بسم الله الرحمن الرحيم

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	Sudan University of Science And Technology **College Of Engineering**	

School Of Electronics Engineering

Multi Farming Hydroponic Plant grow Chamber

A Project Submitted In Partial Fulfillment For Requirement Of The Degree Of **B.Tech** In Electronic Engineering

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الإستهلال

قال تعالى { وَهُوَ الَّذِي أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجْنَا بِهِ نَبَاتَ كُلِّ شَيْءٍ فَأَخْرَجْنَا مِنْهُ خَضِرًا نُخْرِجُ مِنْهُ حَبًّا مُتَرَاكِبًا وَمِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِيَةٌ وَجَنَّاتٍ مِنْ أَعْنَابٍ وَالزَّيْتُونَ وَالرُّمَّانَ مُشْتَبِهًا وَغَيْرَ مُتَشَابِهٍ انْظُرُوا إِلَى ثَمَرِهِ إِذَا أَثْمَرَ وَيَنْعِهِ إِنَّ فِي ذَلِكُمْ لَآيَاتٍ لِقَوْمٍ يُؤْمِنُونَ}

الأنعام.11 -10

Dedication

We are very grateful to almighty Allah for helping us through this long journey, and bless for us, for help and guide us to the right path as the as our messenger Mohammed say: (who ever will not be grateful to worth the people he will be grateful to worth Allah) so we must be grateful.

And we dedicate this project to all finds here, and especially to our parents, those that helped us toward this success, and our family, our teachers, our friends and our colleagues.

Thanks and gratitude to:

Our beloved mothers who showered me with her love and affection trusted and supported us until we got here.

Our dear fathers who took care of us without tiring or boredom until we completed our journey till now. Our brothers and sisters who have been by our side, our friends, and colleague and loved ones.

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And special thanks to our harmonize and manger to our projects (**A.Azza kmalaldeen**).

Abstract

The Hydroponic systems are one of the most effective modern agricultural systems based on growing crops in water without soil. This study is a model for designing a miniature farmhouse system, and providing temperature and humidity using a temperature and humidity sensor and controller as well as providing the appropriate water. The problem statement that we find the hot and cold place is not suited to grow some crops and the problems of soil and environment insects and sun light and it takes more time to grow. The solution is to make farmhouse of hydroponically cultivate with controlling of it is environment includes temperature and humidity and water pumping by use the sensors. Here we designed a chamber, controlled and kipped the temperature and humidity of the room regard to the cultivated crops with set it is temp and hum need to grow with controlled the water flow. The fans and LEDs controlled by the DHT22 sensor, the pump controlled by water sensor and ultrasonic sensor inside the tank, the level of the tank controlled by the sonar sensor and give alert in the buzzer when no water and send a text message by the GSM when the user away.

المستخلص

تعتبر أنظمة الزراعة المائية من أكثر النظم الزراعية الحديثة فعالية والتي تعتمد على زراعة المحاصيل في الماء بدون تربة. هذه الدراسة هي نموذج لتصميم نظام مزرعة مصغرة ، وتوفير درجة الحرارة والرطوبة باستخدام جهاز استشعار درجة الحرارة والرطوبة وجهاز التحكم وكذلك توفير المياه المناسبة. وبيان المشكلة أننا نجد أن المكان الحار والبارد لا يصلح لزراعة بعض المحاصيل ، ومشكلات التربة والبيئة والحشرات واشعة الشمس ويأخذ وقتاً أطول في النمو. يتمثل الحل المقترح في جعل مزرعة الزراعة المائية مع التحكم في البيئة بما في ذلك درجة الحرارة والرطوبة وضخ المياه باستخدام أجهزة الاستشعار. والنتائج كانت واضحة انه جعلنا بيت محمي فيه تم التحكم والحفاظ على درجة حرارة ورطوبة الغرفة بحسب نوع ودرجة حرارة ورطوبة المحاصيل المزروعة التي تحتاج إلى النمو والتحكم في كمية تدفق المياه. تم التحكم في المراوح ومصابيح LED بواسطة مستشعر DHT22 ، ويتم التحكم في المضخة بواسطة مستشعر المياه وجهاز استشعار الموجات فوق الصوتية داخل الخزان ، ومستوى الخزان الذي يتم التحكم فيه بواسطة مستشعر السونار وإعطاء تنبيه في الجرس عند عدم وجود ماء وإرسال رسالة نصية بواسطة GSM عندما يكون المستخدم بعيدا.

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Chapter One: INTRODUCTION

About:

Hydroponics is the agricultural technique of growing plants without use soil, using other growing media and added nutrients in a solvent, it is an attractive agricultural method over conventional agriculture because it is more water efficient, is less labor intensive, yields higher quality crops in less time, and is easier to control [1].
There are several other parameters such as air temperature and humidity, lights, water temperature etc. which are controlled and maintained. These parameters are important for a healthy and faster plant growth [1].
In this thesis, we built a system which monitors and controls all the parameters necessary for healthy indoor plant growth. In general, the process goes as follows: create a nutrient solution based on the plant being grown, apply this solution to a bed of water place a germinated plant into the water such that the exposed roots are touching the solution [2].

If the parameters are maintained within optimum levels, the plant should grow faster and healthier than its natural growth. Typically hydroponic systems require human interaction when it comes to the regulation of certain elements that allow the plant to grow [3].

Indoor farming is the future for agriculture, where we don't need vast lands for agriculture, the gardening and farming can be done easily and even better using smart grow chamber that monitor and supply the plants with all necessary ingredients for proper growth [4].

Our system makes use of smart water supply and draining system coupled with air flow and artificial sunlight for a perfect grow environment [5].

Conventional agricultural practices can cause a wide range of negative impacts on the environment. “Conventional” or “modern industrial agriculture” has been historically defined as the practice of growing crops in soil, in the open air, with irrigation, and the active application of nutrients, pesticides, and herbicides. Some of the negative impacts of conventional agriculture include the high and inefficient use of water, large land requirements, high concentrations of nutrients and pesticides in runoff, and soil degradation accompanied by erosion [6].

And would allow for all weather indoor farming as and when needed for organic food grown indoors, and nevertheless the investment and running costs for an indoor vertical farm to date are immense [7].

Research on closed plant production systems, such as artificially illuminated and highly insulated plant factories, has offered perspectives for urban food production but more insight is needed into their resource use efficiency. This paper assesses the potential of this ‘novel’ system for production in harsh climates with either low or high temperatures and solar radiation levels[7].

Application of hydroponic systems in feed production has not been extensively studied. Therefore, there is insufficient data on the effect of the slope of hydroponic growing trays used in the nutrient film technique on wheat fodder yield and its qualitative parameters. The slope of the trays has only been studied for food crops. This study conducted experimental research using a nutrient film technique hydroponic fodder growing device to evaluate the impact of growing tray slope angle on hydroponic wheat fodder production[8].

India is a developing country, but rural areas do not seem to be developing much. Basically most of the public is farmers, most of the farmers have limited agricultural land and also lack of water resources. in many parts of India rain and is not enough for traditional way farming. To avoid these problems our proposed system is structured a helpful touch of fresh and raw feed for cattle food within affordable natural conditions [9].

This hydroponic system does not require any soil to grow fodders and will absorb 80% less water as compared to the traditional method of farming. Greater topic for work to upgrade the hydroponic fodder Grow room for proper management of cattle fodder in any period during the year. This paper suggests a clever plan no human power or less human power is required for It performance. This is usually a completely automated system. In seven to for eight days the room provides fodder as a ready-to-feed product any cattle or grass-eating animals. This process is aided by a Moisture sensor to produce a certain amount of water [10].

1.1 Problem Statement

The traditional agriculture depends on the type of soil, crop, and weather, so we find hot or cold places have a severe impact on crop cultivation, as well as changing humidity from time to time affects the growth of crops, and grow grasses is affect growing plant.

The environment is due to lack of space and water shortages around the world. It also depends on periodic monitoring of cultivation, and this will delays the production time of the crops.

1.2 Problem Solution

This thesis focus on Hydroponic farming and it is done without the use of soil. Our system makes use of smart water supply and draining system coupled with air flow and artificial sunlight for a perfect grow environment.

And this system would allow for all weather indoor farming as and when needed for organic food grown indoors and the crops is produced in less time.

1.3 Aim And Objective:

The aim of this project is to make farming process easily and safety with objectives:

- To control environments closely in terms of heat, humidity, sunlight, and ventilation.
- To avoid the weather changes.
- To make the product of farming in less time and improve the product of yields.
- To make possible for crops to be grown in their opposite season.

1.4 Methodology

The aim of this project is to provide environment parameter to chamber and controlling with this parameter to growing plants efficiency and correctly, so we uses some of sensors, LEDs, lamps and fans to reach to our goal using microcontroller to make all of this objects work together by using Arduino C Program. First we do is research of this project and after that is design the flow chart and simulate the software and programs and design the hardware

1.5 Chapters Layout

The chapters layout paragraph of this project is divided into five different chapters, the chapter one is the introduction and background of the project, and chapter two includes literature review, in chapter three is talking about methodology and how steps to design software and hardware, and chapter four includes result and discussion that appeared from the design, and the last is chapter five and it includes conclusion and recommendations.

Chapter Two: LITERATURE REVIEW

2.1 The Hydroponic plant:

Almost 870 million people across the globe do not have access to enough food, partially due to increasing population unfavorable weather conditions like drought, low land productivity, and poverty. Conventional agriculture has been struggling to push past these obstacles to efficiently feed the world. As populations grow, agricultural land is overcome by residential needs. Unpredictable, poor weather conditions leave conventional farmers exposed and financially vulnerable. Low land productivity leads farmers to overwork the soil to meet quotas, leading to even more soil degradation, erosion, and fertilizer usage. Widespread poverty inhibits people from purchasing fresh produce, driving food insecurity and malnourishment higher and higher[14].

However, new agricultural techniques are being developed to fill these gaps, meet the needs of future generations, and advance production in ways humanity has never done before. One such agricultural technique is hydroponics, which grows plants without soil in a water-based, nutrient rich solution that can be altered to best suit each crop. Compared with conventional, soil-based agriculture, hydroponics is a more sustainable option both environmentally and economically. It requires less land and grows plants more densely, increasing the productivity of land acre-by-acre. It is protected from unfavorable weather conditions because it is generally stationed in controlled environment greenhouses, and has the added capability of year-round production. It is not reliant upon soil characteristics and does not contribute to increasing soil degradation, run off, erosion, or fertilizer contamination. It is also up to more water efficient because it recycles water in a closed-loop system, eliminating escape through soil infiltration. Lastly, it does not require the use of pesticides, because the risk of soil-borne diseases in plants is eliminated. It is for these reasons that hydroponics is a promising agricultural technology to meet production needs of the future without sacrificing environmental sustainability[12].

2.2 Related Works

The author in [11], is described a NFT hydroponic culture technique. This technique of growing plants in nutrient solutions enhances plant growth, and is an excellent way to obtain intact plants with root systems free of soil or other particulate matter, he used one layer of hydroponic system growing, and arduino controller circuit interfaced with a keypad to get user inputs on the water change and flow and indoor room to control in temperature and fans for cooling with sensors and other to control in the indoor room automatically in order to the threshold set of the temperature and humidity.

The authors in [12] and [13] designed one of the hydroponic systems, and created an educational module that can be utilized by nearby elementary schools. The hydroponic system that designed is a Deep Flow Technique (DFT) hydroponic system where the plants are placed in a floating raft on top of a water reservoir containing a plant nutrient solution. An air compressor and bubbler provide the necessary dissolved oxygen to the plant’s roots. And used light to grow basil but could easily be adjusted to grow other crops, and also worked to create an education module that meets the State of Arkansas science education standards for 5th grade students. And make Tri Cycle farming hydroponic systems. This report demonstrates the processes to design the DFT system, the components in the system that needed to be monitored, a demonstrative educational poster, and discussion of the steps to be taken to fully implement the multiple goals for the Hydro House for Tri Cycle Farms.

It consists of a frame that was made of aluminum profile (40×40×20 mm). Its construction was divided into two different growing floors. Each floor was equipped with four growing trays (1000 mm long, 225 mm wide, and 75 mm high, made of polyvinyl chloride (PVC) plastic). The growing area of a single tray was 0.225 m2, and the total growing area in the device was 1.8 m2. One end of each growing tray was open so that the nutrient solution would moisturize the roots of the cultivated grass by passing through them. The slope angle of the growing trays was changed from 2.0% (1.15◦) to 8.0% (4.57◦)with increments of 1.5% The lower floor lighting was equipped with LED lighting consisting of two strips of wavelengths(blue and red) powered by a 24 V amplifier. Each LED strip was 1 m long. One strip of red and blue was attached above each growing tray at a distance of 0.21 m. The TC420 controller was used to control the illumination flow. Researchers Son and recommend a 4:1 ratio of red to blue illumination, which corresponds to 80% red and 20% blue. This ratio was maintained by selecting449–459 nm blue LED strips and 617–627 nm red LED strips.

2.3 The Structure Of Hydroponic Systems

There are many different systems for hydroponic cultivation which are designed to maximize yield. They differ mainly in function and complexity[15]. In the next slide there are the many types of hydroponic systems:

i. Drip systems:

Drip systems are reasonably simple to control moisture in. Nutrient solution from the tank or reservoir is provided to individual plant roots in appropriate proportion with the help of pump[16]. Plants are usually placed in moderately absorbent growing medium so that the nutrient solution drips slowly.

ii. Wick System:

This is simplest, least used type of hydroponic system requiring no electricity, pump and aerators. Water or nutrient solution supplied to plants through capillary action. You can control the amount of water getting to the plant by using a larger/wider wick, or more than one. This system works well for small plants, herbs and spice and doesn't work effectively that needs lot of water[17].

iii. Deep water culture system:

The deep water culture system is the easiest system to use. Deep flow technique (DFT) suspends plant roots of nutrient solution which is able to flow around the roots. This works well for plants without deep roots and with short grow cycles, commonly herbs or lettuces and other leafy greens but does not support larger plants or those with longer grow cycle s. This system requires aeration to ensure that the water contains appropriate levels of dissolved oxygen for the plants. Water culture is the system most often used for leafy vegetables (Figure 2.1) the Protected Cultivation and Smart Agriculture [18].

Figure2.1 Mesh-pots filled with fenugreek plants placed into a Styrofoam sheet floated on trays having nutrient solution.

iv. NFT systems:

NFT was developed in the mid 1960's in England by Dr. Allen Cooper, whereby a very shallow stream of water containing all the dissolved nutrients required for plant growth is re circulated past the bare roots of plants in a water tight thick root mat, which develops in the bottom of the channel. NFT is widely suitable to grow various vegetables deep flow technique, nutrient film technique(NFT) [19].

Figure 2.2 Growth of spinach in A-Frame hydroponics structure.

❖ **NFT Structure and Essential Components:**

The hydroponic system was chosen to be a vertical NFT hydroponic system since it has the greatest benefits to the other systems [19].

For this paper, the vertical NFT system made by Koray Company (Guangdong, China) was selected, which is consisting of 3 shelves. Each shelf is holding 4 polyvinyl chloride (PVC) pipes with a diameter of 63 mm (0.063 m), and each pipe consists of 9 planting holes with a diameter of 32 mm (0.032 m). The dimensions of the vertical NFT hydroponic systems are 96 cm (L) × 50 cm (W) × 90 cm (H) (Figure 3). The PVC system was purchased off-the-shelf to reduce development time. However, given the known specification it can be manufactured and assembled locally, which will reduce the cost significantly[20].

Figure 2.3 Vertical NFT hydroponic structure assembled and connected to the monitoring and control system.

v. Ebb-Flow (flood and drain) systems:

Flood and drain systems can vary quite a bit in design and supposed to be first commercial hydroponic system which works on the principle of flood and drain. Nutrient solution from reservoir swamped through a water pump into system. The system uses gravity to return the excess water to the reservoir to be reused.

vi. Aeroponic systems:

It is probably the most high-tech type of hydroponic gardening. In this technique, plants are grown with their roots suspended in air while being sprayed continuously with a nutrient solution. The hydroponic system needs a short cycle timer unlike other systems that runs the pump for a few seconds every couple of minutes[21].

To design a successful hydroponics greenhouse, the specific hydroponic system chosen is a critical determinant. Wick systems are arguably the simplest system and employ capillary action to pull water from a reservoir up to the aggregate which holds the roots of a plant [18, 22].

This system is very simple to build but requires constant maintenance to ensure that the wicks are clean and capable of providing enough water to the plant's roots. It is not recommended for larger plants like tomatoes or for delicate plants like strawberries.

Figure 2.4 Hydroponic Agriculture System.

The aim of this hydroponic system is to deliver an optimized nutrient solution to plant roots. The method of delivery can often involve some form of growing medium used to anchor the plant, or to provide a matrix which supports nutrient and water accessibility. The interaction between the plant, growing medium and nutrient solution determines the efficacy of the growing environment. The most important factors governing the interaction between a substrate/growing medium and the nutrient solution are porosity, water holding capacity, water availability, buffering capacity and caution exchange capacity (CEC). These factors govern how quickly the nutrient solution passes through them, how often Irrigation required, and how available nutrients are to the plants.

And this system uses component as:

- Pump Motors
- Piping and Drainage Connectors
- Supporting Frame Rods
- Water Tank
- Temperature Sensor
- Water Sensor
- Moisture Sensor
- Controlling Circuitry
- LCD Display
- Keypad
- Transparent casing
- Cooling Fans

2.1.2 Growing Mediums in hydroponics

In most hydroponic systems, growers use different types of hydroponic media to help support their roots and maintain a good water/oxygen ratio[15].

❖ **The common growing media used in a hydroponics:**

1. Rockwool

Rockwool is one of the most common growing media's used in a hydroponics. Rockwool is a sterile, porous, non degradable medium that is composed primarily of granite and/or limestone which is super-heated and melted, then spun into small threads. The rock wool is then formed into blocks, sheets, cubes, slabs, or flocking. Rockwool sucks up water easily so you'll want to be careful not to let it become saturated, or it could suffocate your plants roots, as well as lead to stem rot and root rot. Rockwool should be pH balanced before use. That's done by soaking it in pH balanced water before use.

2. Coco coir

Coco coir /Coconut fibber is from the outer husk of coconuts. What was once considered a waste product is one of the best growing mediums available. Although coco coir is an organic plant material, it breaks down and decomposes very slowly, so it won't provide any nutrients to the plants growing in it, making it perfect for hydroponics. Coco coir is also pH neutral, holds moisture very well, yet still allows for good aeration for the roots. Coco fibber comes in two forms, coco coir, and coco chips.

3. Perlite

It is mainly composed of minerals that are subjected to very high heat, which then expand it like popcorn so it becomes very light weight, porous and absorbent. It has a neutral pH, excellent wicking action, and is very porous. It can use by itself, or mixed with other types of growing media's. It is so light that it floats, depending on how you designed your hydroponic system and it may not be the best choice of growing media for flood and drain systems. It is widely used in potting soils, and any nursery should carry bags of it.

4. Vermiculite

Vermiculite is a silicate mineral that like perlite, expands when exposed to very high heat. As a growing media, vermiculite is quite similar to perlite except that it has a relatively high caution exchange capacity, meaning it can hold nutrients for later use.

5. Oasis Cubes

Oasis Cubes are similar to Rockwool cubes, and have similar property. But oasis cubes are more like the rigid green or white floral foam used by forests to hold the stems in their flower displays. Oasis cubes are an open cell material which means that the cells can absorb water and air.

6. Sand

Sand Is actually a very common growing media used in hydroponic systems. Sand is like rock, just smaller in size. Because the particle size is smaller than regular rock, moisture doesn't drain out as fast.

7. Rice Hulls

Depending on the availability, rice-hulls may be used. It's a by-product of the rice industry. Even though they are an organic plant material, they break down very slowly like coco coir, making them suitable as a growing media for hydroponics. Rice hulls are referred to as fresh, composted and parboiled, or carbonized.

2.1.2 The advantages of hydroponic system:

Hydroponics is the growing of plants in a liquid nutrient solution with or without the use of artificial media. Commonly used media include expanded clay pellets, peat coir, vermiculite, brick shards, polystyrene packing peanuts and wood fiber. Hydroponics is a viable method of producing vegetables, foliage plants and other crops. The demand for locally grown produce has risen dramatically Growing these crops hydroponically is a very efficient means of meeting that determined, and the advantages of the hydroponic systems is[15]:

- No need for soil & sunlight
- An extended growing season.
- Higher plant density
- Less water consumption.
- Easier to harvest mature plants
- Automatic water level check & Auto temperature control.
- Fewer pesticides.
- We can grow anywhere.
- Your environment is sterile, which means no pesticides.
- You'll use 20% less space for growing.
- The system water can be reused, allowing you to conserve water.

2.1.3 The disadvantages of hydroponic system:

The disadvantages of the hydroponic plant is below[15]:

- Requires power supply.
- Most available plant varieties adapted to the controlled growing conditions must require thorough research and development.
- The grower must observe the plants every day because the reaction of the plant to good or poor nutrition is unbelievably fast.
- Need constant monitoring.
- Expensive to set up. The cost of hydroponics unit construction per unit area is very high[15].

2.3 Component:

Here we will talk about the main component that can be used to design a hydroponic system and it can be divided as flows:

2.3.1 Pump motor:

About

The main difference between motor and pump is that a motor is a device that converts electricity to mechanical energy which results in motion, whereas a pump is a device that is used to transfer a fluid from one place to another. All pumps use basic forces of nature to move a liquid. Sizing the water pump is very important as selecting the right pump would assure the sufficient amount of water is flowing continuously in the system. For this design, submersible pumps were selected to be used since they suit the small systems that need 1200 of gallons or less. The sizing of the pump was done in three steps:

The first step was to calculate the gallons per hour (GPH) that the pump was required to supply to the system, and the second step was to measure the head height of the hydroponic system and the third step to use the first two information to verify if the pump was suitable using the water pump datasheet [23].

2.3.1.0 The type of motor is used in water pump:

i. Induction motor

Is an AC machine that produces mechanical energy based on electromagnetic induction Although there are various types of electric motors in use today split phase, shaded pole, and synchronous motors the most common type of motors used in water well and water works is the induction motor. There are basically two types of induction motors the single-phase induction motor and three-phase induction motor [24].

ii. Centrifugal and positive displacement pumps

The several different types of water pumps commercially available and the dynamic pump is the one of it's type. The two most common ones are centrifugal pumps and positive displacement pumps. Centrifugal pumps use a rotating impeller to generate a centrifugal force that sucks the water while the impeller directs the water to the pump outlet with high velocity and pressure [25]. These types of pumps tend to be installed as part of PV pumping systems, given that the motors in PV systems are DC-or AC-driven. The hydraulic efficiency of these systems is in the range of 30% [26].

iii. Diaphragm and progressing cavity pumps

In general, these pumps have relatively high efficiency, along with minimal capital costs and PV input power needs. Positive displacement pumps are designed to provide a fixed amount of water through the contraction and expansion of a diaphragm[26].

Both centrifugal and positive placement pumps are used for the same purpose, which is to reduce downtime from main events and to continuously move water from point A to point B. In the present work, we investigate a dynamic pump, which is a type of centrifugal pump. We chose the dynamic pump mainly because of its low maintenance needs. However, centrifugal pumps can be problematic in that their efficiency reduces under low levels of solar radiation. To offset the problem, we modify motor speeds depending on the irradiance that is available at any given time. Note that the pump’s torque is generally proportional to the rotor speed’s square [27, 28].

iv. water pumps – inline and submersible

First the Inline pumps are air-cooled and are place outside of the tank. It placed directly in the water of hydroponic reservoirs, and use fittings and hoses to transport the water within a system. Since inline pumps are mainly used in large-scale hydroponics operations, most hobbyists should just be concerned with submersible pumps because of their limited power[29].

❖ **Types of hydroponic pump system:**

A. Hydrofarm is the active aqua submersible water pump, is well known and well-regarded brand in the hydroponics community. It has high quality and highly rate as shown in the figure 2.5 [30].

Figure 2.5 hydrofarm pump motor.

Features:

- Can be used below the water level (non-submersed).
- Vortex impeller.
- Durable impeller can withstand operation in water containing solids and sediment (up to a 6 mm particle size).
- Ceramic bearings for continuous use.
- All electrical parts completely sealed in.
- Energy-saving split tube motor.
- Built-in thermal overload protection.
- Removable rotor assembly for simple maintenance.
- Optimal filtration and Dual use (submersed and inline).

B. Homasy Upgraded 400GPH Submersible pump, is the ultra quiet water pump for hydroponics and it is offers pumps in sizes starting at 53 GPH and up. It has threaded fittings for extra stability and the stainless steel impeller shaft is corrosion resistant and long lasting. Included is a 4 suction cups for mounting vertically or horizontally and a 5.9′ power cord to reach your outlet as shown in figure 2.6 in next slide [31].

Figure 2.6 homasy pump motor.

Pumps Used:

Pumps that are designed to be submersible are placed within the reservoir of water that needs pumping out. As such, they are often used for drainage in floods, sewerage pumping, emptying ponds or even as pond filters. Filtration pumps found inside fish tanks are a type of submersible pump.

2.3.2 The Arduino

About

It is an open-source platform used to make electronics projects. It consists of both a microcontroller and a part of the software or Integrated Development Environment (IDE) that runs on your PC, used to write & upload computer code to the physical board. The platform of an arduino has become very famous with designers or students just starting out with electronics, and for an excellent cause as shown in figure below [32].

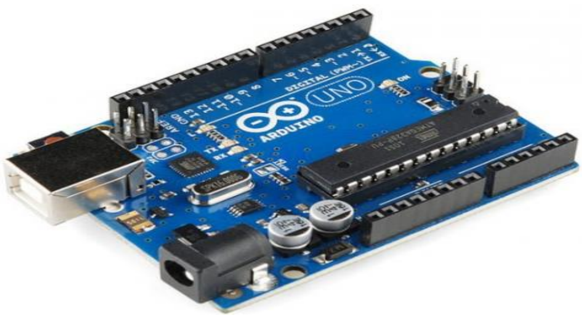


Figure 2.7 The Arduino Board Circuit.

2.3.2.0 Arduino Development Board:

Arduino board designs use a variety of microprocessors and controllers. The main function of the arduino board is to control electronics through reading inputs & changing it into outputs because this board works like a tool. This board is also used to make different electronics projects in the field of electronics, electrical, robotics, etc.[33].

The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. It does not require a separate part of hardware in order to program a new code onto the board you can just use a USB cable. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the arduino project provides an integrated development environment (IDE) based on the Processing language project [34, 35].

2.3.2.1 Advantages And Disadvantages Of Arduino:

❖ **The Advantages :**

- Inexpensive.
- Cross-platform.
- The simple, clear programming environment.
- Open source and extensible software.
- Open source and extensible hardware.

❖ **The Disadvantage :**

- Arduino shields away a lot of complexity which is an advantage to get started, but limits you later. It also makes understanding how certain things work more difficult, but that's inevitable.
- Arduino libraries are not very efficient in certain parts and waste RAM and CPU cycles.
- Sketches and shields are difficult to modify.
- No debugger included for checking scripts.
- You get no experience of C or professional development tools.
- Arduino is very limited and can’t to uses with the multi-circuits system[35].

2.3.2.2 Different types of arduino boards:

The list of arduino boards and it different regard of the number of input and analog\digital pin and process and includes the Following such as:

1) Arduino uno.
2) Arduino mega.
3) Arduino nano.
4) Arduino micro.
5) Arduino due.
6) LilyPad arduino board.
7) Arduino robot.

2.3.3 The Artificial Lights

Lighting is essential for the plants as it plays an important role in the photosynthesis process. Any lack of lights would limit the photosynthesis which affects the growth of the plants [36].

Plants do not require the full range of light spectrum for growth, they only absorb their needed amount of light in the spectrum The lights requirement is between 400 and 700 nm which lies within the visible range and it is also known as photo synthetically active radiation (PAR). Moreover a high intensity of red and blue lights is needed to grow flowering plants while for non-flowering plants need a high intensity of red light only [10, 37].

2.3.3.0 LED Lighting:

The light emitting diode is the electronic component use to radiate light object and this light may use to input to another objects like photo resistor phototransistor, but here we use it to generate heat to environment but it not very hot.

The Advantages of LED lights:

1. Fast Harvest Cycling: we can use LED's around the clock without affecting the temperature of our grow room.
2. Energy Savings: LED's consume around 60% less energy than a conventional lighting system to deliver the same light.
3. Adaptable Wavelengths: With LED's we can regulate the light wavelengths and we can tailor these to plants requirements to photosynthesize
4. Extended Lifespan: An LED bulb can last as much as 50,000 hours, they last so long in fact, and it is often the control unit that stops working long before the bulbs. These can be easily changed if this does happen.

Disadvantages of LED:

It is unfortunate, a lighting system, which comes with so many advantages, has to come with some disadvantages at the same time.

- Higher Purchase Cost: LED's do cost more to purchase in comparison to conventional lighting fixtures.
- Directional Light**:** LED fixtures throw light out the same way as flashlights do.

- Growth Results**:** This is the determining factor of any grow light system. There has been a lot of discussion about the overall growth results using LED's. Manufacturers claim a 300w LED lighting system compares to an HPS setup of 600-1,000w, yet growers are proving otherwise. For a one light setup, they are not as effective, and are better suited to the vegetative stage of growth.

2.3.4 Water tank

Consider the hydroponics tank the heart of our system. Our water reservoir, or tank, is what holds the very thing your plants need to live: the nutrient saturated water solution. Once you start looking into hydroponic tanks more, you'll quickly realize that they're more complicated than simply being a tub where you hold your nutrient solution.

2.3.5 Cooling fans

It is essential to maintain the temperature in a specific range for the healthy growth of plants in an indoor hydroponic system. Plants require a certain range of temperature, which allows the suitable environments for the plants to grow healthier, and better. In order to control the temperature and the humidity of the room, an air conditioning subsystem with automatic triggers to turn the AC on or off was implemented [38].

❖ **Benefits of Hydroponic Fans:**

For optimal growth, hydroponic plants need temperatures between 65 and 75 degrees and humidity levels between 50 and 80 percent and plenty of fresh air. When growing temperatures and air circulation are not maintained, plants can fail to thrive, when humidity is greater than 80 percent. Ventilation fans can help control heat and humidity and provide adequate fresh air and air circulation so that you can achieve the best possible yields and grow rates for your plants[39].

2.3.6 LCD display

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizer. Liquid crystals do not emit light directly instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden.

For instance: present words, digits, and seven-segment displays, as in a digital clock, are all good examples of devices with these displays. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance[40].

2.3.6.0 LCD displays used and types:

LCDs are used in a wide range of applications, including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays and indoor and outdoor signage.

Small LCD screens are common in LCD projectors and portable consumer devices such as digital cameras, watches, digital clocks, calculators, and mobile telephones, including smart phones. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. LCD screens have replaced heavy, bulky cathode ray tube (CRT) displays in nearly all applications. It can be available in a wider range of screen sizes than CRT and plasma displays, with LCD screens available in sizes ranging from tiny digital watches to very large television receivers[40, 41].

2.3.7 The Sensors

A sensor is as a device that receives and responds to a signal or stimulus. Grow control precision digital hydroponics sensor transmitter and it is an energy convertor, data logger and mini-controller for temperature, and humidity and electrical conductivity. A three button interface make this unit capable of operating stand-alone for sensor monitoring, alerts, dosing pump control and more. Precision digital electronics with isolated probe inputs accurately read and record sensor data**.**

- **The sensors that we need for hydroponics**

Also the system contains four sensors: an electrical conductivity probe, a pH sensor, a water temperature sensor, and an air temperature/humidity sensor. The electrical conductivity probe allows us to estimate an amount of salts or nutrients in the water**.**

2.3.7.0 The types of sensors we use it in deferent systems:

i. Water level sensor

If the water supply lines on your washing machine fail, it can cause significant damage to your home. If that leak goes undetected because you are away from home, the accumulated water can cause potentially catastrophic damage. Water sensors detect the presence of water and, when placed in locations where water should not be present, a leak. When Wi-Fi is enabled, the sensor can send out a notification to the homeowner through a smart phone app.

ii. Temperature sensor

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. There are many different types of temperature sensors. Non-contact temperature sensors are usually infrared (IR) sensors**.**

iii. Moisture Sensor

The sensor contains a fork-shaped probe with two exposed conductors that go into the soil or anywhere else where the water content is to be measured.

Like said before, it acts as a variable resistor whose resistance varies according to the soil moisture. The module has a built-in potentiometer for sensitivity adjustment of the digital output (DO).

You can set a threshold by using a potentiometer; So that when the moisture level exceeds the threshold value, the module will output LOW otherwise HIGH.

This setup is very useful when you want to trigger an action when certain threshold is reached. For example, when the moisture level in the soil crosses a threshold, you can activate a relay to start pumping water.

2.4 A Guide To A Hydroponically Growing Lettuce:

Figure 2.8 sample of hydroponically grow lettuce.

There are only a few varieties of lettuce plants to choose from. We have Bibb lettuce, Tom Thumb lettuce, and Romaine lettuce. But how are they different? The easiest lettuce type to grow is Bibb lettuce. If you're seeking small space consumption, Tom Thumb is a better option. And there steps of growing it:

1) To hydroponically grow lettuce, you need to pick a suitable medium. Several mediums can be used, such as coco fiber, pine shavings, sand, rock wool, vermiculite, and river rock. You can choose the one that is most suitable for you since they all have high success rates.
2) Despite this, rock wool is the most preferred material due to its porous nature and its sterility. You must, however, be cautious not to overwater the roots since excessive water can cause rot and suffocation.
3) Installing your water reservoir is the first step in setting up your system. You will store water and nutrients in the water tank.

4) The size and surface area of the container that will serve as your nutrient reservoir can be whatever you prefer, but make sure it is at least 8 inches deep. The roots must be able to immerse themselves in the water entirely, or else everything will be fail.
5) When choosing a container, it is recommended to avoid all metal options. When a metal container oxidizes or rusts, it will cause stress on your plants, causing their nutrients to be disrupted.
6) Putting the plant in a net pot is the only way to grow a hydroponic plant. The roots will float on a surface above the water in this net pot, so the water will not contact the roots. Take advantage of all the net pots you can.
7) Make holes in a polystyrene plank. These holes are required to accommodate the net pots over which you will place the plants. There should be at least 12 inches between each hole so for excellent plant growth.
8) Fill in as many holes as possible so that you can fit in as many net pots as possible. Lettuce, in particular, requires an air pump to keep the water in the reservoir fresh.
9) Ensure that the reservoir is fitted with a high-quality air pump. Using this pump will ensure the circulated water contains oxygen dissolved in it. It will also ensure freshwater is being circulated to prevent suffocation.
10) The reservoir finally needs to be built. Then add the right amount of water, followed by the hydroponic nutrients. This type of nutrient is usually sold already mixed for convenience.
11) Plants differ in their needs for nutrients, so the nutrients that you mix will depend on them. In addition to magnesium and potassium, lettuce needs calcium as well. It would help if you also kept in mind that the nutrients will vary depending on the lettuce

variety you grow. Some lettuce varieties may be sensitive to nitrogen, so make sure you look into it.

2.4.0 Setting Up a Hydroponic Lettuce Garden:

To get the lettuce seeds going in your small nursery, you need to take care of the seeds in ideal conditions properly. They should be watered regularly and placed in a place with good circulation that is well-lit.

Temperatures between 65 F and 80 F would be ideal. Be sure to take good care of the lettuce seedlings until they reach a height of 2 inches and develop four leaves.

Maintaining the right temperature for your lettuce is crucial. Cooler temperatures suit them well rather than warm climates. It would help if you kept temperatures between 55 and 75 degrees Fahrenheit at night and 75 degrees Fahrenheit during the daytime. Overheated lettuce will flower or bolt, resulting in a bitter taste.

Chapter Three: RESEARSH METHODOLOGY

3.1 Controller hardware requirements & Block Diagram:

In order for the controller to be used for growing, a study was made on how we actually use the hydroponic system and these will be the requirements with which we will base the HW and SW on.

3.1.1 The Block Diagram of The Hydroponic System:

The system makes use of sensors to monitor temperature, moisture and water level in the grow chamber. The temperature is range and required moisture level can be programmed by the user in the system. The system monitors these parameters and operates the fans to maintain required temperature and moisture in the chamber. The system then uses the water sensors to check level of water in the system, the pump motors pump water into system or remove excess water from the system as and when needed.

The artificial sunlight is switched on and off automatically as instructed by user to maintain proper temperature and get desired light for plant growth. The onboard water tank is used to maintain water supply and sounds a buzzer when system is out of water. An onboard controller circuit is used to run the entire setup as programmed by user. Thus the system provides a fully automatic method to monitor and bolster plant growth by ensuring perfect plant growth conditions as programmed by user as shown in next slide in **Figure 3.1**.

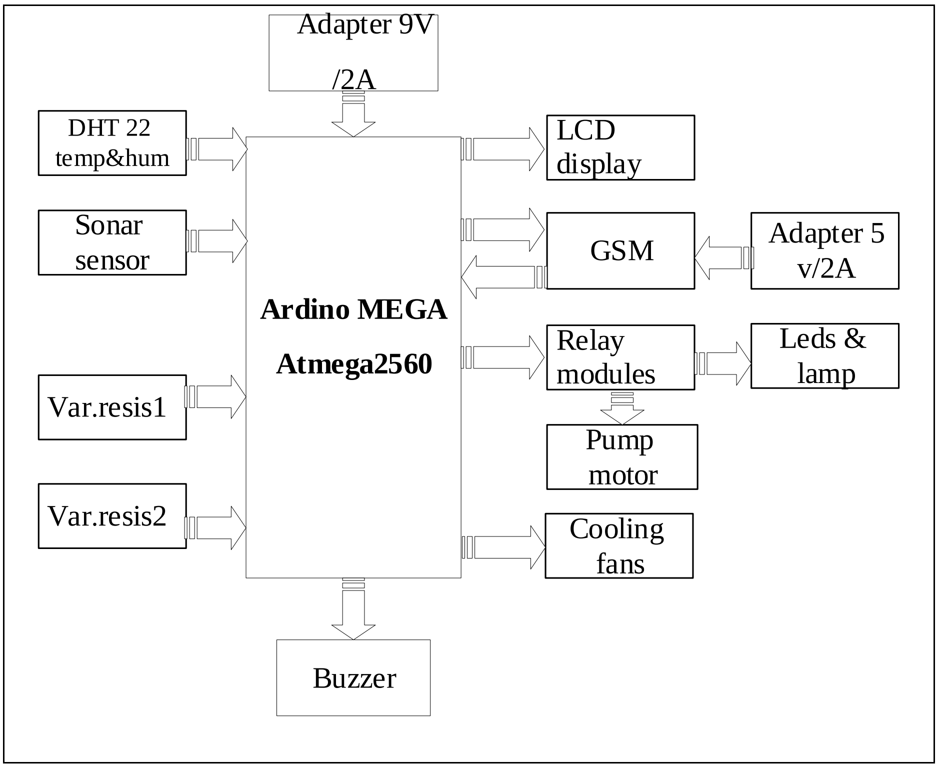


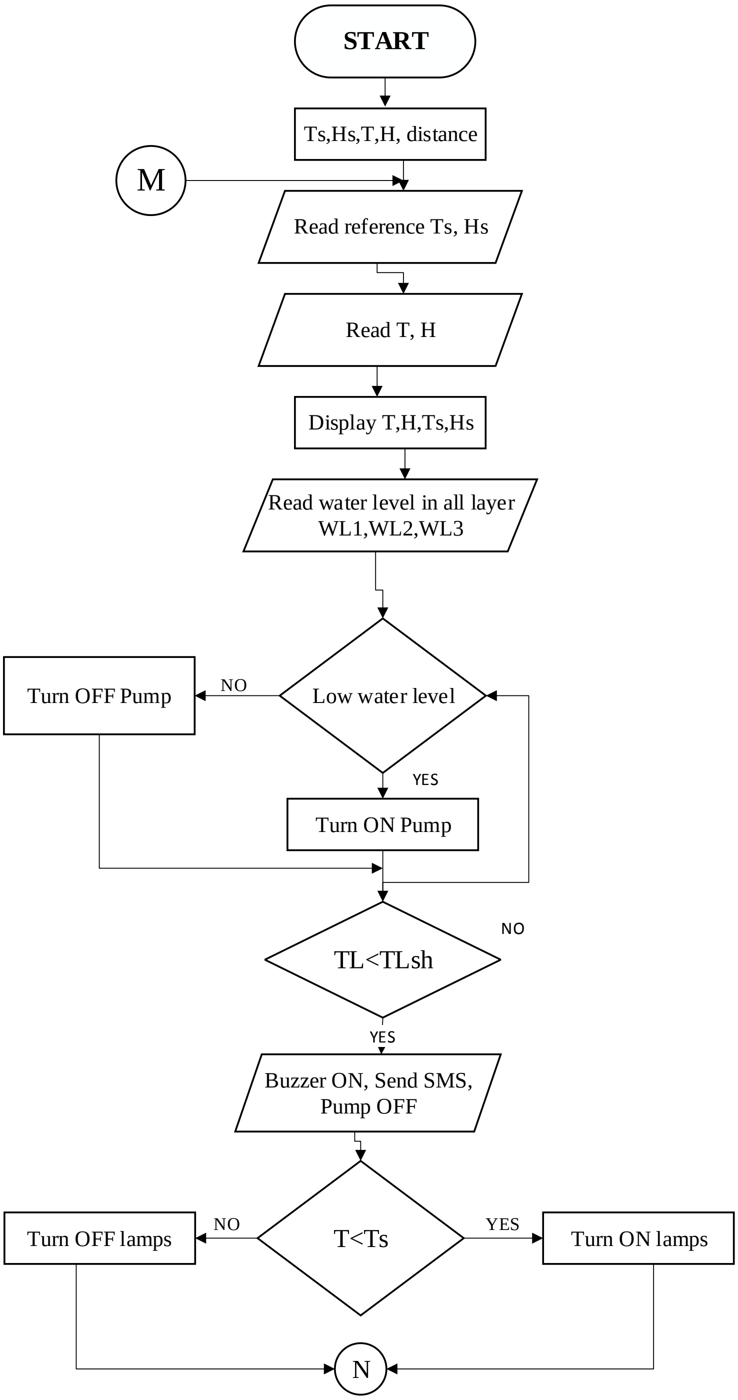
Figure 3.1 The block diagram of the hydroponic system.

3.2 The Flow Chart The Hydroponic System:

Initially the water tank level has to be checked for Upper Level (level 50), and the pump motor has to be connected to relay with Arduino microcontroller and make a serial connection of motor for pumping water into the plants through the pipes when the level of water is less than the level of water sensor. Similarly all sensors such as temperature & humidity sensor (DHT22) connected to the light and fans, and potentiometers for set threshold (T_S and H_S) the sensor, and LCD4x16 for display the result, and GSM device for connect the system to mobile device for wireless communication.

The sensor values take reading and send to the microcontroller then it will decide according to the threshold value set. If the humidity crossed the threshold value it will automatically open led light else open the fans and the temperature and humidity that needed to be controlled and the lamp will be ON to reach the temperature set, until the humidity and temperature set equal near to environment of the room, and the ultrasonic sensor chick the level of water tank and if it empty the motor is off automatically and buzzer sound will operate and send alert message by the GSM device to our phone.

Finally all sent SMS message through GSM for further analytics process or if the tank is out of water as shown in **figure 3.2** in the next slid.



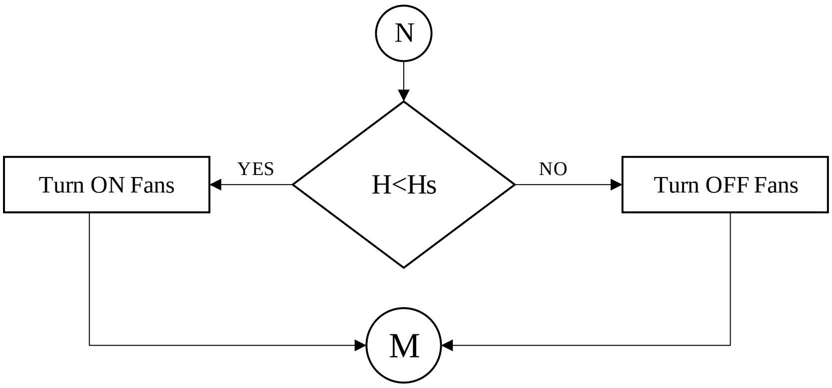


Figure 3.2 The flow chart of the hydroponic system.

3.2.2 The Components Requirement:

The component that used to design hydroponic system hardware to achieve the circuit diagram is subjected into:

3.1.2.1 Arduino Mega 2560

It is basic component in the system of type ATmega2560. And it is a microcontroller board based on our circuit. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started as shown in **Figure 3.3**.

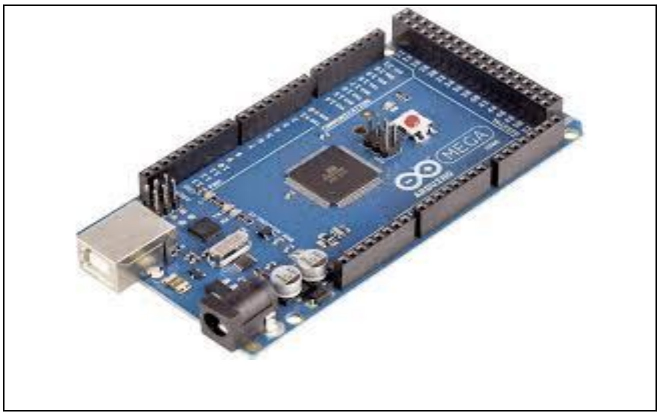


Figure 3.3 The Arduino Mega 2560.

And it can be powered by USB connect to PC or from external voltage range (**12v to 20v**), but it mainly powered by 12v to avoid heat of arduino board.

3.1.2.2 Temperature and humidity sensor (DHT22):

The controller must be able to measure the air temperature and humidity at the same time. For this a DHT22 sensor is used here. We chose it as its temperature range falls well into the range required for growing plant, which is 0-50°C It also has a temperature accuracy of ±2°C as shown in **Figure 3.4** in next slide.

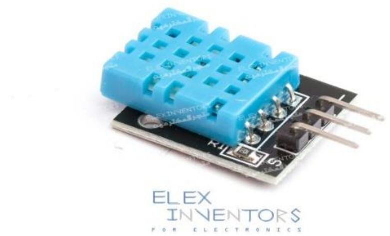


Figure 3.4 Temperature and Humidity Sensor

❖ **Specifications:**

- Humidity measurement range: 0 to 100% (0 degrees 100 degrees range) Humidity measurement accuracy (±2-5%).
- Temperature measurement range: -40 to 80°C / Temperature Measurement accuracy ± 0.5°Cdegrees.
- Working voltage 3.3V-5V.
- Output form: digital output.
- Small Board PCB Size: 3.2cm * 1.4cm and weighs about 8g.

This should not be a problem though for hydroponics. The chance of a big fluctuation in air temperature within two seconds is not very likely. It operates between 3 to 5V and the max current use during conversion is 2.5mA, and there is a table shown how it connects to the pins **Table 3.1**:

Table 3.1 dht22 pins descriptions:-

Pin	Description
GND	Ground
VCC	Between 3&5.0 V
Data	Used to get the temperature

3.1.2.3 Water Level Sensor:

The non-contact capacitive water level sensor was continuously reading '0' when it senses there is liquid at the sensor level. However, if the water evaporates or loses due to the consumption of the plants, the water level sensor outputs '1' which triggers ON the fresh water pump until it delivers water from the reservoir, so pump does not need to be turned ON frequently as shown in **Figure 3.5**.

Figure 3.5 The water level sensor component.

3.1.2.3.0 How To Wiring Water Level Sensor with Arduino

First you need to supply power to the sensor. For that you can connect the + (VCC) pin on the module to 5V on the Arduino and – (GND) pin to ground.

However, one commonly known issue with these sensors is their **short lifespan** when exposed to a moist environment. Having power applied to the probe constantly speeds the rate of corrosion significantly.to overcome this, we recommend that you do not power the sensor constantly, but power it only when you take the readings.
Connect the VCC pin to a digital pin of an Arduino and set it to HIGH or LOW as per your requirement. So, we'll connect the VCC pin to the digital pin #7 of an Arduino.
Finally, connect the S (Signal) pin to the analog pins on the Arduino.

3.1.2.4 Potentiometers

Potentiometers are simple electromechanical devices that translate rotary or linear motion into a change in resistance has been a cornerstone of measurement control and position systems for more than a century. It has three pins as shown in **figure 3.6**.
Here we select tow potentiometer one for set the temperature and the second for set the humidity are needs.
In a potentiometer, one terminal is looked up to a voltage source and the second to ground. A third terminal connects a sliding contact called a wiper that runs across a resistive track. As the wiper is moved across the resistive track the voltage is changes, corresponding to the new position.

Figure 3.6 The Variable Resistor (Potentiometer).

3.1.2.5 GSM SIM800L:

GSM module is a chip or circuit that will be used to establish communication between a mobile device or a computer machine and a

GSM system. The modem (modulator-demodulator) is a critical part here as shown in **figure 3.7** in next slid.

The GSM will sent a text message to our phone number when the tank is out of water to avoid work of pump motor continually in accordance to indicator of the water level sensor inside the pipes . And it worked by adapter 5V/2A.

Figure 3.7 The GSM Device in tow sides with it is antenna.

3.1.2.6 Cooling Fans:

The voltage a computer cooling fan receives is defined by the difference between the voltage wire (+12V) and the ground wire (+0 V). By connecting one or both wires to a different voltage, the voltage the fan receives will be different from the default 12 V the fan was designed for as shown in figures below.

Figure 3.8 The Cooling Fans.

Specifications:

- Size – 120 mm.
- Cubic Feet per Minute (CFM) -53 CFM.
- Max Rotations per Minute (RPM) – 1350 RPM.

- Pulse Width Modulation (PWM) Support – No.
- Static Pressure or High Airflow? – Static Pressure.
- Estimated Max Noise Level – 35 decibels.
- RGB Support – No.

3.1.2.7 Pump Motor:

Here we used a Homasy water pump motor because it is a lower cost and pump small water. It loses a lot of its strength when traveling vertically, used only a small amount of water flow, it work with voltage 220v as shown in **figure 3.9**.

Figure 3.9 The pump motor.

And there is a table to show some specifications about this motor as appear in **Table 3.2**.

Table 3.2 show some specification of the pump motor

GPH	Dimensions	Max Head	Noise Level	Longevity	Price
80 GPH	1.87″ x 1.68″ x 1.24″	2.6′	Very Low	3-6 Years	Impossibly Low

3.1.2.8 LCD 16x4:

These LCDs are ideal for displaying text/characters only, hence the name 'Character LCD'. The display has an LED backlight and can display characters in 4 rows with 16 characters on each row.

Here we use to display the value of temperature and humidity and light status and work with DC 5v. In next slide in details how to connect pins with arduino as shown in figure 3.10.

Figure 3.10 The LCD Type 16x4.

3.1.2.9 Relay Module (4 channel x2):

A relay is an electromagnetic switch operated by a relatively small current that can control much larger current.

Here's a simple animation illustrating how the relay uses one circuit to switch on another circuit.

This is a 5V 4-Channels Relay module, It can be controlled directly by a wide range of microcontrollers such as Arduino, AVR, PIC, ARM and MSP430.4 relays are included in this module, with "NC" ports means "Normally connected to COM" and "NO" ports means "Normally open to COM". This module also equipped with 4 LEDS to show the status of relays as shown in figure 3.11.

Figure 3.11 The Relay 4-module.

❖ **Specifications:**

- Drive current: 20mA.
- Control signal: 5V/12V/24V TTL level.
- Maximum switching voltage: 250VAC 30VDC.
- Standard interface that can be controlled directly by microcontroller (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic).

3.1.2.10 Adapter

We use it to provide the arduino enough power to operate and it powered by 12 v dc as shown in the figure below.

Figure 3.12 Adapter DC 12v.

And in more details we will show how to connect the pins with the arduino as shown in the table below.

Table 3.3 she details about Power Adapter.

Pins	2
Input Voltage	AC100-275V
Input Frequency	50-60Hz
Output Voltage	12V
Output Current	2A
Output Power	24W
Output Regulation	± 6%
Operating Temperature	-0ºC~ + 40ºC
Storage Temperature	-40ºC~ + 85ºC

3.1.2.11 Artificial Sunlight (LED strip) & Neon Lamp

There is so much hype about the efficiency of LED lights, making you wonder if they can heat a room. Regards to its high efficiency and heat, where minimal energy transforms into heat, LED Light bulbs increase a room's temperature but not much work current 12V\2A.

And addition to that if we want to increase the temperature more than 30C we use the neon lamp work with AC 220V and the figures below show the neon lamp and led light strip.

Figure 3.13 LED light & Neon lamp.

3.1.2.12 HC-SR04 Ultrasonic Distance Sensor:

It all starts, when a pulse of at least 10 µS (10 microseconds) in duration is applied to the Trigger pin. In response to that the sensor transmits a sonic burst of eight pulses at 40 KHz. This 8-pulse pattern makes the "ultrasonic signature" from the device unique, allowing the receiver to differentiate the transmitted pattern from the ambient ultrasonic noise.

And here we use it to sense if the tank is near or out of water to stop the water pump and send a message and alert to user thought the GSM module.

And the **figure 3.13** show the sonar sensor including it is pins to connect to the circuit.

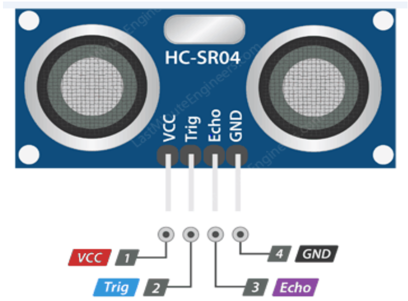


Figure 3.14 Ultrasonic Sensor And Pins.

Table 3.4 Table Show The Specifications Of The Ultrasonic Sensor.

Operating Voltage	DC 5V
Operating Current	15mA
Operating Frequency	40KHz
Max Range	4m
Min Range	2cm
Ranging Accuracy	3mm
Measuring Angle	15 degree
Trigger Input Signal	10µS TTL pulse
Dimension	45 x 20 x 15mm

Chapter Four: Results & Discussion

4.1 Introduction to Simulations and Results

In this part, simulation we are carried for the developed circuit. The digital from D0 to D54 and analogy from A0 to A15, we implemented the program and obtained the results shown in the pictures. Before wiring the LCD screen to your Arduino board we suggest to solder a pin header strip to the I2c pin count connector of the LCD screen, as you can see in the value of sensor above. To wire your LCD screen to your board, connect the following pins:

It has 14 pins, and D4 ,D5 ,D6 ,D7 ,E , Rw, Rs pin of the LCD connected as input to I2c and the ground pin and should be connected to the ground of Arduino , (VDD) pin connect to power to the module and the LCD Connect it to the 5V output of the Arduino or a separate power supply , (SDA) pin is a Serial Data pin This line is used for both transmit and receive Connect to the (SDA) pin on the Arduino, (SCL) pin is a Serial Clock pin. This is a timing signal supplied by the Bus Master device. Connect to the (SCL) pin on the Arduino.

For the DHT11, (VCC) pin supplies power for the sensor. 5V supply is recommended, (Data) pin is used to communication between the sensor and the Arduino connected to the pin (8), (GND) pin should be connected to the ground of Arduino.

Variable resistance used to set the temperature and humidity, the resistance Rv1, Rv2 connected to the (A0) and (A1) pin of the arduino. And water level sensors connect to (A2, A3, A4) of arduino pins, and for all it is pins the (S Signal) connected to the analog inputs on Arduino. (VCC) pin supplies power for the sensor, (GND) is a ground connection.

And GSM connected to serial 3. (TX) of the GSM connected to (RX) pin of arduino, and the (RX) connected to (TX) pin.

For the Ultrasonic (VCC) is the power supply for Ultrasonic distance sensor which we connect the 5V pin on the Arduino. (Trigger) pin connect to pin (D11), (Echo) pin connect to pin (D12), (GND) should be connected to the ground of arduino.

The relay's (GND) pin connected to ground, (IN1, IN2, IN3, IN4) controls the relays that it will be connected to arduino digital pins, as shown in the **figure 4.1**.

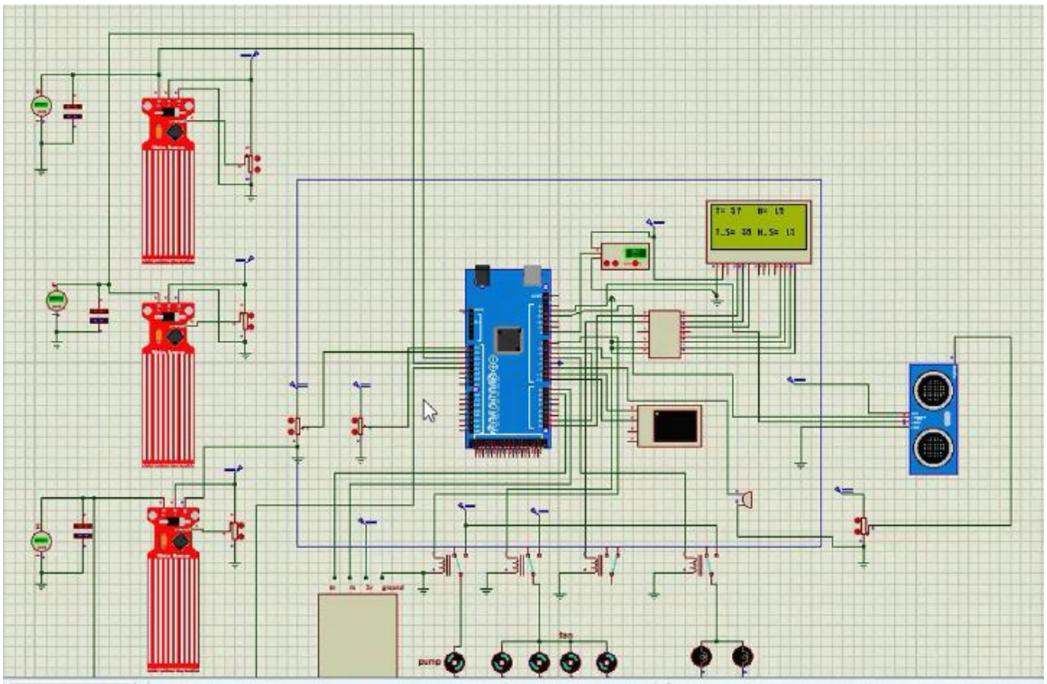


Figure 4.1 Circuit diagram of simulated system.

The figure 4.2 shows the hardware design of the general hydroponic system that shows the water level sensors inside the pipes and the position of the dht22 sensor and it will be divided into many Scenarios shown in the next slide.

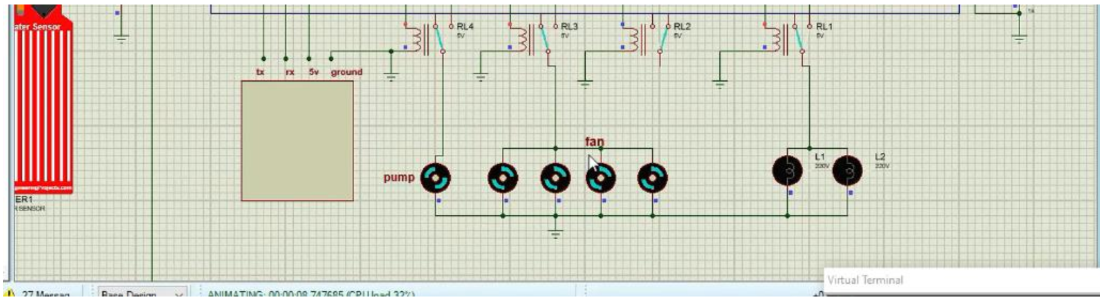


Figure 4.2 Scenario 1

In this Scenario we connect the foure fans repersent it by motors in the simulation and the foure LED by one lamp L1 and the other tow neon lamp by another lamp L2 and represent the pump by a motor and all connect to the realyes and the lamp and led work together with controlling of increasing temprature in the dht 22 and fans work when controlling the dht 22 on the humidity section , the GSM is work when the ultrasonic sensor work to indicate that the tank is empty , and send a masseg to the user, and we set the level of the water level sensor from it is potenitometer depend on the set level in the code (50) if it be less than 50 the pump will be work to reatch the set level.

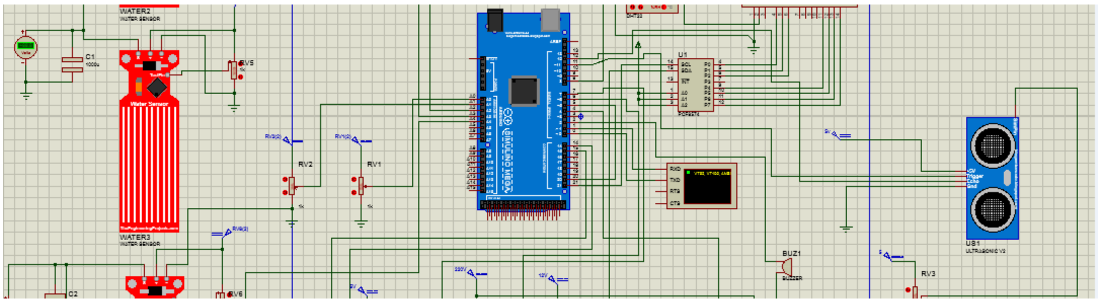


Figure 4.3 Scenario 2

In this Scenario the arduino in the middel and it take plase to controll all of this component to work togather, in the right showing the ultrasonic sensor , we connect the virtual terminal to veiw the levels of the water level sensors and the level of water tank in steps.

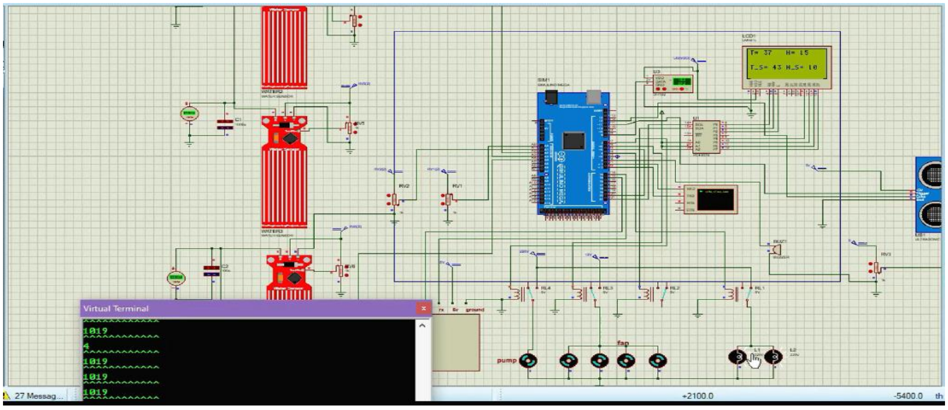


Figure 4.4 Scenario 3

Here we use in the simulation the I2C connect it to the LCD screen to reduse the nimber of bins to the arduino so it has seven input and tow output connect to the digital pins of the arduino and it displays the values of the teperature and humidity set H_S & T_S and reads from sensor T & H.

Figure 4.2 The normal humidity and temperature

The figure 4.2 shows the normal humidity and temperature in the environmental without control the inside chamber of it is humidity and temperature by fans and lamp.

4.2 The abnormal temperature

When the system work we set the temperature and humidity that needed to be controlled and the lamp will be ON to reach the temperature set as shown in the **figure 4.3** and when the humidity exceed the set humidity the led lamp will be ON and the fans OFF until the humidity set equal to humidity of the room as shown in **figure 4.4**.

Figure 4.3 The abnormal temperature

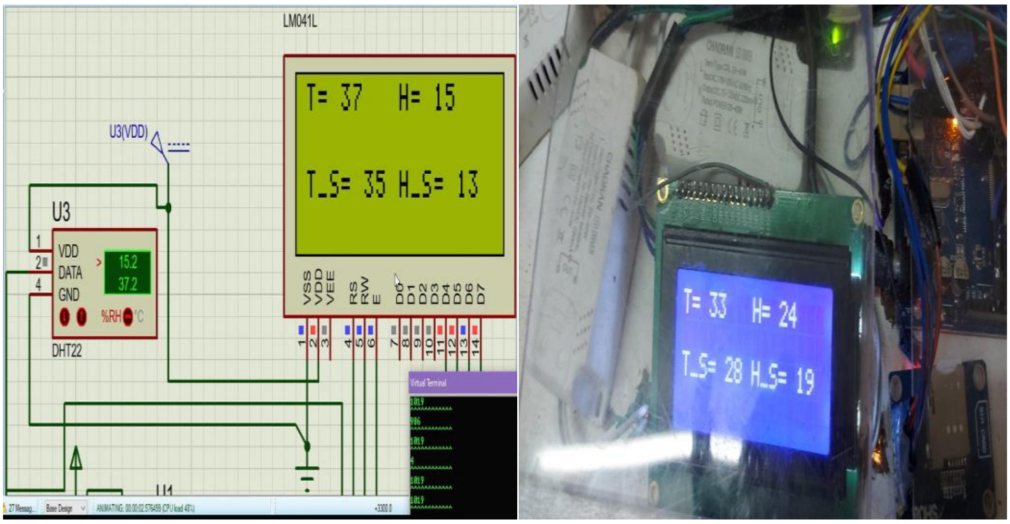


Figure 4.4 The abnormal humidity and temperature

The figure 4.4 contains the value of humidity and temperature (H, T) on the screen LCD and the set value (H_S, T_S) from the potentiometers. And the set of the temp and hum in the simulation from the sensor DHT22 itself.

4.3 Abnormal humidity set

But when the temperature room exceeds the temperature set the lamp will be off but not all it will be operate one led lamp to keep some temperature inside and the fans will be ON and that make the humidity increasing as shown in the **figure 4.5**.

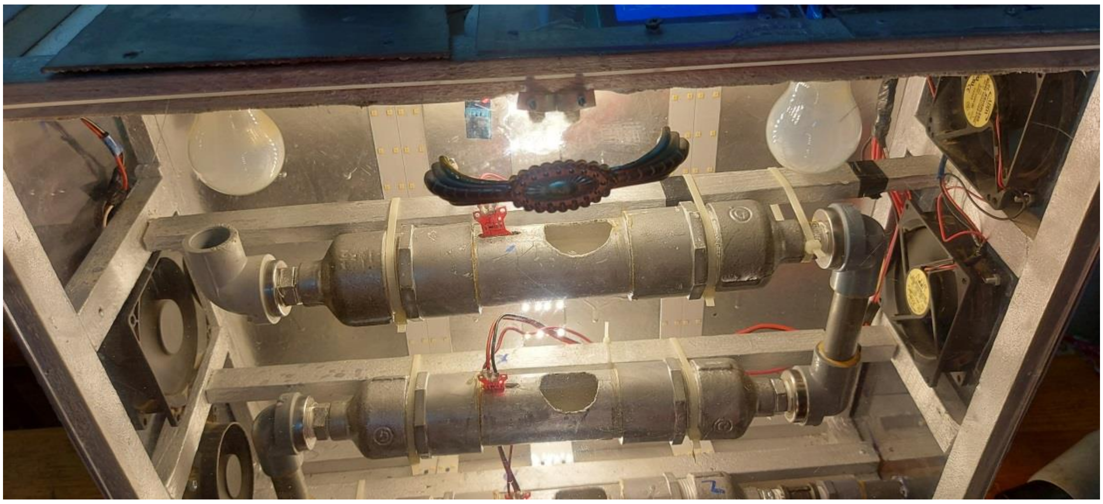


Figure 4.5 Abnormal humidity set

4.4 The hardware design and component

And the other components connected to the arduino in the design like LCD to display results and the pump motor and potentiometers to set temperature and humidity, and GSM and relays and HC-SR04 ultra sonic sensor connected to arduino as shown in the **figure 4.6** in the next slide.

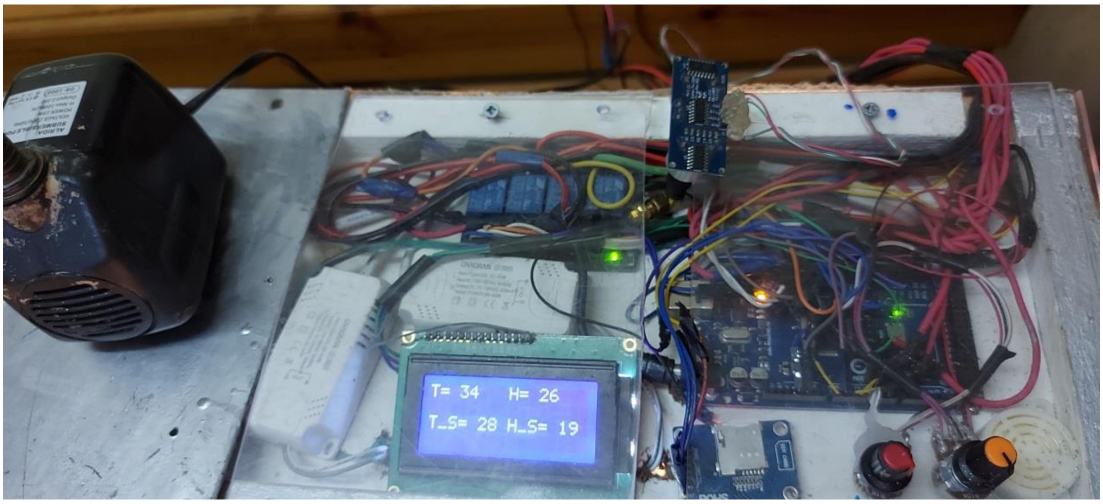


Figure 4.6 The hardware design and component

Chapter Five: Conclusion And Recommendations

5.1 Conclusion

Here we monitored our hydroponic system design in the increase of the temperature and humidity of the room so fast and decreased it but slowly because it depend on the environment of the nature. And we controlled the water flow to the plant roots just when needed for water. And we make chamber safety from cultivations and insects and, and we succeed to avoid use of soil. The fans and LEDs controlled by the DHT22 sensor, the pump controlled by water sensor and ultrasonic sensor inside the tank, the level of the tank controlled by the sonar sensor and give alert in the buzzer when no water and send a text message by the GSM when the user away.

5.2 Recommendations:

In The future the important recommend that will be developed, is to makes electric redundancy. And make the way fill the tank automatic. And make pick up part machine artificially. The detailed analysis would be stored as big data using IoT (internet of things) and it would be analyzed based on various analytic methods.

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Appendix A

1.1 Arduino Program Code:

Here the following tables shows the details about the written code:

Table 5.1: The Configurations and input and output part

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,4);
#include <dht.h>
dht DHT;
int DHT11_PIN=8 ;
int relay_lamp=4;
int relay_led=5;
int relay_fan=6;
int relay_pump=7;
int buzzer=2;
int trigPin=11 ;
int echoPin=12 ;
int duration;
int distance;
  void setup(){
Serial.begin(9600);
Serial3.begin(9600);
  lcd.init();
  lcd.backlight();
   pinMode( relay_lamp, OUTPUT);
  pinMode(relay_led, OUTPUT);
  pinMode(relay_fan, OUTPUT);
  pinMode(relay_pump, OUTPUT);
 digitalWrite(relay_fan,HIGH);
 digitalWrite(relay_pump,HIGH);
   lcd.setCursor(0,0);
  lcd.print("hellow");
 delay(1000);
 lcd.clear();
}
void loop(){
 DHT.read22(DHT11_PIN);
int t_sen=DHT.temperature;
```

Table 5.2: The LCD screen part and water sensor

```
int h_sen=DHT.humidity;
  lcd.setCursor(0,0);
  lcd.print("T= ");
  lcd.setCursor(0,3);
  lcd.print(t_sen);
  lcd.setCursor(0,8);
  lcd.print("H= ");
  lcd.setCursor(11,0);
  lcd.print(h_sen)
  int t=T(A0);
  int  h=H(A1);
   int w_m=analogRead(A2);
   int w_d=analogRead(A3);
   int w_up=analogRead(A4)
  Serial.println(w_up);
  Serial.println("^^^^^^^^^^^^^");
  Serial.println(dits());
  Serial.println("^^^^^^^^^^^^^");
  lcd.setCursor(-4,2);
  lcd.print("T_S= ");
  lcd.setCursor(1,2);
  lcd.print(t);
  lcd.setCursor(4,2);
  lcd.print("H_S= ");
  lcd.setCursor(9,2);
  lcd.print(h);
if(w_m<50||w_d<50|| w_up<50){
    digitalWrite(relay_pump,LOW);
}
else{
    digitalWrite(relay_pump,HIGH);
}
if(t> t_sen){
     digitalWrite(relay_lamp,LOW);
}
else if(t< t_sen ){
    digitalWrite(relay_lamp,HIGH);
}
 if(h> h_sen){
   digitalWrite(relay_fan,LOW);
}
else if(h< h_sen ){
    digitalWrite(relay_fan,HIGH);
}
```

Table 5.3: The GSM Part and sensors Function

```
 if(dits()<=15)
{
   digitalWrite(buzzer,LOW);
    }
  else{
   digitalWrite(buzzer,HIGH);
  Serial3.print("AT+CMGF=1\r");                //Set the module to SMS
mode
  delay(1000);
  your country code, example +212123456789"
  delay(1000);
  Serial3.print(" mohamad omer police no water");      //This is the text
to send to the phone number, don't make it too long
1\r");                 //Set the module to SMS mode
  delay(1000);
  your country code, example +212123456789"
  delay(1000);
  Serial3.print(" Nidal_ mai _Muaffag no water");      //This is the text
to send to the phone number, don't make it too long or you have to
modify the SoftwareSerial buffer
  delay(1000);
  Serial3.print((char)26);// (required according to the datasheet)
  delay(1000);
   }
delay(10);
}
int T(int number_pin){
   int value=0;
  for ( int i = 0; i < 10; i++){
int dits()
{
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin HIGH (ACTIVE) for 10 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  distance = duration * 0.034 / 2; // Speed of sound wave divided by 2
(go and back)
  // Displays the distance on the Serial Monitor
 return distance;
  }
```

THE END