set-move systems, adequate water must be applied to meet crop needs until the linear-move can irrigate the area again. Early center pivots had impact sprinklers mounted on top of the irrigation pipe that required 500-600 kPa. Most new systems have low-pressure nozzles (70-200 kPa) mounted on tubes that extend below the irrigation pipe, so nozzle height varies from 1 to 3 m above the soil. Manufacturers make numerous types of low-pressure nozzles with fixed or spinning spray plates that provide a wide range of application rates and water-droplet sizes to meet field conditions and operator preferences. A common feature to all nozzle types is a pressure regulator, which maintains constant nozzle pressure as the system travels across a field with varied elevation (Figure 2.9) [2].

Figure 2.8: Linear-Move irrigation system

- **Traveling Gun**

A traveling gun has a large-capacity sprinkler on a cart that is pulled across the field by a cable or by the water-supply hose. These systems irrigate an area 50-100 m wide and up to 400 m long. A traveling gun can be considered a moving, set-move system because water is applied as the cart moves across the field and then the system is moved to another area in the field for the next irrigation set. For cable-tow systems, a winch on the cart winds the cable, pulling the cart and a soft hose across the field. A hose-reel system pulls the cart as a hard plastic (polyethylene) hose is wound around a reel on a trailer anchored at the end of the run. The reel or winch is powered by an engine or a water turbine. Smaller versions of traveling guns are available for irrigating athletics fields, small pastures, or arenas (Figure 2.9) [2].

Figure 2.9: Traveling Gun irrigation system

2.2.3 Micro irrigation

Micro-irrigation applies water at low rates and pressures to discrete areas so irrigation water reaches the root zone with minimal losses. Water drips from emitters in plastic pipe or tape, or bubbles or sprays from small emitters that only wet a portion of the soil surface. Micro-irrigation systems are popular for permanently installed systems that irrigate trees, vineyards, orchards, and shrubs. These systems are typically automated so that water is applied frequently (e.g., daily) to maintain optimum soil-water content near the plants. Filtration is important for micro-irrigation, because sediment and algae can plug the small openings on drip emitters, bubblers, and micro-sprays. Chemical treatment may also be necessary to reduce salt or mineral deposits that can plug emitters. Drip irrigation emitters are preinstalled within polyethylene pipe at regular intervals or emitters are attached to the outside of the pipe at desired locations. Emitter flow rates typically vary from 2 to 7.51h-1 . Pressure-compensating emitters maintain a constant flow rate as pressure varies from approximately 70 to 200 kPa (Figure 2.10).

Figure 2.10: Pressure-compensating drip emitter watering ornamental plants

This type of system is common in vineyards. Drip tape is thin-walled (0.1-0.375 mm) plastic tubing (10-20 mm in diameter), with outlets at 100-600-mm intervals (Figure 2.11). Flow rates can vary from 100 to 4001h-1 per 100 m of length.

Figure 2.11: Drip tape installed on the soil surface to irrigate edible beans.

Typical operating pressure for drip tape is 35- 100 kPa. Drip tape is commonly installed below the soil surface, where there is less opportunity for damage. Buried drip tape can be used for several seasons or retrieved after a single season, depending on crop types and farming practices. Bubblers and micro-sprays are often used for irrigating trees, shrubs, or ornamental plants. Bubblers discharge water with low energy to flood a small area. Flow rates up to 1001h-1 can apply water to 4-mdiameter areas, depending on nozzle size, type, and pressure. Micro-sprays apply a fine spray or mist with similar flow rates and wetted areas as bubblers [3].

2.2.4 Subsurface

Subsurface irrigation applies water below the soil surface to raise the water table into or near the plant root-zone. Sub-irrigation is not often used in arid or semiarid irrigated areas; it is typically used in conjunction with subsurface drainage. Subsurface drainage lowers the water table and removes excess water through open ditches or perforated pipe. Water-table depth can be controlled by installing a weir on the drainage system. During wet periods, the water table is lowered so the root zone remains unsaturated. During dry periods, water is pumped into the drainage system to raise the water table and provide additional water for plant growth. In some situations, drained water can be stored for use when irrigating [3].

Subsurface irrigation pipes setting is shown in (Figure 2.12).

Figure 2.12 Subsurface irrigation

2.3 Choosing an irrigation system

Choosing an irrigation system is a difficult task. Irrigation systems are as varied as the people who use them. The right selection for a user depends on soil, water, and climatic conditions, as well as crop types, user knowledge and preference, capital and operating costs, and infrastructure availability. No system is best for all situations. Some typical advantages and disadvantages of irrigation systems are shown in (Table 2.2).

Table 2.2:

Typical advantages and disadvantages of irrigation systems [3]

System type	Advantages	Disadvantages
Furrow	Low capital and maintenance costs; water flows in small channels.	High labor; less water control; soil erosion; possible
Level basin	Efficient with good design; less labor than furrow.	runoff and percolation losses Ponded water; sloping fields must be leveled
Border	Less labor and less runoff than furrow; easier to manage infiltration depth	Water flows over entire soil surface
Solid set	Good water control; possible to automate and frequently irrigate; fits odd-shaped fields	High capital cost; system may interfere with field operations
Set-move	Lower capital cost than other sprinkler systems	More labor than other sprinkler systems; poor uniformity in windy conditions; greater application depth

Center Pivot and Linear Move	High uniformity; low labor	High capital and maintenance costs; not suitable for odd shaped fields; potential wind and evaporation losses
Traveling gun	Lower capital cost than other sprinkler systems	Higher operating cost; wind and evaporation losses
Micro-irrigation	Excellent water control; frequent applications possible	Higher capital cost; requires clean water or treatment and filtration

As shown in Table 2.3 sprinkler or micro-irrigation are often better choices than surface irrigation on sandy soil, where excessive percolation is a problem. Surface irrigation may be better in arid, windy areas, where wind and evaporation losses can be significant. Surface irrigation offers less control of application depth, so small, frequent irrigations are not practical for water-sensitive crops, which are better suited to micro-irrigation, solid-set, or center-pivot systems [4].

Table 2.3: Suitable soil and crops for different irrigation methods

Irrigation Method	**crops**		**soils**	
	Suitable	**Not Suitable**	**Suitable**	**Not Suitable**
Basin irrigation	- Paddy rice - pastures, e.g. alfalfa, clover;	potatoes, cassava, beet and carrots	- loamy soils - clayey soils	- Coarse sands

	- trees, e.g. citrus, banana; - crops which are broadcast, such as cereals; - to some extent row crops such as tobacco.			
Furrow irrigation	-tree crops - row crops such as maize, sunflower, sugarcane, soybean; - crops that would be damaged by inundation, such as tomatoes, vegetables, potatoes, beans;	Crops need to stand in wet or waterlogged conditions for periods longer than 24 hours	most soil types	very coarse sands

	- fruit trees such as citrus, grape; - broadcast crops (corrugation method) such as wheat.			
Border irrigation	Close growing crops such as pasture or alfalfa	crops that would be damaged by inundation, such as tomatoes, vegetables, potatoes, beans.	Deep homogenous loam or clay soils with medium infiltration rates	Heavy, clay soils
Sprinkler irrigation	row, field and tree crops	delicate crops such as lettuce	best with sandy soils with high infiltration	soils which easily form a crust.
Drip irrigation	row, tree and vine crops	Low value crops	most soils.	

CHAPTER THREE

AUTOMATION OF IRRIGATION

3.1 Introduction

The automation of the irrigation system means that the system is running without or with Minimal manual intervention [5].

Automatic irrigation system is an electrical system that controls operation repeat of the channel by controlling the sluice remote control along the canal and monitor water level and inflow of water in the canals, and the exact amount of water delivered to the field at a specific time and under the appropriate environmental conditions.

3.2 Smart irrigation system

It's one of the automatic irrigation systems which switches the pump or motor ON/OFF upon sensing the moisture content of the soil [6]. It is a growing system of everyday object which can complete tasks while you are busy with other activities.

The smart irrigation system in general contains controllers, power source, sensors, water pump, solenoid valve, protection element etc…

3.2.1 Controllers

This device is the heart of the smart automation, which coordinates operations of the entire system. The controller is programmed to run various zones of an area by their required duration or volume. In some cases, sensors are used to provide feedback to the controller. In the simplest form, irrigation controllers are devices which combine an electronic calendar and clock and are housed in suitable enclosure for protection.

The PLC’s, microprocessors and computers are examples and are being used extensively in this field nowadays [7].
(PLC-Programmable Logic Controllers).

3.2.2 Power source

The control systems are usually powered through the central unit, which is sometimes plugged directly into the main electric utility line, but more often connected through a rechargeable battery with trickle charger. In order to ensure continuous operation of the control system and to avoid loss of data in case of power failure, an uninterrupted power supply unit and a lightening protector are included in the power units (Figure 3.1).
Where utility supply power is not available, power for the control system can be provided by solar panels or from generators on diesel units. Intermediate control units, which are typically located far from standard power lines, are frequently powered this way [8].

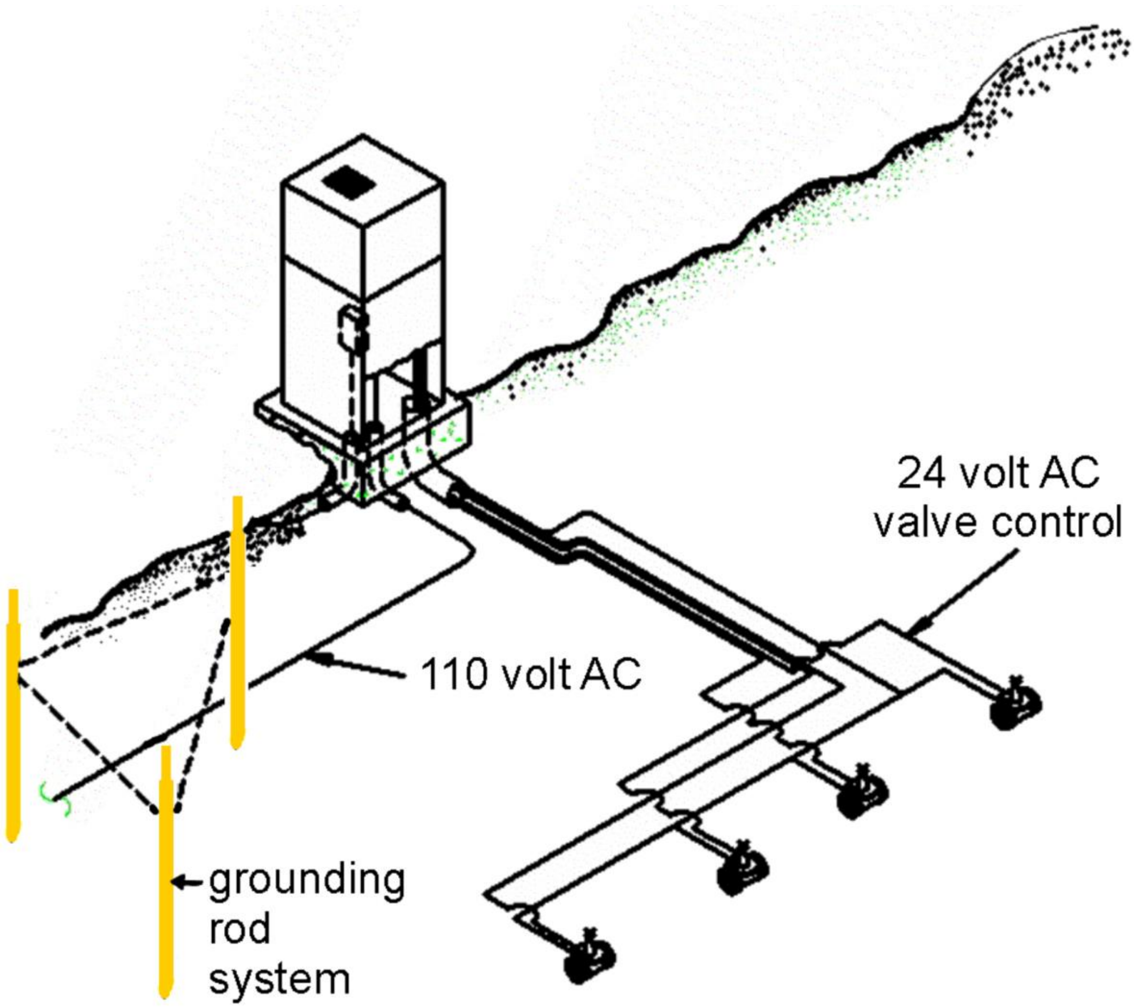

Figure 3.1 An uninterrupted power supply unit and a lightening protector

3.2.3 Solar Panel:

The function of solar panel is to charge the battery throughout the day when sunlight is available, the basic element of the solar panel is the Photo-Voltaic cell which also called as solar cell (Figure 3.2)which captures the sun rays and converts that energy into electricity. A solar cell is generally made from silicon or any other semi conductive materials that can convert solar energy into DC electricity through the Photo-Voltaic effect. When the sunlight falls on the solar cell, it may be reflected, absorbed, or passes right through. The absorbed light generates electricity. Solar cells do not use the sun's heat to produce electricity. They produce electricity directly when sunlight interacts with semi-conductor materials in solar cells [9].

Figure 3.2 Solar Panel

3.2.4 Sensors

A sensor is a device placed in the system that produces an electrical signal directly related to the parameter that is to be measured. In general, there are two types of sensors: continuous and discrete. Continuous sensors produce a continuous electrical signal, such as a voltage, current, conductivity, capacitance, or any other measurable electrical property. Continuous sensors are used when just knowing the on/off state of a sensor is not sufficient.

Discrete sensors are basically switches (mechanical or electronic) that indicate whether an on or off condition exists.

Discrete sensors are useful for indicating thresholds, such as the opening and closure of devices such as valves, alarms, etc. [7]. They can also be used to determine if a threshold of an important state variable has been reached. Some examples of discrete sensors are a float switch to detect if the level in a canal is below a minimum desirable level, or a switching tensiometer to detect if soil moisture is above a desired threshold.

Sensors are an extremely important component of the control loop because they provide the basic data that drive a smart control system.

Understanding the operating principle of a sensor is very important.

Some of the variables that are often measured in computer-based control systems are: flow rate, pressure, soil-moisture, water level, air temperature, wind speed, solar radiation, relative humidity, conductivity (total salts) in irrigation water, and pH of irrigation water.

- **Flow sensor**

  The measurement of flow rate in the mainline (Figure 3.3) is one of the most important measurements in an irrigation system. Flows that are out of range, either high or low, can be reported and acted upon.

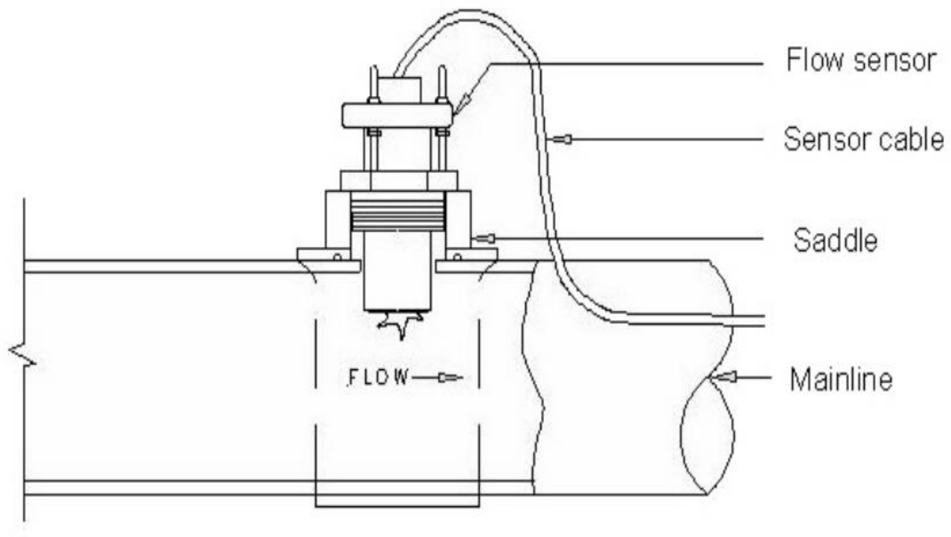

Figure 3.3 Paddle wheel flow sensor installed in mainline allowing remote monitoring of flow rate in system.

Typically, flow sensors utilize a paddle or propeller inserted into the water stream that turns with the RPM (revolutions per minute) directly related to the flow velocity. Electrical pulses are generated by the sensor relative to the RPM.

Software used with the control system can continually check on the flow rate in the system and compare it to pre-defined acceptable levels. High flow conditions indicate pipe failures or stuck valves.

Since the results of broken mainlines can be disastrous (erosion, washouts, etc.), systems are often programmed to shut down when high flows (25-30% above normal) are detected [8].

- **Soil moisture sensor:**

  Soil moisture sensor is used to sense the moisture content in the soil. The required value of moisture is fed prior to the controller. Soil moisture sensor works on the principle of resistance. When the soil is dry it gives high resistance for the connection of two electrodes, and when the moisture content in the soil increases the resistance given by the soil is less as water being good conductor of electricity conducts between the two electrodes. When the moisture level in the soil is below than the set value the pump gets on, and when the moisture content reaches the required level the power supply to the pump is cut-off. The moisture content required for different type of crops varies from crops to crops [9].

- **Temperature sensor**

  Temperature sensor used to detect the temperature in the farm environment. When the temperature sensor detects a high temperature, it gives an output voltage linearly proportional to the sensed temperature value. The Microcontroller will send the output signal to the relay base on the pre-set temperature value contained in the embedded program stored in the microcontroller to either ON or OFF the pump [7].

  Recent climate trends evidence a rise of temperatures and an increase in the duration and intensity of droughts which is in turn leading to the occurrence of larger wildfires, which threaten the environment as well as human lives and beings which insure the importance of the temperature sensor in the smart irrigation [10].

- **Water Level Sensor**

  It measures the level or height of water in a container using the conductive property of water. It's made up of electrodes positioned at different levels in the container housing the liquid. As water rises in the container the electrodes make new connection with a varying analog voltage at different levels [11].

Figure 3.4 Water Level Sensor

3.2.5 Water pump

Pump is a device that moves fluid by mechanical action. Here in this system it pumps the water from the water source to the field. There are other benefits of pumps such as pumps other liquids like manure and plants medicines [9].

3.2.6 Solenoid valve

The solenoid is an electromagnetic part of a valve, composited of solenoid coil, core tube, core and enclosure. The selection of 2- way, 3-way and 4-

waysolenoid valves, designed to handle the most demanding fluid control applications [12].

Solenoid coil is used to convert electrical pulses into hydraulic pulses, which enables opening and closing of specific hydraulic valve. The solenoid coil has a metal plunger inside the electromagnetic coil. The coil gets actuated after receiving required voltage. It pulls up the plunger and water passes from the lower orifice port to control tubing towards the hydraulic valve. When operation time is over, the controller stops sending signals to the solenoid coil to deactivate. Thus the plunger again seals the orifice port to close [7].

Figure 3.5 solenoid valve

3.2.7 Protection element

There function is protecting power and control's components of the system from electrical surge and power fluctuations. Such as relay, voltage regulator, etc… [8].

3.2.8 A/D Interface

Since computer systems work internally with numbers (digits), the electrical signals resulting from the sensors must be converted to digital data. This is done through specialized hardware referred to as the Analog-to-Digital (A/D) interface.

The A/D interface converts discrete signals resulting from switch closures and threshold measurements into digital format, either 0 or 1. Continuous electrical (analog) signals produced by the sensors signals are converted to a number related to the level of the sensed variable [8].

3.2.9 Wireless module

It describes an application of a wireless sensor network for wireless controlled irrigation solution and real time monitoring of water content of soil. The data is recorded by using solar energy for the wireless station for the purpose of control of valves to do irrigation. The system has a distributed wireless network of soil moisture and temperature sensors placed in the root zone of the plants and water level sensor is placed in tank for checking the water level in tank. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature, soil moisture and water level that was programmed into a micro-controller based gateway to control water quantity [13].

3.3 Internet of Things (IoT)

The Internet of Things (IoT) refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines and other physical objects.

For consumers, the IoT has the potential to deliver solutions that dramatically improve energy efficiency, security, health, education and many other aspects of daily life. For enterprises, IoT can underpin solutions that improve decision-making and productivity in manufacturing, retail, agriculture and other sectors [14].

The Internet of things refers to a type of network to connect anything with the Internet based on stipulated protocols through information sensing equipment to conduct information exchange and communications via the Internet in order to achieve smart recognitions, positioning, tracing, monitoring, and administration [15].

IOT architecture consists of different layers of technologies supporting IOT such as:

- **smart device / sensor layer**

  The lowest layer is made up of smart objects integrated with sensors. The sensors enable the interconnection of the physical and digital worlds allowing real-time information to be collected and processed. Sensors are grouped according to their unique purpose such as environmental sensors, body sensors, home appliance sensors and vehicle telematics sensors, etc.

  Most sensors require connectivity to the sensor gateways. This can be in the form of a Local Area Network (LAN) such as Ethernet and Wi-Fi connections or Personal Area Network (PAN) such as ZigBee, Bluetooth and Ultra Wideband (UWB). For sensors that do not require connectivity to sensor aggregators, their connectivity to backend servers/applications can be provided using Wide Area Network (WAN) such as GSM, GPRS and LTE. Sensors that use low power and low data rate connectivity, they typically form networks commonly known as wireless sensor networks (WSNs).

- **Gateways and Networks**

  Massive volume of data will be produced by these tiny sensors and this requires a robust and high performance wired or wireless network infrastructure as a transport medium. Current networks, often tied with very different protocols, have been used to support machine-to-machine (M2M) networks and their applications. With demand needed to serve a wider range of IOT services and applications such as high speed transactional services, context-aware applications, etc, multiple networks with various technologies and access protocols are needed to work with each other in a heterogeneous configuration. These networks can be in the form of a private, public or hybrid models and are built to support the communication requirements for latency, bandwidth or security.

- **Management Service Layer**

  The management service renders the processing of information possible through analytics, security controls, process modeling and management of devices.

  Data management is the ability to manage data information flow. With data management in the management service layer, information can be accessed, integrated and controlled. Higher layer applications can be shielded from the need to process unnecessary data and reduce the risk of privacy disclosure of the data source.

- **Application Layer**

  The IoT application covers “smart” environments/spaces in domains such as: Transportation, Building, City, Lifestyle, Retail, Agriculture, Factory, Supply chain, Emergency, Healthcare, User interaction, Culture and tourism, Environment and Energy [15].

3.3.1 IOsA (internet of smart agriculture)

Internet of Things(IoT) is transforming the agriculture industry and enabling farmers to content with enormous challenges they face.

Livestock monitoring, conservation monitoring and plant & soil monitoring are the challenges where IoT can be a solution.

The innovative IoT applications address the issues in agriculture and increase the quality, quantity, sustainability and cost effectiveness of agricultural production [10].

Agriculture IoT helps in increasing crop productivity by way of managing and controlling the activities like:

- Crop water management - Adequate water supply is an essence for agriculture and the crops can be damaged in either of situation of excess of water supply or in shortage of water supply. In areas of drought condition, IoT can prove to be a great value as it manages the limited water supply smartly with least wastage of water resource.
- Precision agriculture - The level of accuracy of temperature, moisture, pH of the soil affects the crop productivity to a greater extent. Higher the level of accuracy, lower would be the chances of crops being damaged [10].

The automatic IoT irrigation system was designed and implemented to use in agricultural crops. The system uses a website or a smartphone to capture and process the situation of the soil nearby the root zone of the crop, and estimates the water contents. The system's sensor is confined in a chamber and buried at the root level of the plants.

A website or smartphone's application were developed to operate directly the computing and connectivity components, such as the Wi-Fi network. The website or the mobile App wake up the smartphone, activating the device with user-predefined parameters. After the Wi-Fi connection is enabled, the moisture ratio is transmitted via a router node to a gateway for control an irrigation water pump [10].

Some functions of a smart irrigation systems that uses IoT[16]:

- Control climate conditions of the room, the proper amount of compost, humidity and temperature levels. to maximize the production of crops and their quality and to prevent crops from fungus and other microbial contaminants.

- Animal Farming/Tracking: Location and identification of animals grazing in open pastures or location in big stables. Study of ventilation and air quality in farms and detection of harmful gases from excrements.

- Field Monitoring: Reducing spoilage and crop waste with better monitoring, accurate ongoing data obtaining, and management of the agriculture fields, including better control of fertilizing, electricity and watering.

3.4 Related Work

After extensive research in the agricultural field, many researchers found that the agriculture area and its productivity are decreasing by the day. With the Use of different technology in the field of agriculture we can increase the production as well as reduce manual efforts.

This project shows the technology used in agriculture sector based on IOT and NodeMCU.

Chandan kumar Sahu proposed a system on “A Low Cost Smart Irrigation Control System”. It includes a number of wireless sensors which are placed in different directions of the farm field. Each sensor is integrated with a wireless networking device and the data received by the “ATMEGA318” microcontroller which is on the “ARDUINO-UNO” development board. The Raspberry pi is used to send various types of data like text messages and images through internet communication to the microcontroller process [17].

Supraha Jadhv proposed, automated irrigation system using wireless sensor network and raspberry pi that control the activities of drip irrigation system efficiently [18]. Sebastian Hentzelt proposed a paper on the water distribution system and gave results to decompose the original nonlinear optimal control problem (OCP) [19]. Joauin Gutierrez attempted a paper that research automated irrigation system using a wireless sensor network and GPRS module instead of the Raspberry pi [20]. Ms. Deweshvree Rane Proposed "Review paper based on Automatic Irrigation System Based on RF Module" it is based on the RF module; this device is used to transmit or received radio signal between two devices. Its design is complex because of the sensitivity of radio circuits and the accuracy of the components [21]. Karan Kansara proposed "Sensor based automatic irrigation system with IoT", this irrigation system is used a rain gun pipe, one end connected to the water pump and another to the root of plant. It doesn't provide water as a natural rainfall like sprinkler and also it uses only soil moisture sensor [22].

CHAPTER FOUR
SYSTEM IMPLEMENTATION

4.1 Introduction

Greenhouses have become a new and popular technique in agriculture, this new method needs wise and professional management to gain the best production of crops. This leads to have an elaborate system that works perfectly to control and observe the growing of plants step by step.

4.2 System Design

The main block diagram of the system is shown in a Figure 4.1. It explains, how the devices are connected with each other physically.

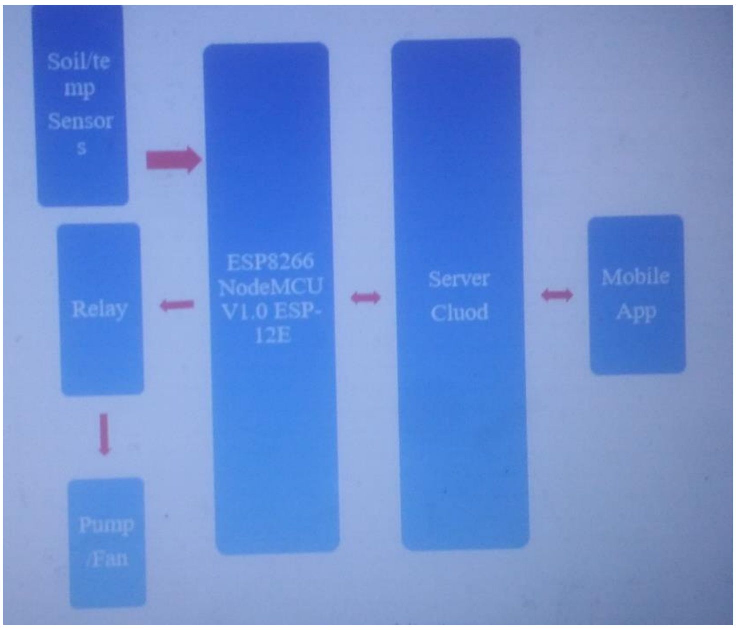

Figure 4.1 System architecture

The technology used to get the data as well as the notification on mobile and email is the IoT. There are four layers of IoT architecture: (a) Smart Device or

Sensor Device Layer, (b) Gateway and Network Layer, (c) Management Service Layer, and (d) Application Layer. Here we are using IoT architecture to connect soil moisture and temperature sensors data to the mobile and e-mail via mobile application named Blynk through which pump works. Here soil moisture sensor, temperature sensor and relays are directly connected to the NodeMCU to control the Fan and motor for proper irrigation of the field. The relays are connected to the motor and fan.

We use Arduino supported motor of 5v and as alternative to the fan an LED. The relay is a switch which opens and closes the circuits electromechanically or electronically. When the switch is open, the circuit will incomplete and if it is closed then circuit completed and motor runs. The solar power is used to run the devices. The control of this switch is done with the help of NodeMCU and programming. The NodeMCU get all information from all devices and transfer it to the mobile as well as to the web page. We use the Arduino Integrated Development Environment for doing programming. It consists of the source code editor. On source code editor we program the device as per our requirement. For

programming, we use embedded C language.

Figure 4.2 shows how the application Blynk works.

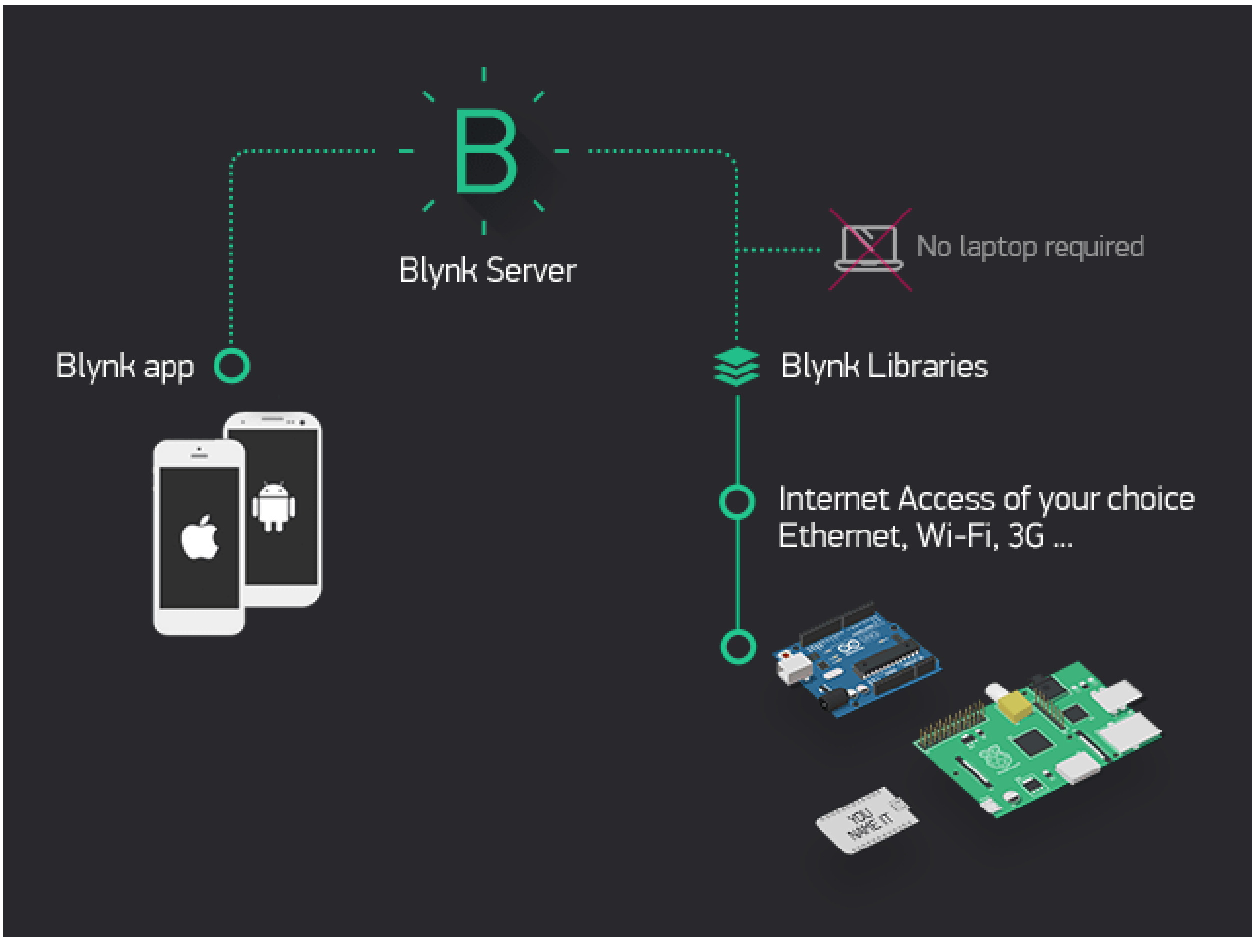

Figure 4.2 Blynk System Principle

Principle and an overview of the system process is shown the flow chart in (Figure 4.3).

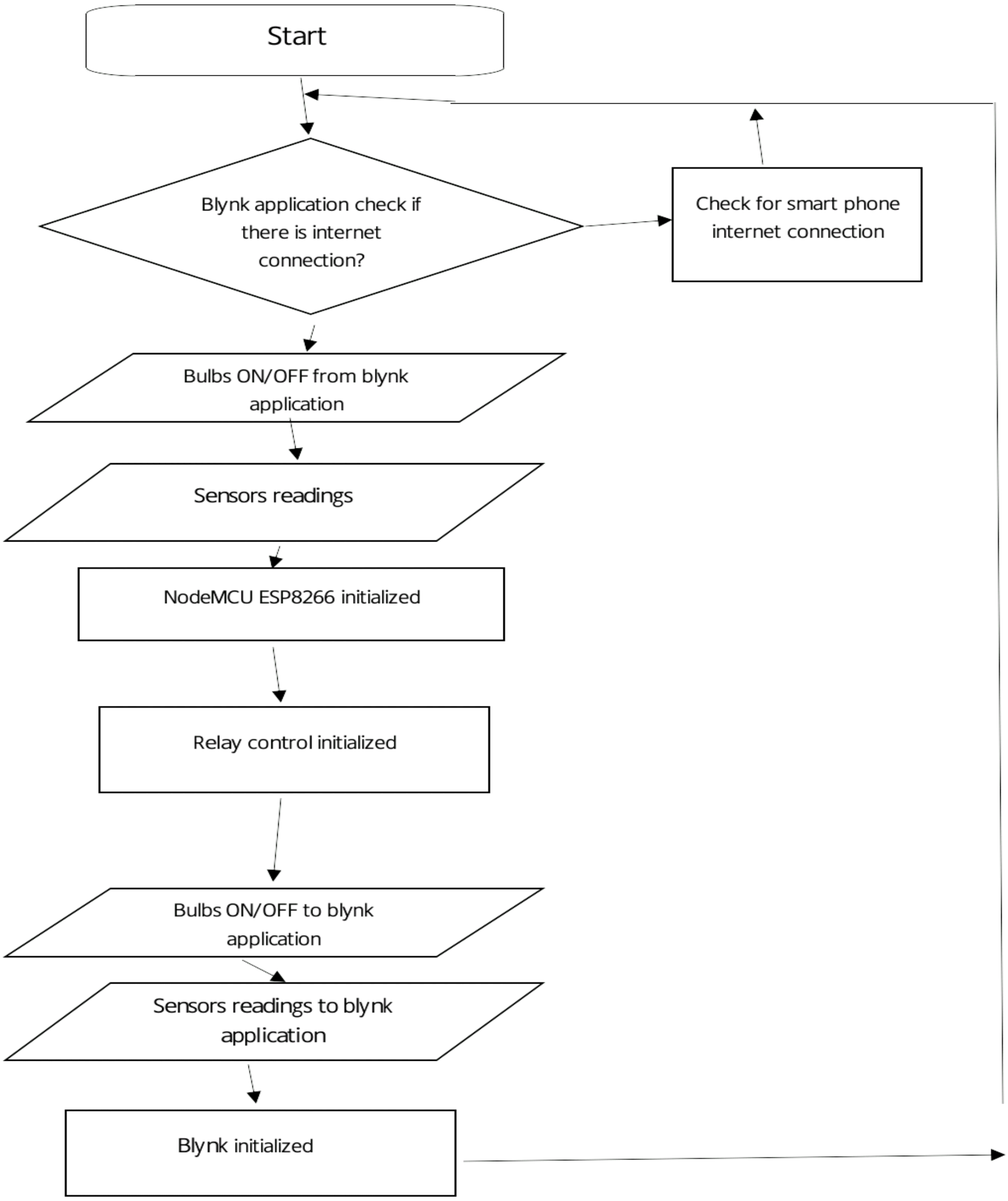

Figure 4.3 An Overview of the System Process

4.3 System Components

The system components are:

- ESP8266 NodeMCU V1.0 ESP-12E
- YL-69 Soil moisture sensor

- Temperature sensor type DHT11
- 5v Relay
- Breadboard
- 5 MB102 Breadboard Power Supply Module
- LM2596 Voltage regulator
- Transistor type 2N2222
- 5K resistor
- 5v DC water pump
- Arduino IDE Software
- Blynk application

4.3.1 **NodeMCU**

This is developed a kit which is totally based on ESP8266. This is the device which is user-friendly and connects to the internet faster than any other Arduino board. There is no need for external Wi-Fi module so it is cheaper than other Arduino board.

The ESP8266 NodeMCU V1.0 ESP-12E WiFi module is the latest version of this popular module and can be used as a WiFi enabled replacement for an Arduino in many applications. ESP8266NodeMCU-12E shown in figure 4.4.

Technical specification of NodeMCU V1.0 ESP-12E:

- Type: Single-board microcontroller
- Operating system: XTOS
- CPU: ESP8266
- Memory: 128kByte
- Storage: 4Mbyte
- Power by: USB
- Power Voltage: 3v,5v
- Code: Arduino Cpp(C++)
- IDE Used: Arduino IDE

- ADC: 1-10 bit
- GPIO:13
- Reset button: 1
- Flash button: 1
- PMW Pins: 9 (having a ~ sign)
- GND = 2
- VCC = 2
- Upload Using: Serial
- CPU Frequency: 80MHz
- Flash Size: 4Mb
- Communication Protocol: MQTT
- Current at startup: 320mA

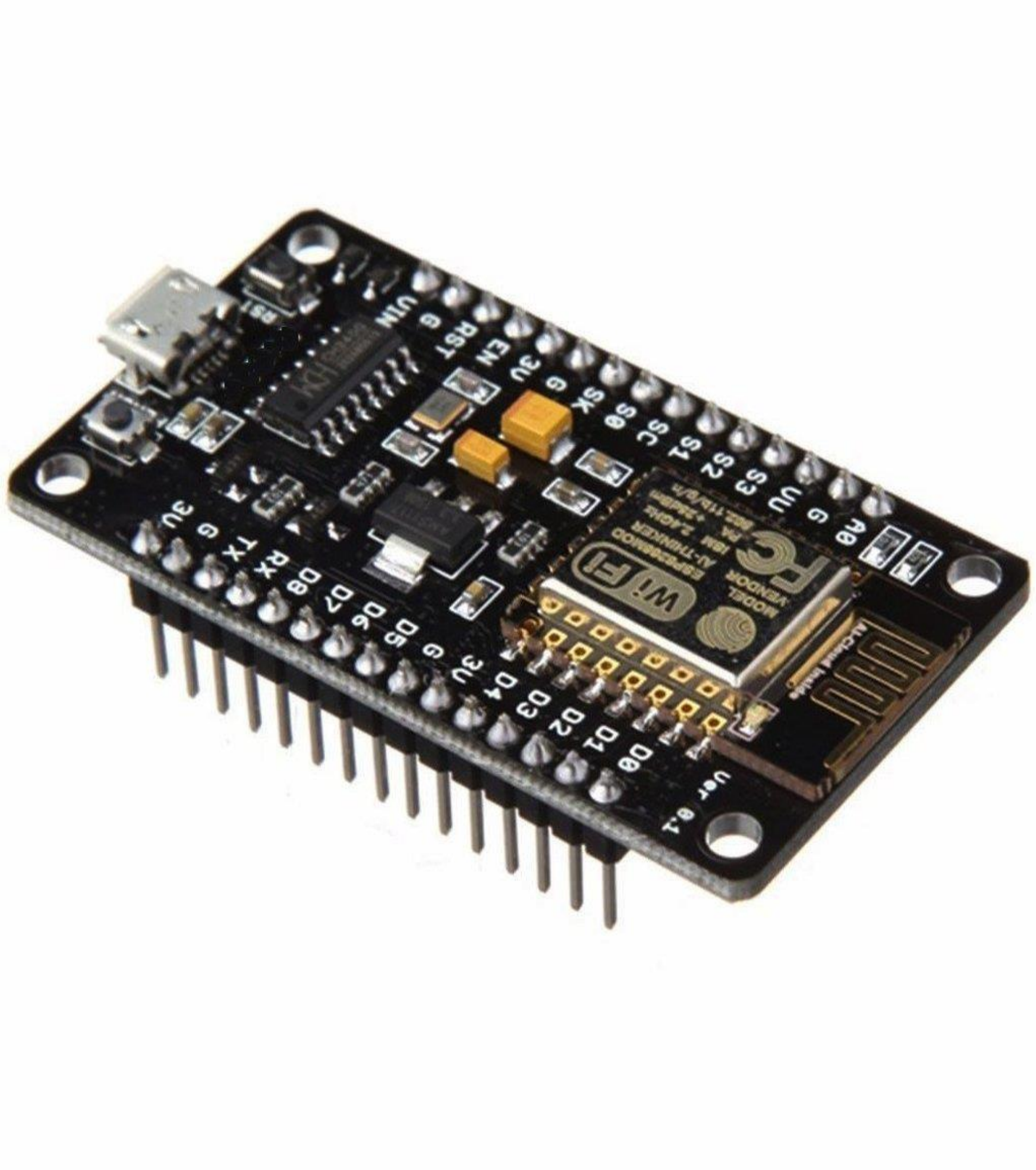

Figure 4.4 ESP8266NodeMCU-12E

4.3.2 Temperature sensor DHT11

The DHT11 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 (Figure 4.5).

Features:

- can detect the humidity and temperature of the surrounding environment sensor using DHT11.
- Humidity measurement range: 20%-95% (0 degrees -50 degrees range) Humidity measurement error: +-5%.
- Temperature measurement range: 0-50 degrees Temperature measurement error: +-2 degrees.
- working voltage 3.3V-5V.
- output form: digital output.
- with bolt holes for easy installation.
- Small Board PCB Size: 3.2cm * 1.4cm
- Power indicator (red)

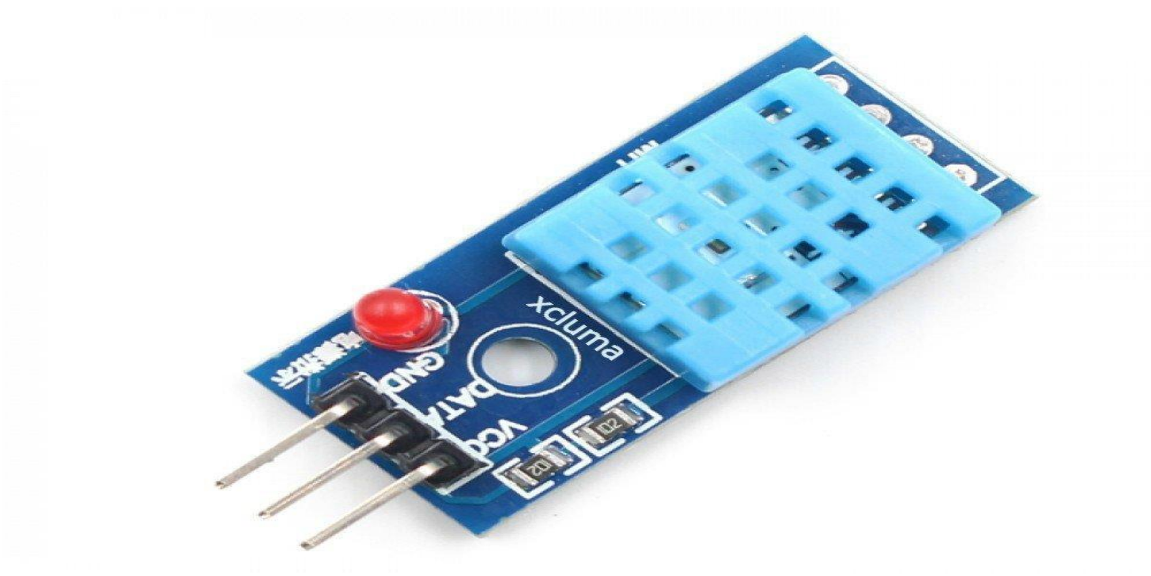

Figure 4.5 Temperature sensor DHT11

4.2.3 Soil moisture sensor YL-69

Soil moisture sensor is a sensor which senses the moisture content of the soil. The sensor has both the analogue and the digital output. The digital output is fixed and the analogue output threshold can be varied. It works on the principle of open and short circuit. The output is high or low indicated by the LED. When the soil is dry, the current will not pass through it and so it will act as open circuit. Hence the output is said to be maximum. When the soil is wet, the current will pass from one terminal to the other and the circuit is said to be short and the output will be zero.

The sensor is platinum coated to make the efficiency high. The range of sensing is also high. It is anti-rust and so the sensor has long life which will afford the farmer at a minimum cost.

$$\textbf{Moisture} = \frac{\mathbf{1023}-\boldsymbol{Sensor\ Voltage}}{\mathbf{1023}}\ \boldsymbol{x}\ \mathbf{100\%} \quad \textbf{(1)}$$

Soil moisture sensor (YL-69) is represented in Figure 4.6.

Figure 4.6 Soil moisture sensor YL-69

Table 4.1 Features of soil moisture sensor

Name	Specification
Power indicator	Red color led
Digital switching output indicator	Red color led
Comparator	YL38 comparator
Operating voltage	3.3V-5V
Digital output interface (0 and 1)	DO
Analog output interface	AO

4.3.4 Relay

The relay is the switch (turn on and off) which operates electrically or electromagnetically [5]. In this project, the relay is used for turn on and off the water pump.

4.3.5 Breadboard

Breadboard is ideal for a beginner to learn in building the circuitry. The breadboard does not require soldering to make connections. Sometimes, it is called as solderless breadboard. You can just experiment with your circuit design by plug in the components without any soldering. Thus, this breadboard and the components are reuse able, you can modify your circuit easily without any hesitation. With this feature, it is suitable for beginners like students to build the prototype on the breadboard in order to test the circuit design. used breadboard specifications are:

Full size breadboard, total 830 holes, standard 2.54mm spacing between two holes and dimension: 16.5x5.5cm.

4.3.6 Breadboard Power Supply Module type MB102

The 3.3V/5V output MB102 Breadboard power supply module is an easy to use, most useful breadboard component that can be added with any breadboard related projects where 5V, 3.3V or both power requirements are required. Its ease of use allows users to connect any DC power supply unit that has 6.5-12 VDC power output from a barrel jack. The board has two independent channels of power output for breadboards. These power channels can be independently configured for 3.3V, 0V, and 5V operations.

The module also offers a push switch to turn OFF and ON the entire power supply module.

An additional feature is a USB input with two 5V, two 3.3V, and 4 GND pinout for additional power pin requirements.

The power LED will notify the user of input power availability status.

4.3.7 Voltage Regulator

LM2596 Voltage regulator is used. It is designed to provide a flexible and fixed voltage regulator up to 1A output and it has been operated on 5V input. The maximum guarantee of the device's dropout voltage is 1.3V, which decreases in low load currents. In order to limit the current and to reduce the stress under the overloading condition both the Power Source Circuitry and Regulatory are used. It has less current drop and turns5V, 0.7A into 3.3 V for the ESP8266 module.

4.3.8 Transistor type 2N2222

The 2N2222 is a common NPN bipolar junction transistor (BJT) used for general purpose low-power amplifying or switching applications. It is designed for low to medium current, low power, medium voltage, and can operate at moderately high speeds.

The 2N2222 is considered a very common transistor, and is used as an exemplar of an NPN transistor. It is frequently used as a small-signal transistor, and it remains a small general purpose transistor of enduring popularity.

4.3.9 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In this circuit, (5K, 100) resistors are used to connect (2N2222 transistor, LED) and output pin in NodeMCU, to reduce current flow and protect the NodeMCU.

4.3.10 Water pump

5v DC Mini Water is used with this Specifications:

- DC Voltage:3-6V
- Maximum lift:40-110cm / 15.75"-43.4"
- Flow rate:80-120L/H
- Outside diameter of water outlet: 7.5mm / 0.3”; Inside diameter of water outlet: 4.7mm / 0.18"
- Driving mode: brushless dc design, magnetic driving

4.3.11 LED

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it.

4.3.12 Arduino IDE Software

Arduino IDE is a software application where we easily write the instructions and upload it to the board. It can run on Windows, Linux etc. This can be used with any Arduino board, NodeMCU and many more. This application compiles your code before uploading to the NodeMCU board to find errors. In this IDE, we use basic embedded C. Also, one may need to create their own header files to carry out certain operations. This helps to increase the functionality. It has the following sections:

- **Text editor:** The conventionalized version of C++ programming language is used to write the interpreted code.
- **Message section:** This error shows and also gives a response to save and export code.
- **Text:** Easy to display text output by Arduino IDE with full of error messages and other data.
- **Console Toolbar:** This toolbar includes various buttons like verification, upload, new, open, save and use the development board and serial port in the bottom right corner of the serial monitor window.

4.3.13 Blynk application

Blynk is an online raised area with iOS and Android device to control many boards like Arduino, NodeMCU etc. it is a digital dashboard. Here we can construct a graphic interface with our project. This support the hardware, NodeMCU, which connects with the Internet. Blynk can connect with the device through the internet and the project is ready to communicate with each other.

To create the project on it. we need to create three virtual button pins (V0, V3, V4) for (auto, pump, fan), two sliders (V1, V2) for (humidity threshold, temperature threshold) and two gauges (V7, V6) for (soil humidity, temperature) sensor's

readings. Figure 4.7 shows the interface of the application blynk.

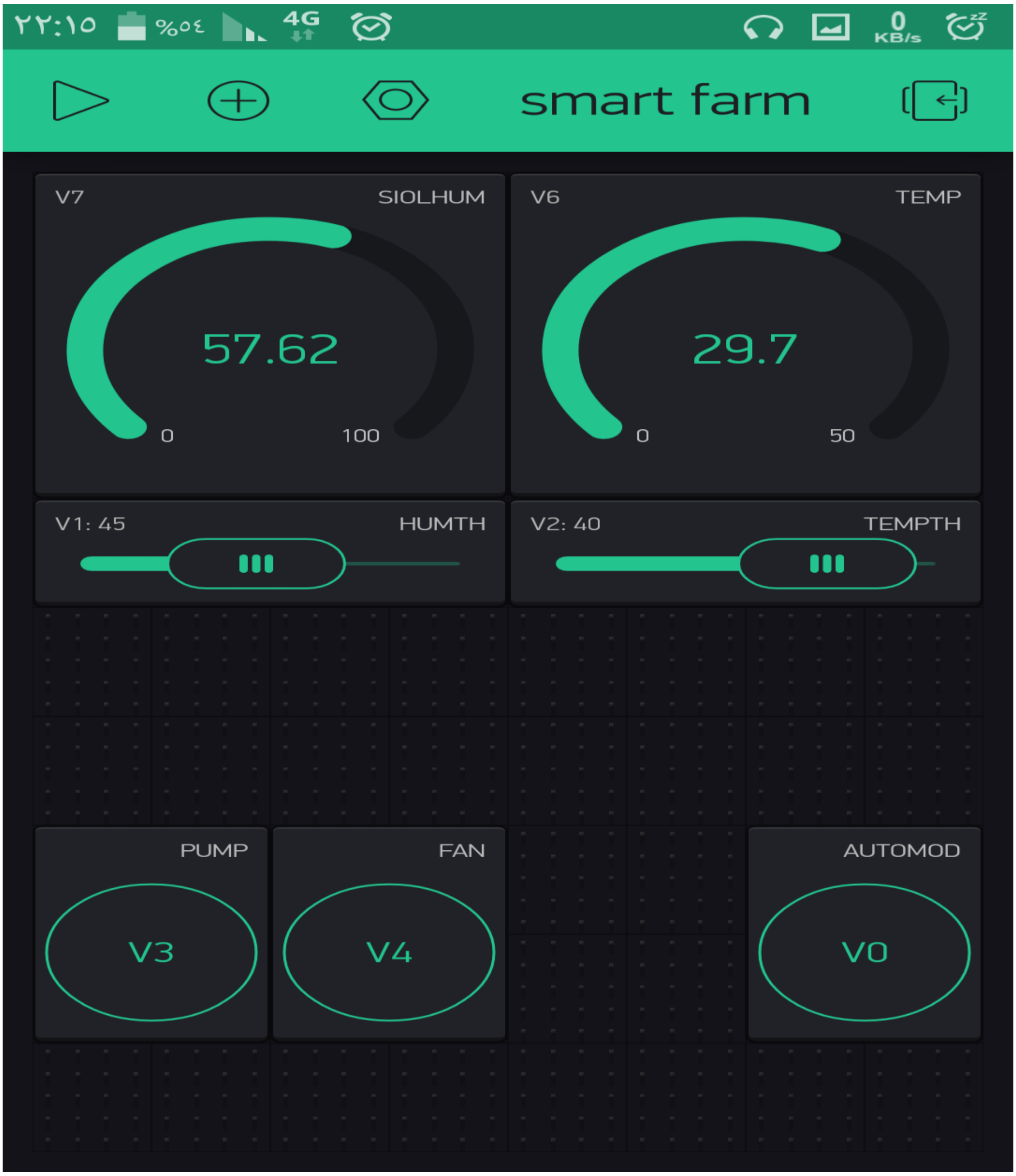

Figure 4.7 Blynk application system interface

4.4 Hardware Implementation

As mentioned above, components used to build the circuit, NodeMCU needs 5VDC as a supply voltage Vin pin, AC-DC step down converter 12V and DC-DC step down converter 5V or MB102 Breadboard Power Supply Module used to power NodeMCU, DHT11 data pin connected to NodeMCU pin D1 and (GND, VCC) to (ground, 3.3v), YL-69 Soil moisture sensor analog pin connected to NodeMCU pin A0 and (GND, VCC) to (ground, 3.3v), LED is connected from ground to resistor 100ohm to NodeMCU pin D2.

To connect water pump motor we will need relay module. Because relay module uses 5V power supply and ESP8266 uses 3.3V power supply we will add transistor to drive 5V relay with 3.3V. Transistor is connected to ESP8266 D7 pin trough 5k resistor. Other side of relay is connected to motor pump and adjustable power supply.

The actual circuit of the system is represented in Figure 4.8.

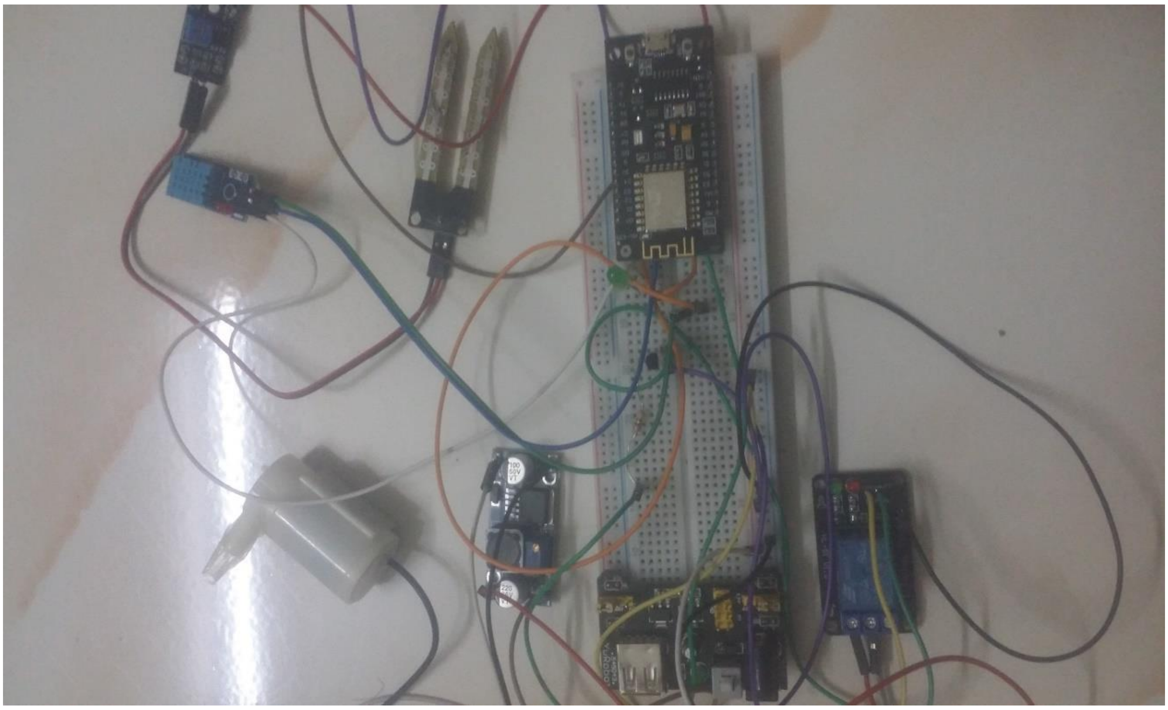

Figure 4.8 Actual circuit of the system

The soil sensor output in the idle condition is 1023 which is the Highest value, and it reached to 0. The temperature sensor sends digital values from 0 to 50. The NodeMCU receive sensors data and application's signals and take an action and send control signals to the output pins and massages to the application.

All cases of the received values have been illustrated in more details below.

Case 1: Idle status, the input signals is auto mod (V0) = 0, pump(V3) off, fan (V4) off, the system waiting for changing the inputs to start movement (Figure 4.9).

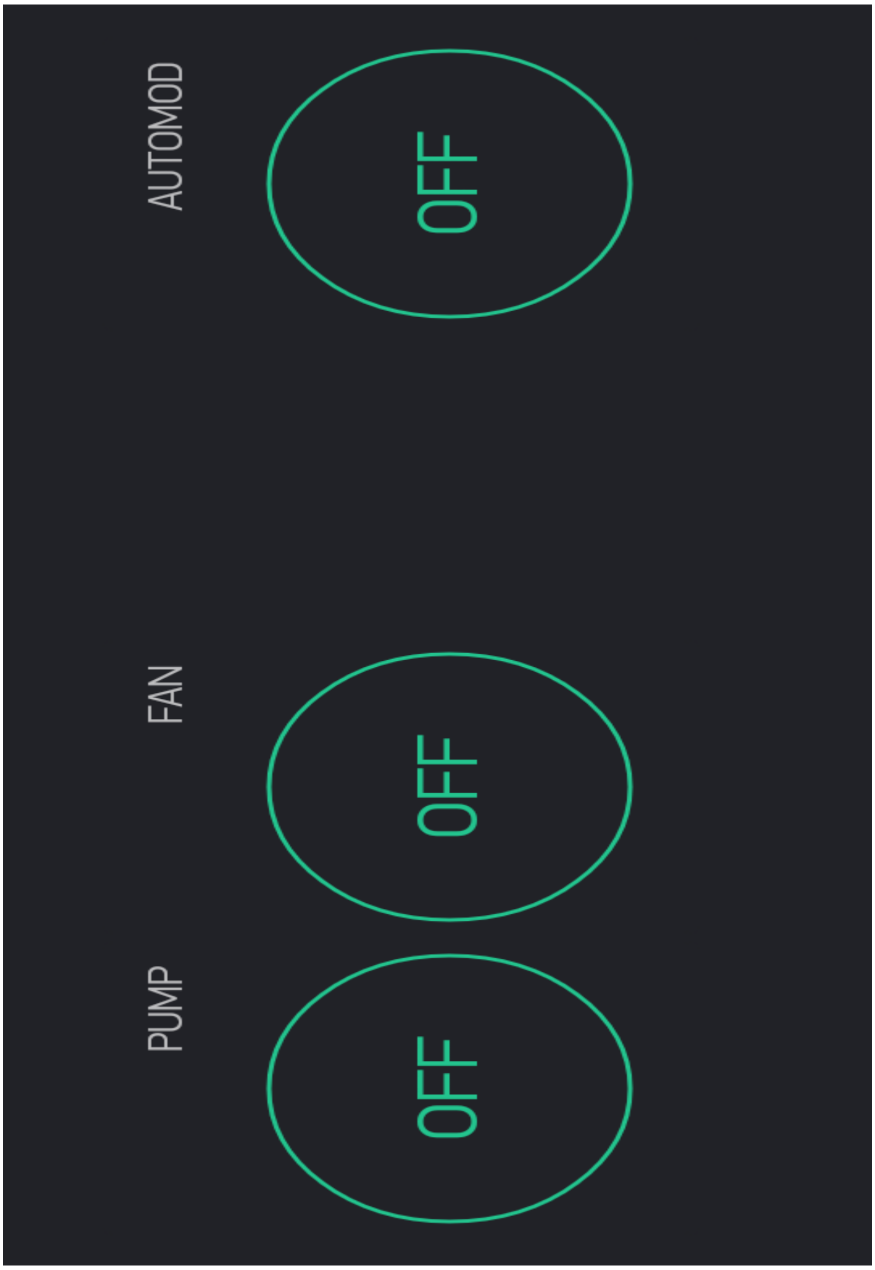

Figure 4.9 Case 1

Case 2: when the input signals is auto mod off, pump on, fan off the controller send signal to the relay to start the pump (Figure 4.10).

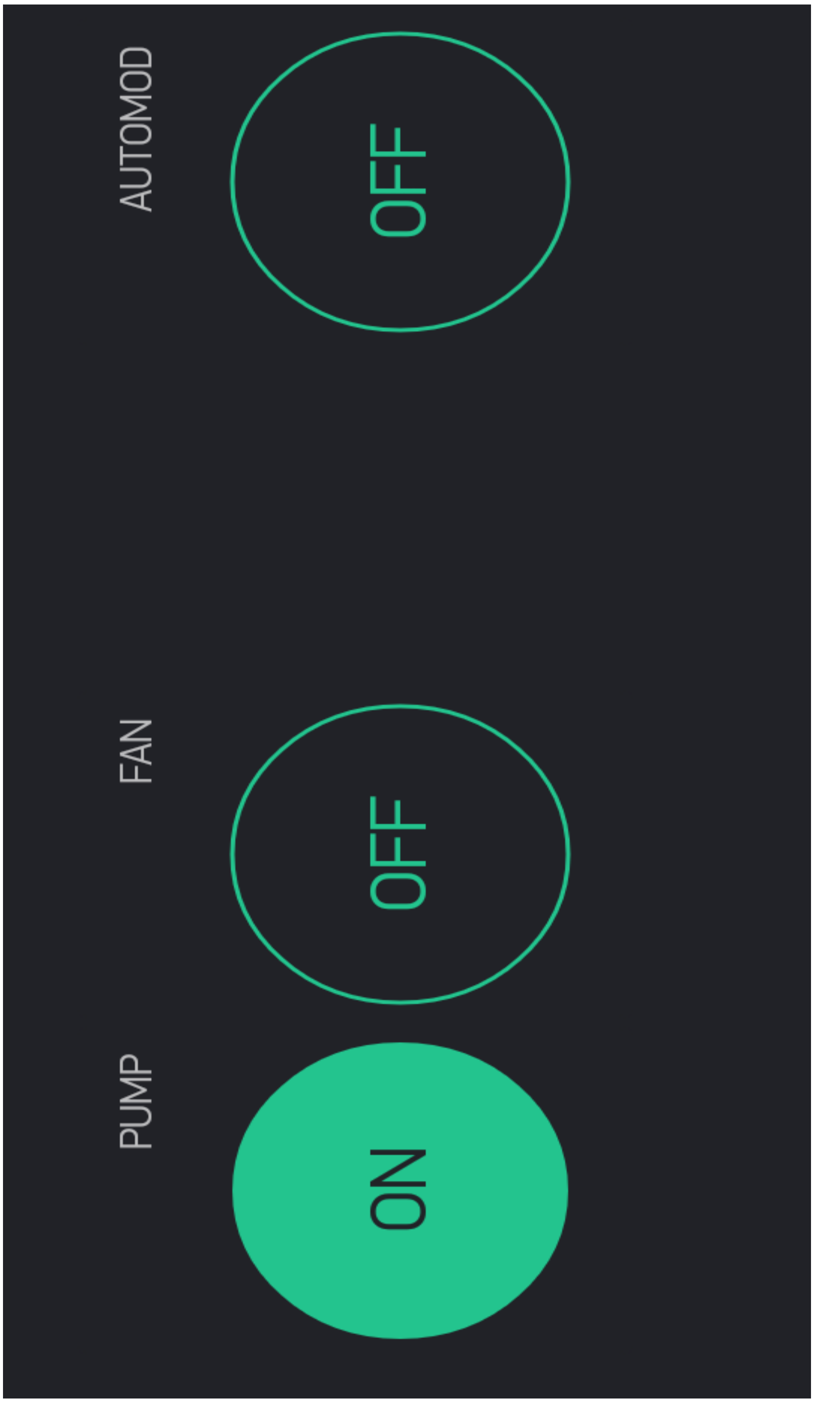

Figure 4.10 Case 2

Case 3: when the input signals is auto mod off, pump off, fan on the controller send signal to start the fan and stop the pump (Figure 4.11).

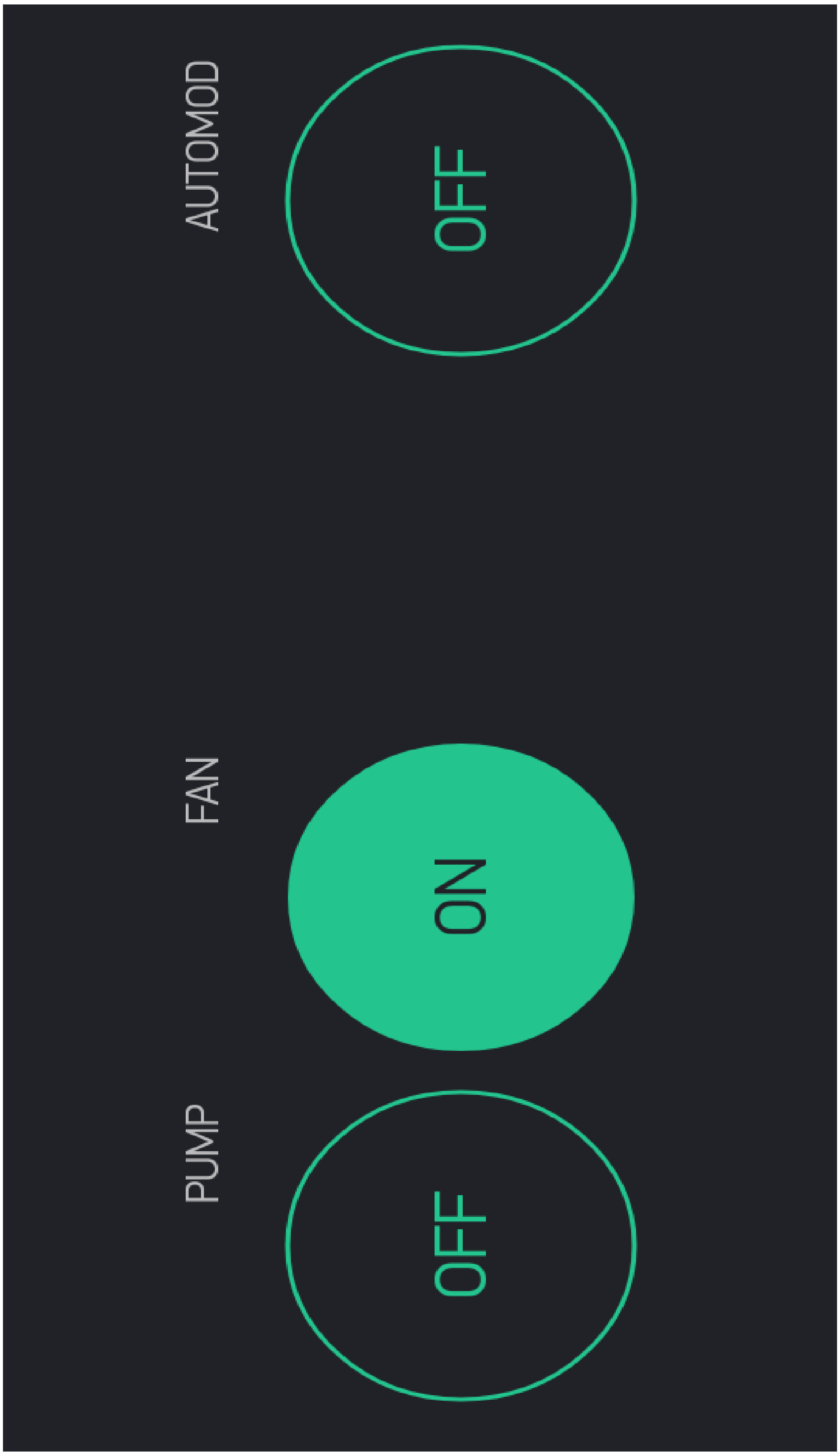

Figure 4.11 Case 3

Case 4: when the input signals is auto mod off, pump on, fan on the controller send signal to start the fan and the pump (Figure 4.12).

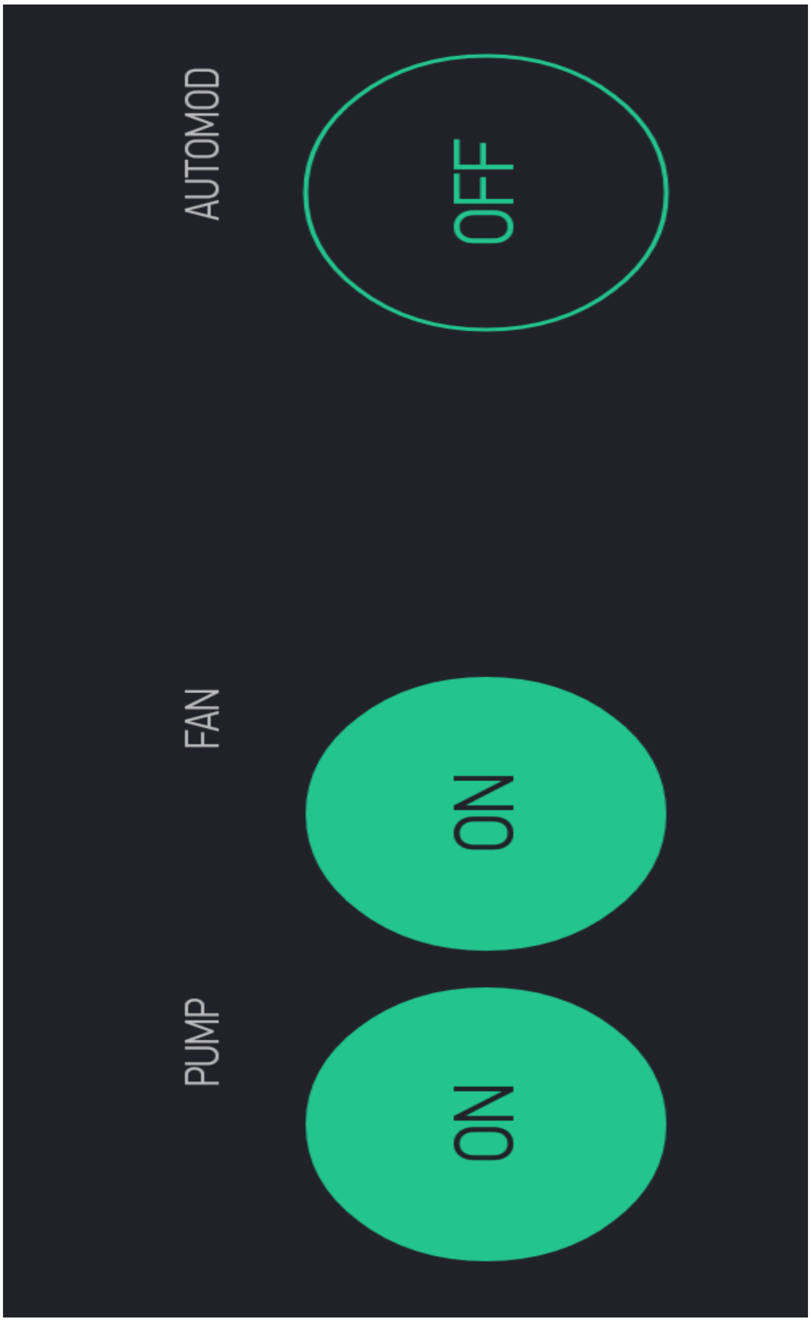

Figure 4.12 Case 4

Case 5: when the input signals is auto mod on, (humidity(V7) > 50, and temperature(V6) < 30), the controller send signal to stop the pump and the fan (Figure 4.13).

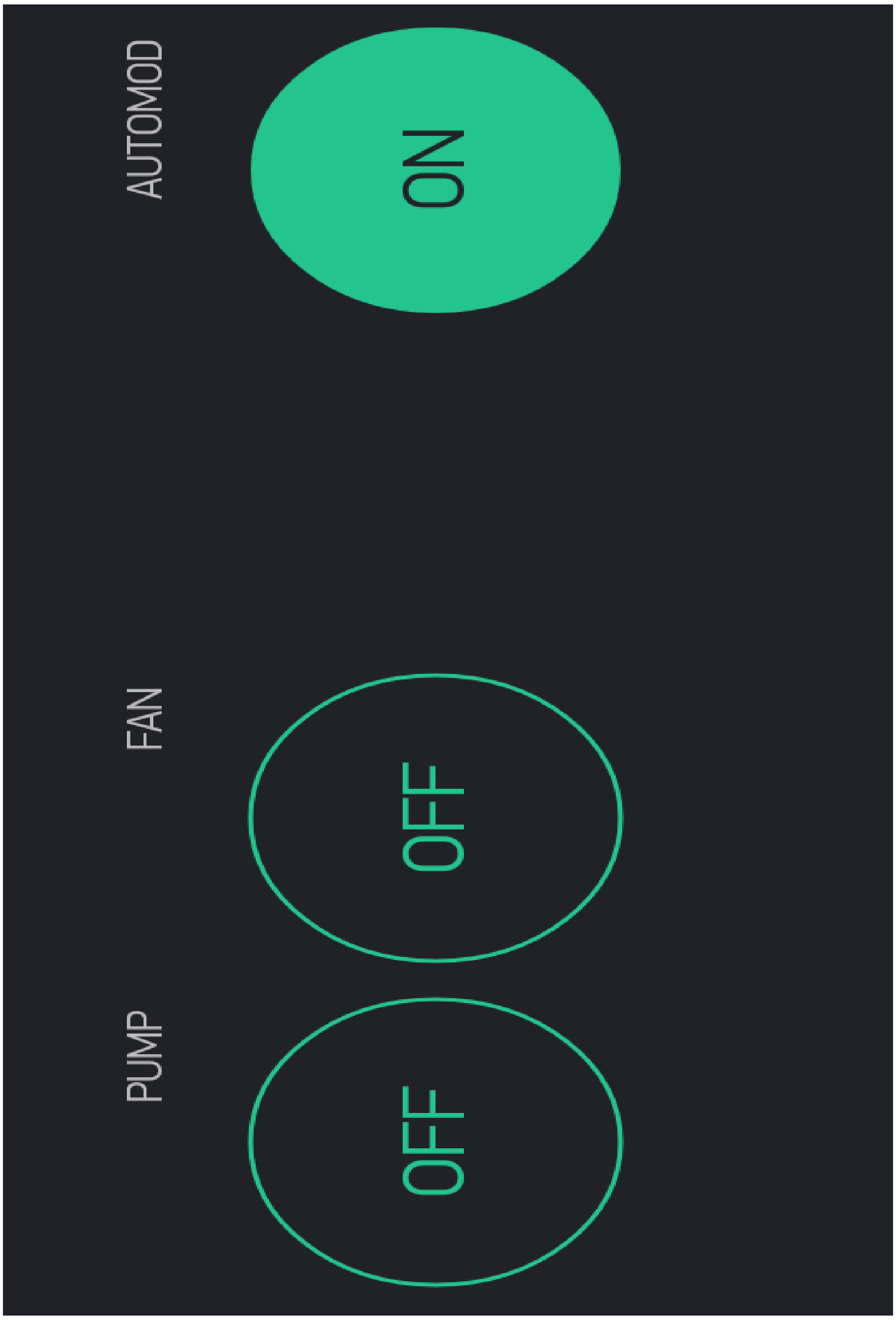

Figure 4.13 Case 5

Case 6: when the input signals is auto mod on, (humidity(V7) = < 50, and temperature(V6) < 30), the controller send signal to start the pump and stop the fan (Figure 4.14).

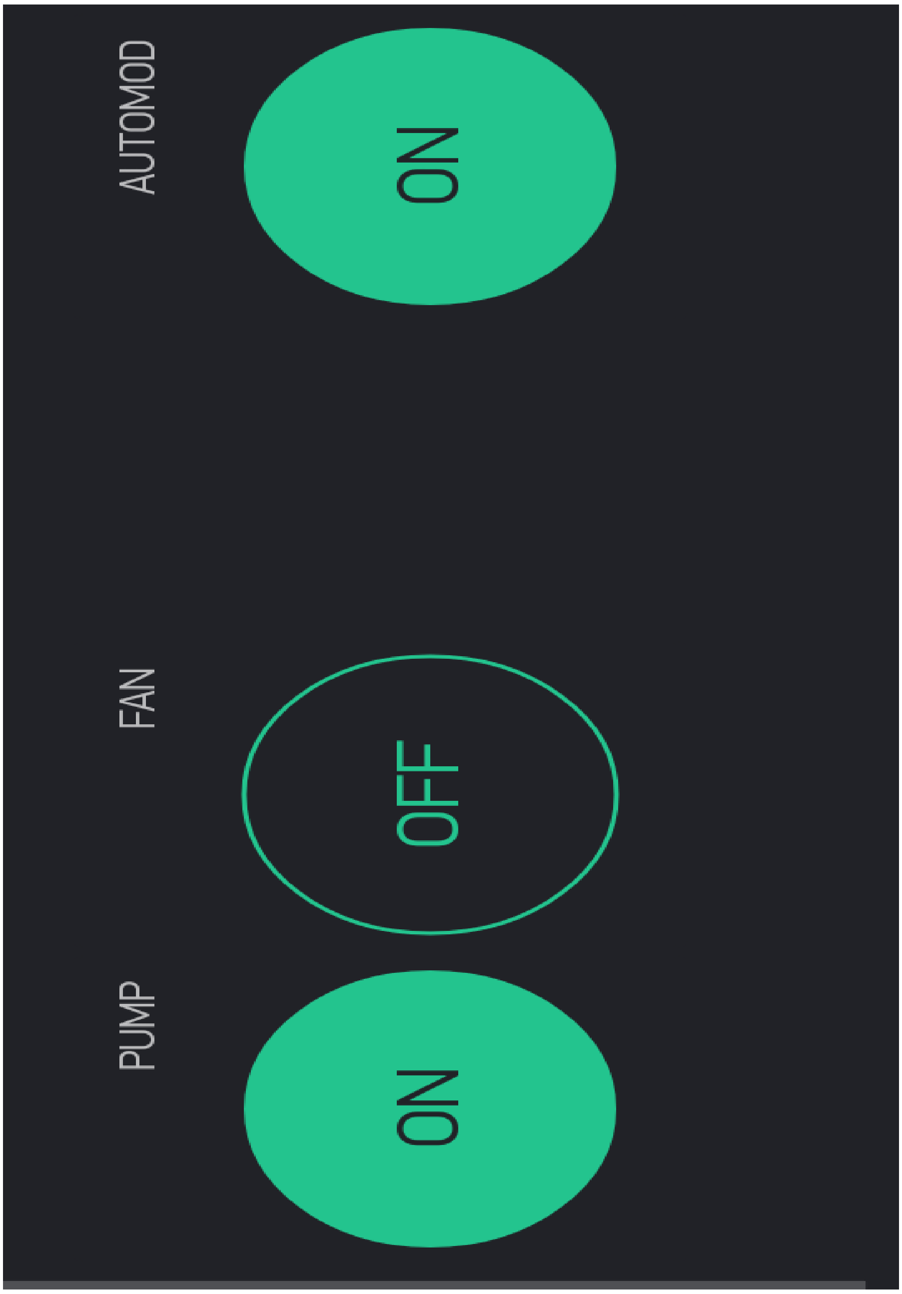

Figure 4.14 Case 6

Case 7: when the input signals is auto mod on, (humidity(V7) > 50, and temperature(V6) >= 30), the controller send signal to stop the pump and start the fan (Figure 4.15).

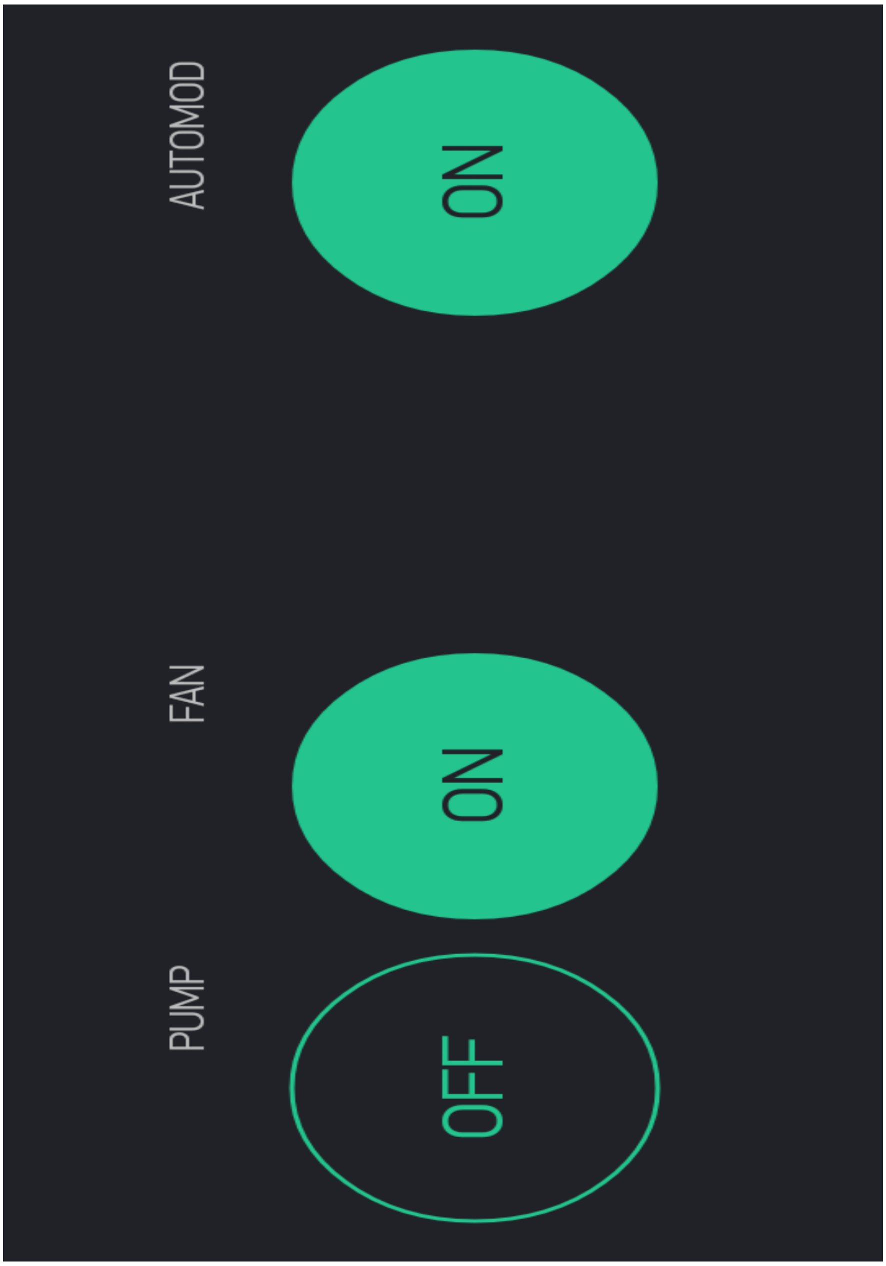

Figure 4.15 Case 7

Case 8: when the input signals is auto mod on, (humidity(V7) = < 50, and temperature(V6) >= 30), the controller send signal to start the pump and the fan (Figure 4.16).

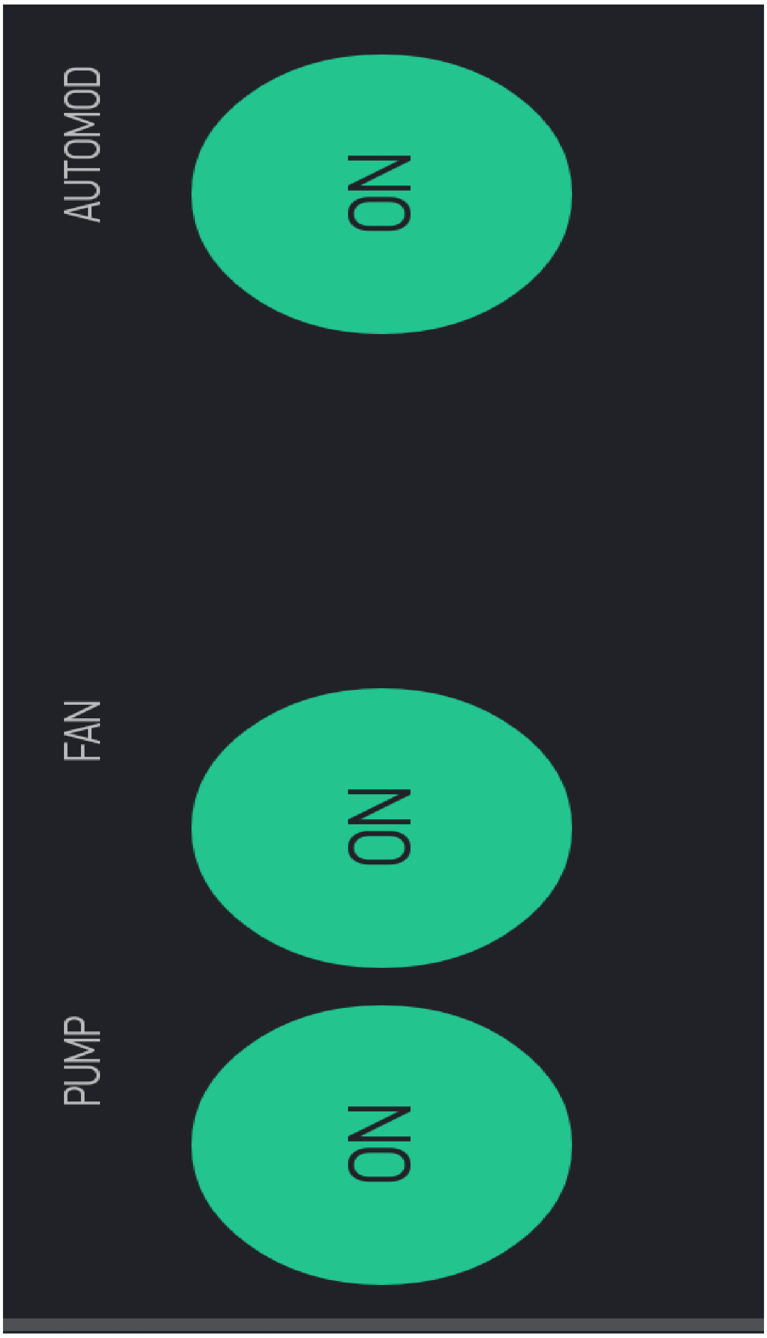

Figure 4.16 Case 8

In all the cases the controller sends the values data to the application.

4.5 Experimental Results

Table 4.2 illustrated the NodeMCU phases, reading phase, recognizing phase and action phase.

Table 4.2 NodeMCU Phase – Hardware Implementation

Reading					Recognition	Action	
Input						output	
V0	V3	V4	V7	V6	Operation	pump(D7)	Fan(D2)
0	0	0	ignore	ignore	Case 1	0	0
0	1	0	ignore	ignore	Case 2	1	0
0	0	1	ignore	ignore	Case 3	0	1
0	1	1	ignore	ignore	Case 4	1	1
1	ignore	ignore	>50	<30	Case 5	0	0
1	ignore	ignore	<50	<30	Case 6	1	0
1	ignore	ignore	>50	>30	Case 7	0	1
1	ignore	ignore	<50	>30	Case 8	1	1

Temperature Sensor Testing is done by recording the temperature changes that occur every minute (Table 4.3). This is done after the system is turned on and connected to a Wi-Fi internet connection. If at any time the internet connection is disconnected or bad signal, then it also affects system performance.

Table 4.3 Temperature Test

Minute	Temperature (C)
1	32
2	30
3	31
4	32

5	30
6	31
7	31
8	32
9	32
10	33

Same way Soil Humidity Sensor Testing is done by recording the humidity changes that occur every minute (Table 4.4).

Table 4.4 Soil moisture Test

Minute	Soil moisture (%)
1	51
2	53
3	51
4	56
5	52
6	55
8	54
9	53
10	57

NodeMCU has been successfully used to design and test automatic irrigation controlled pump and fan using soil humidity sensor, temperature sensor and blynk application.

In this case the hardware that plays a very important role as the main device is the NodeMCU ESP8266 module. The advantages of using the NodeMCU ESP8266 are more practical and cheaper than buying various components and then assembling them. The outcomes of the variously conducted trials have been observed and logged to be used in case of future studies.

CHAPTER FIVE

CONCLUSION AND RECOMMENDTIONS

5.1 Conclusion

In agriculture, the first aim is to have high production of crops, this can't be done without making best planting, care and best performance from workers.

In this project we've managed to have a system that doesn't need much interference from outside and can solve irrigating problems.

This system is designed in such a way that is simple, cost effective and easy to operate so that it can automatically irrigating and monitoring the filed providing high accuracy whit minimum use of power, water and labor. It consists of soil moisture sensor, temperature sensor, controller type NodeMCU, pump and LED. The soil moisture and air temperature is tracked by the sensors and the pump and LED is activated accordantly. The system's stats and measurements is reflected in the application.

5.2 Recommendations

In order to increase the efficiency of this system we recommend to:

- For the protection of the soil, we need to monitor the soil's salts rate and irrigation method.
- In order to increase the crops production, controlling and monitoring the process of fertilization must be placed under consideration.
- Improve the system by adding and connecting more controllers, sensors, etc... so that it can be used with different types of irrigation.

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APPENDIX

Code of the NodeMCU programming

```
#define BLYNK_PRINT Serial
#include <BlynkSimpleEsp8266.h>
char auth[] = "qja1uMy5EpzMYDcCdsKrUAc9gozVcRnQ"; //Auth
Blynk
char ssid[] = "awadamba"; //SSID WiFi
char pass[] = "awadamba"; //Pass WiFi
BlynkTimer timer;
#include "DHT.h"

#define DHTPIN D1 //Deklarasi pin DHT11 = 4 (D2)
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
#define PIN_FAN          D2
#define PIN_PUMP         D7

boolean PUMPStatus = 0;
boolean FANStatus = 0;
boolean AutoStatus = 0;
int humth;
int tempth;

float persen;
float t;
```

```
float h;
BLYNK_WRITE(V0)
{
  int a = param.asInt(); // assigning incoming value from pin V1 to a
variable
  AutoStatus = a;
  auto_on_off();
  auto_on_off1();
}
BLYNK_WRITE(V1)
{
  int hum = param.asInt(); // assigning incoming value from pin V1 to a
variable
  humth = hum;
  auto_on_off();
}
BLYNK_WRITE(V2)
{
  int temp = param.asInt(); // assigning incoming value from pin V1 to a
variable
  tempth = temp;
  auto_on_off1();
}
BLYNK_WRITE(V3)
{
  int p = param.asInt(); // assigning incoming value from pin V1 to a
variable
  PUMPStatus = p;
  aplyCmd();
}
```

```
BLYNK_WRITE(V4)
{
  int f = param.asInt(); // assigning incoming value from pin V1 to a
variable
  FANStatus = f;
  aplyCmd1();
}
void setup() {
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  dht.begin();

  aplyCmd();
  aplyCmd1();

  pinMode (PIN_PUMP, OUTPUT);
  pinMode (PIN_FAN, OUTPUT);
  timer.setInterval(1000L, sendUptime);
  timer.setInterval(1000L, auto_on_off);
  timer.setInterval(1000L, auto_on_off1);
}

void loop() {
  Blynk.run();
  timer.run();
}
void auto_on_off() {
  if (AutoStatus == 1) {
    if (persen <= humth) {
      PUMPStatus = 1;
```

```
      aplyCmd();
    }
    else if (persen > humth) {
      PUMPStatus = 0;
      aplyCmd();
    }
  }
}
void auto_on_off1() {
  if (AutoStatus == 1) {
    if (t > tempth) {
      FANStatus = 1;
      aplyCmd1();
    }
    else if (t <= tempth) {
      FANStatus = 0;
      aplyCmd1();
    }
  }
}

void aplyCmd()
{
  if (PUMPStatus == 1)
  {
    Blynk.notify("pump ON");
    digitalWrite(PIN_PUMP, HIGH);
    Blynk.virtualWrite(V3, HIGH);
  }
```

```
  else {
    digitalWrite(PIN_PUMP, LOW);
    Blynk.virtualWrite(V3, LOW);
  }
}
void aplyCmd1()
{
  if (FANStatus == 1)
  {
    Blynk.notify("fan ON");
    digitalWrite(PIN_FAN, HIGH);
    Blynk.virtualWrite(V4, HIGH);


  }


  else {
    digitalWrite(PIN_FAN, LOW);
    Blynk.virtualWrite(V4, LOW);
  }
}
void sendUptime()
{
  float s1 = analogRead(A0);
  persen = ((1024 - s1) / 1024) * 100;
  h = dht.readHumidity();
  t = dht.readTemperature();
  Blynk.virtualWrite(V5, h);
  Blynk.virtualWrite(V6, t);
  Blynk.virtualWrite(V7, persen);
}
```