# Smart Indoor Gardening System


**BY**

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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# APPROVAL

This Project titled "**Smart Indoor Gardening System**", submitted by *Mohammad Mansur Billah* *Khandaker Tanvir Ahmed* and *Afsana Khondokar Mimi* to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on *12, September 2022*.

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# DECLARATION

We hereby declare that this project has been done by us under the supervision of **Dr. Sheak Rashed Haider Noori, Associate Professor & Associate Head, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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# ABSTRACT

In the world where pollution is increasing and fertilization of agriculture is decreasing, because of natural calamities, drought, and heavy rainfall. For this situation, import of agricultural products prices are increasing very costly and it has become quite impossible for people who earn very little to buy these agricultural products and are deprived of their basic needs. To make a small effort to bring a change we proposed a method which is smart indoor gardening based on IoT (Internet of Things) which is eco-friendly, it does not need any maintenance, it can be maintained automatically when it feels the needed things such as: water, temperature, air, lights etc. By using this system one can make a very less costly, good cultivating and earn a handsome profit, also the crops will be fresh and healthy. To provide electrical supply of less cost we are using solar systems, we also use Light Emitting Diode (LED) for growth of plants as an alternative light source. In the model we have some components like ultrasonic sonar sensor, Arduino uno, as a sensor module, temperature sensor, soil moisture, water pump, and android application using Graphical User Interface (GUI). In this proposed system it sends Email notification to the user automatically when critical situations arise and informs users to take necessary steps. We have made an environmental setup which can be beneficial more than outdoor gardening and in future times it will be very much efficient for the agricultural field.

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# CHAPTER 1

# ACQUAINTANCE

## 1.1 Introduction

Our country is called an agricultural country because of its cultivation. But sometimes due to natural calamities, drought, heavy rainfall many plants can't grow properly. As a-result we have to get or bring vegetables, fruits very costly [1]. Where growing sensitive and costly vegetables are expensive to buy and to cultivate, we need to be very cautious because for those to be cultivated in the traditional way we need much space and have to make the environment friendly [2]. To make these products available and cultivated in Bangladesh we have proposed a system. By using it, anybody can cultivate and buy these products very cheaply. In this paper we have briefly described our proposed system based on IoT (Internet of Things) technology which will ease our problem. This makes the positive effects on physical, mental wellbeing for a healthy lifestyle also bring economic help in growing GDP. Because doing those products cultivate in traditional quite impossible that's why Bangladesh always import vegetables like-lettuce, capsicum yellow, Chinese cabbage, choy sum, French bean, etc. In Bangladesh, GDP of agriculture increased to 11540.50 BDT Million in 2021 from 11242.30 BDT Million in 2020. By importing those products from many countries Bangladesh has to give a big fat amount. This method is a kind of innovation in the agricultural field. By producing a plant by increasing and self-regulating using sensors and monitoring devices to control the growth of a plant conditions, automate the whole process when it needs water, nutrients, lights, temperature etc. In many countries this method is used but in our country like Bangladesh this method is new to use. There for gardening at home with a friendly environment in a short financial amount we proposed a system which is Smart Indoor Gardening [3]. Which is basically an indoor system of gardening that controls air, temperature, nutrients, pH level, water supply, and plant growth. Here we use LED grow lights because of many uses: red lights for blooming and fruits because of peak wavelength, photosynthesis, photoperiodism [4]. Blue lights for photosynthesis which enhance the activities of chloroplast helps to grow healthy leaves. White light for full spectrum to provide fill for all missing spectrums and add lux. Ultraviolet light for sterilization, reduce plant diseases, improved by long irradiating the seeds, short Rays control over growth of plants. Infrared light for heat effect which supplies the growth and development of the crops and makes the fruit mature in consistency.

In this proposed system it also uses some sensors which makes the system very strong. Soil moisture sensor is very essential for this proposed system because in our country there are many types of soil which causes problems because some soils are productive and some are non-productive [5]. So we use coco feed and if it gets dry then soil moisture detects it and indicates for generating water by water pump. Temperature sensor, we use for our proposed system because sometimes its temperature will increase though it is one kind of greenhouse and when it happens the temperature sensor gives an indication for checking temperature and balancing it by cooling the exhaust fan [6]. The majority of residential neighborhoods' tiny gardens are not covered by the roofs of the houses, making them vulnerable to adverse weather conditions like torrential rain or sweltering heat. These many environmental conditions may have an influence on the growth of the plants in the garden. The homeowner should routinely inspect this small garden to make sure the plants are growing appropriately. If the homeowner is gone for a long time, it could be difficult for them to keep a watch on their plants [32]. Ultrasonic A sonar sensor is used for monitoring plant growth whether its growth, flower blooming, or developing. In our country Bangladesh where 96 percent water is used for agriculture purposes [7]. To make these products available and cultivated in Bangladesh we have proposed a system. By using it, anybody can cultivate and buy these products very cheaply. In this paper we have briefly described our proposed system based on IoT (Internet of Things) technology which will ease our problem. Many irrigation systems are available now that operate using an automated system. However, the system cannot be installed in a small home garden because of the high cost of the equipment. A sophisticated and expensive computer is required by the drip irrigation that several researchers have devised to track plant development [33]. So, everyone should try to save the wastage of water because usage of water is also increasing. If we don’t take necessary steps then one day our country will be a desert like India’s many regions. In traditional gardening there always should be someone to [8] water the plants which is quite tough because sometimes the caretaker of the plants forgets to water the plants from time to time [9] [10]. For watering the plant the caretaker needs a daily routine of watering the plants which is very troublesome [11]. Here we proposed a system which will automatically pour water when needed by giving notification to the user and if the watering level is filled then it will again give the notification to the user and by automation it will stop pouring water [12]. In this era where getting electricity is rare, many people are using solar panels to supply power in this system which conducts [13] everything to provide power in our whole system. Using the same traditional way of the agricultural field we try to break the chain and try to bring out a different system which we proposed in this paper [14]. This process can be done in a small [15] space by not taking much space, saves much money, reuses water, reduces insects, no use of pesticides or chemicals and is highly energy efficient [16].

## 1.2 Problem Statement

A rising number of new services and technologies are being created to help urban agriculture, all with the goal of enabling effective food production, from Grove Lab's Eco - system to a MIT Open Ag project. The majority of these systems, however, have the same fundamental problem in that they necessitate close both hardware and software interaction. Despite the fact that this is appropriate given the complicated way that hardware and software interact, it does provide considerable entry barriers. Although Grove Labs' ecosystem's vertical integration results in a rather basic and uncomplicated user experience, it nevertheless limits users' control over the plants they grow and what happens to their data. On the other hand, the MIT Open Ag project allows users to customize their system any way they see fit, but it does so at the expense of in-depth electrical engineering, systems engineering, and manufacturing knowledge. As a result, the primary objective of the project was to create a system that would enable users to customize their own configuration without needing a graduate degree. We can better encourage research and experimentation if we decrease the entry barrier to urban agriculture.

## 1.3 Solution

The solution was to create a hardware-independent, open-source internet platform for controlling hydroponic growing systems and gathering data. In order to demonstrate the system's possibilities and serve as a potential foundation for other users to build upon, we intended to develop a hardware system that interacted with the software platform.

## 1.4 Scope

The project's objective was to provide assistance in situations where accurate plant data collection and environmental maintenance are essential, including in researching, commercial, or testing contexts. That is not to say that they are the only situations in which the system may be utilized; rather, user research carried out as part of the project demonstrated that these were the most pertinent use cases for this type of system.

## 1.5 Target Users

We were able to categorize the target users of the system, who both have a keen interest in growing plants, based on consumer research we conducted at the beginning of this development.

**Botanically challenged but technically inclined:** This person is familiar with information management and has little experience dealing with plants and is unsure of what they require or how to best assist them. This user is mostly interested in research and experimenting since they are familiar with information extraction and analysis but want a simple entry point into hydroponic farming.

**Botanically inclined but not technically inclined:** This person knows the needs of plants and is interested in precisely documenting data about them, but lacks the technical competence to build up automated systems on their own. This user is mostly interested in using technology to assist their current activities in research or commercial applications.

## 1.6 Literature Review

Nature is a blessing for the world where many people are busy in their day-to-day life constructing their empire by cutting trees. Which hampers our environment, especially decreasing our mental-health. Here we discuss about COVID-19 how it impacts our life physically, mentally, financially and for this reason almost 80 percent of people stay in their house for lockdown and it makes us understand the greenness in the home and the surrounding environment and the nationwide physiological effect in Italy. By doing a survey they understand

by sitting at home where no greenness is present their life becomes more irritable, facing sleep disturbance so they proposed those of hydroponic systems where they can make a small home garden which removes their monotony, sleep disturbance, anxiety, anger etc [17].

Food is a basic and foremost important thing in human life without which no people can survive. In the world where population growth is increasing rapidly and it cannot give enough agricultural products by traditional gardening so they proposed a greenhouse project which they make it with Arduino by connecting it with an android application where they can automate the greenhouse farming [18] condition by regulate it of the database of the plants by making optimum temperature, humidity, light, soil moisture. And this project is 40 percent more efficient than traditional farming.

In the paper here is used a smart home gardening system which can gather real-time data with various parameters used in gardening systems. It is generally a cloud based IoT technology which implement in VANET cloud where there is set sensors of humidity, temperature, fertilizers, compositions first it takes plants sensor for gathering data in data center then transfer it to data analytics then transfer it to controller then the further process will continue like this [19].

In this paper they discussed how to work in the Internet of thinking and other new generations of technologies where they try to use every sec information of smart gardening by making big data and analyzing it when the temperature, water supply, humidity is necessary and giving it properly by monitoring many new technologies [20]. Increasing population where human accommodation is getting shortage farming in traditional ways is becoming too tough so, in this paper we propose a method of indoor gardening by making short spaces in gardening by an android application which will notify when sensors give alert [21].

Watering in plants sometimes is so irritable because one cannot always check through seeing so, in this paper they describe the irrigation system for allowing water when it is needed. For this they used soil moisture sensor, ultrasonic sensor, light sensor and also used a solenoid valve for checking the moisture of soil and controlling it for human requirements. It conducts Graphical User Interface (GUI) by android application for watering activation and notify via email when required [22]. Power supply is a very important part in any system and when it is indoor gardening then it is a must. In this paper they propose indoor gardening while they use Raspberry pi, temperature, humidity sensor modules, for power supply use solar panel and to see the plants update and to notify via email use Blynk mobile application [23]. Gardening is becoming very popular day by day where watering and soil moisture checking

Physically it is much tougher than doing it through a smartphone. So here they proposed the Internet of Things (IoT) an established home-based system by which watering plants, checking light publicity, water level checking whether it is full on tank or not and monitoring it through an application which is controlled by the user through smartphones. Which makes less time complexity and does the work automatically [24]. Like Bangladesh agriculture is also very much important in India where many people's earning source is this. In Indian Agriculture they get 16% of total GDP and 10% of total exports. Water is too much essential for living being which is also applicable for plants but checking of water level whether it is time to give water in manually is much harder. That's why they proposed a smart irrigation system using the Internet of Things (IoT). In that system they used a temperature sensor, humidity sensor, soil moisture sensor which automatically notified by user devices when water should be given. Because in manually given water too much water is wasted and this system utilizes it [25].

Agriculture in the traditional way is getting tough day by day because of a lack of fields. To solve this problem, they proposed roof agriculture by using a smart irrigation system which will give water by monitoring automatically. In this era where many people use many kinds of medicines and pesticides which makes the crops or vegetables harmful, making use of this system anybody can produce their own vegetables or crops and it will be healthy. Besides, watering plants manually cannot get the proper information of plants whether or when needed and how much quantity provided can make plants grow properly [26].

(SOA) which in full form is Service oriented architecture an undeveloped automation that helps many applications via communicating by conversing one, contribution data and service over provider also give the description of intermediary and service requestor. Here they proposed a smart indoor gardening system with web services of combination that is Internet of Things (IoT). This helps to evolve, expand, combine and also do collaborative framework through plant growth by many services. It also measures soil moisture, nutrients, regulating water management of plant rise and also complete characteristic fertilizer and make environmental dependability and continuous maintenance [27].

ATMega328P is a kind of microcontroller which automatically controls its functions to control data, record it and save it. Here they proposed that the automatic pitcher irrigation system is the combinational development of hardware and software. Hardware consists of a sensor, which is basically a series of soil moisture sensor, microcontroller, stackable SD card shield, real time clock, relay, battery, solenoid valve, a program called software where the microcontroller is used in C/C++ language. Single sensor is examined very precisely since used. Statistics of water layer and soil moisture are taken in 5 minutes and updated in the microcontroller through memory by recording it. By seeing the result, the microcontroller's high-level water and soil moisture monitoring accuracy is high. And the association of coefficient equations from high water level is 0.955 and from soil moisture sensor is 0.887. Controlling the water layer point abide 5 cm base edge along with 14 cm primary edge [28]. In our lives gardening is not only an income source but also it helps humans to improve mental-health. Here they proposed an irrigation system which combines Internet of Things (IoT) and android apps by monitoring plant growth. It takes real time data by monitoring and also provides the system control. Basically, IoT is a mutual network of objects which interact with each other. In this paper many sensors have been used for many reasons-feel the moisture of soil, analyze humidity and temperature, detect light depth and measure soil temperature. Collected data is received from sensors by using cloud with wireless transmission. The system controls irrigation systems which supply water through mobile apps. As a light source they used light- emitting diodes or UV LED. For control of air purifying systems which give oxygen in the greenhouse and clear away carbon dioxide [29].

Traditional gardening is a very popular and most used method but, in this Era where technology has invented many things which makes life very easy. Here they proposed a smart irrigation system which controls the water supply when the plants are needed. It also controls the wastage of water because in traditional gardening controlling water is not possible because there is no scope of controlling water. In the system when the plants need water or not will be notified to the users. Also, many sensors have been used here which measure soil moisture and air moisture which detect soil and air temperature in that field [30].

Here, in this paper they have proposed the method of soil sensor which helps soil moisture for planting plants. Here they used FC-28 soil moisture sensor and Arduino uno as microcontroller which audited the soil humidity and also did the sprayer of plants which helps plant to moisture soil by using web server. It will help the farmers know the soil moisture of the plants [31].

# CHAPTER 2

# OFF-STAGE STUDY

## 2.1 Background Study

In our life we learn many things and apply them in our day-to-day life. So many papers we learn many techniques of smart indoor gardening. We learn about an indoor smart home garden irrigation system where water will be given by using sensors and raspberry pi and will notify automatically. By using this we can save water and use it when needed. We also learned about a new hydroponics system using solar panel sensors which will give better yield growth in a short amount. Also, we learn about green-house projects which help to grow agricultural products very nicely with less cost using Arduino and some sensors.

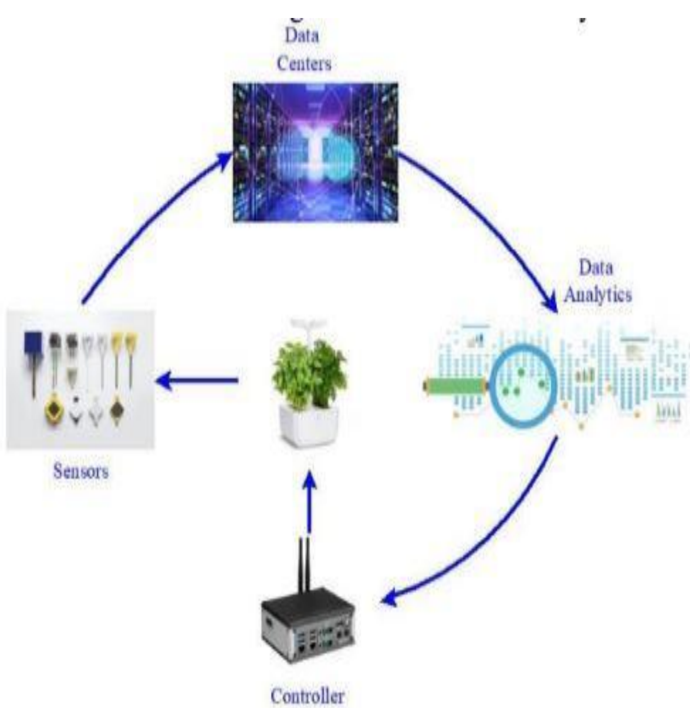


Fig 2.1: In SHGMS, IoT is being implemented.

## 2.2 Rational Study

By knowing many systems, smart indoor gardening is such a system where creating a garden and planting plants is much easier because it takes a small amount of space. Many people make many systems of smart indoor gardening. Some make greenhouse system using sensors and Arduino by which yields grow rapidly, some make irrigation system by watering plants when necessary it gives an indication of how we can save water from getting wastage and make it proper use. Some make hydroponics systems by which people can monitor soil moisture, temperature, water usage, lights by getting notified via email and make everything under control for plants growth. It gives directions on how anyone can do home/indoor gardening. Some people make alternative ways of not using electricity for power supply rather than using solar panels which will be budget friendly and also helpful where load shedding happens frequently. It indicates how we can save electricity in gardening and make indoor gardening with less electricity because in many countries, electricity is an issue. Also, in this system using many sensors and components one can monitor it outside the house also which will make less time assumption and one can do it with less time in it.

## 2.3 Available Systems That Are Use In Present Time

**Aeroponics:** Aeroponic systems only use nutrient-rich mist to feed plants. The idea is based on hydroponics, which entails that the roots are kept in a soilless growth medium, such as coco peat, and nutrient-rich water is pumped over them on a regular basis. In aeroponics, the growth medium is simply eliminated, allowing the roots to hang in the air and be regularly puffed by specialized misting equipment.

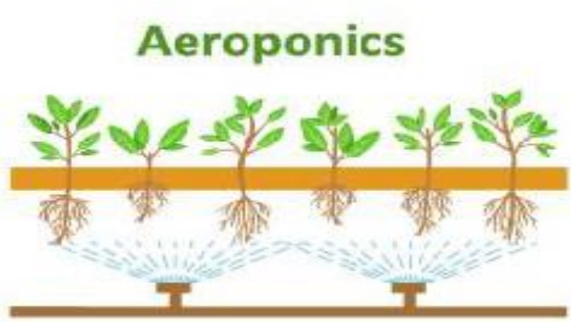


Fig 2.2: Aeroponics

**Deep Water Culture:** In deep water farming, sometimes referred to as mains water cultivation, the roots of something like the plants are continually suspended in water that is nutrient-rich and highly oxidized. Contrary to other hydroponic farming methods such as the flood and flow technique, drip method, and aquaponic where the plant is only completely exposed to water, the emphasis is still on total submersion**.**


Fig 2.3: Deep Water Culture

## 2.4 Our System and Its Purpose

**Our System:** In hydroponics, crops are grown without the need of soil and instead in nutrient-rich water that serves as the plant's root system. This ostensibly little change in how we generate food (by excluding the dirt, that is) is nevertheless a revolutionary one since it enables producers to grow food anywhere on the globe, at any period of the year, and to get a larger rate with fewer resources. In actuality, hydroponic systems consume less water than conventional soil-based ones. In hydroponic systems, water is continually recycled rather than being lost through filtration, nutrient replenishment, and feeding back to the plants. Our solutions at Vertical Roots utilize up to 98% less water than conventional systems that are based on soil.

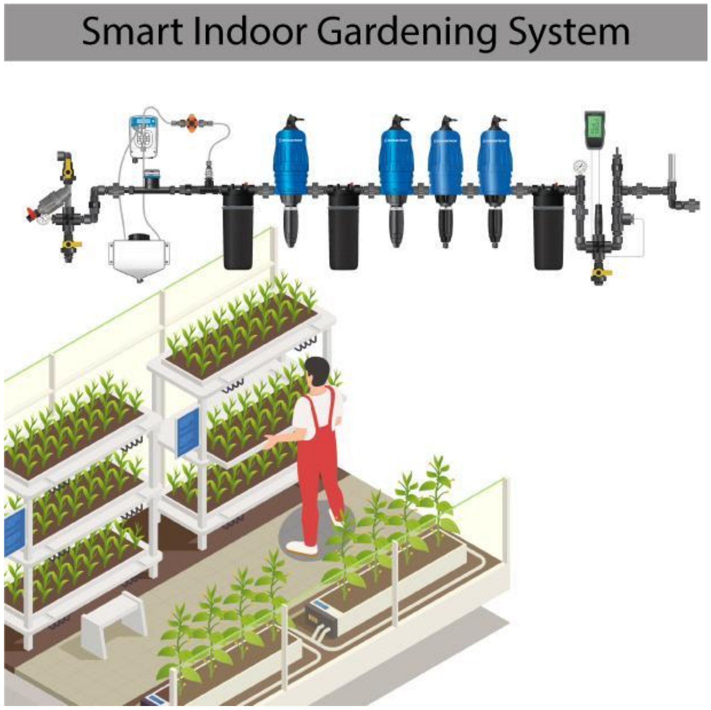


Fig 2.4: Our Smart Indoor Gardening

**Purpose:** In the era of digitalization where everything is coming closer to us traditional farming is becoming tough day to day life because of many reasons. But sometimes due to natural calamities, drought, heavy rainfall many plants cannot grow properly. Besides the increase of population and environmental pollution we have a very shortage of land for this reason. In the next decade there will be land problems and traditional farming will be time consuming. So, we proposed this system to give an alternative chance of farming by doing indoor gardening. In a country like Bangladesh where the population is increasing day by day, supply of food or agricultural products among consumers is quite impossible. For this reason, product prices become quite expensive and it creates an imbalance in the market. So, we propose smart indoor gardening where we can get or produce enough agricultural products. In Bangladesh where we have different types of soil it is costly, in our system, we are not using any soil as an alternative we are using coco feed which will reduce the cost of farming. We also have space problems because in traditional farming we need a lot of space for farming but in our system, we can set up the environment by using a rooftop bucket. Also, it can be done in cities which can provide agricultural goods and unemployment problems can be mildly solved. Also, we do not need to worry about lights because we are using LED grow lights in which traditional farming cannot provide lights every time and our system can. And by this, plants it will grow two times faster. It will also lower transport cost because it can be applied in every house and everyone can get fresh agricultural products. It also saves water consumption because in our system we generate pumps and reuse water when it is needed. By considering overall possibilities we can assure that our system is very efficient, less time consuming and budget friendly.

## 2.5 Key Features of Our System

1.Our system is eco-friendly.

2.It saves money.

3.In this process it will not take much space.

4.It saves electricity because here we are using solar panels.

5.This project is budget friendly.

6.It will give a good profit.

7.Minimise water usage.

8.Unaffected by adverse weather conditions.

9.No chemicals or pesticides.

10.Reduce transport costs.

11.Highly energy efficient

**Features Description:**

**Less fertilizer & nutrient:** Which system we are using needs less fertilizer because our environment setup will be closed so this cannot affect plants and we use coco feed so nutrient loss will be less than any other system.

**Saves water usage:** In our system when a pH meter gives a signal for water changing, pumps automatically generate water by which its usage will happen when needed and it saves water by reusing it.

**Save space:** Using the system the process will be done vertically which can be done in small portions which saves much space.

**Costing be budget friendly:** Our system's cost will be budget friendly because in this system we use very good components which are cheaper than other components as we have to notice the budget.

**No unnecessary weeds:** In that process we make a system where growing weeds is never possible because it’s monitoring automatically and by chance if it happens then it will notify via email.

# CHAPTER 3

# ACCORD

## 3.1 Motivation

This project's inspiration came from all of the client research that was done for it. This initiative got its start after learning about people's worries and also being able to address some of them by creating this system.

## 3.2 Research Question

The elemental study objectives for such a research project were based on the notion that people who practice indoor urban farming would want to automate as much of their growth as feasible. The original goals were defined based on this premise and focused on researching customer demands in the indoor farming arena. The primary objective was to discover existing solutions, how consumers utilize them, and possible chances for the system to improve on those solutions. We were willing to concentrate on three primary research issues as a result of our emphasis on user demands and differentiation opportunities:

- **What are the most common user complaints about current systems?**
- **What part does technology and innovation play in their development?**
- **What are the important metrics that users care about?**

## 3.3 Differences between existing and our system's features

Table 3.1: Differences between existing and our system's features

| | Existing Features | Our System |
|---|---|---|
| 1 | There is no work where a pH meter is used for monitoring water pH level which can prevent plants from growing. | Here in our proposed system we use a pH meter which gives the information of water quality by which we can handle the pH level of water and plant growth will rapidly increase. |
| 2 | In existing works there is no use of a sonar sensor which is a very important component for plants growth, blooming and flowering. | We use sonar sensors in our system for monitoring plant growth, blooming and the consistency of fruits which will notify us. |
| 3 | Most of the work we have seen them working with normal LED lights for indoor gardening. But this is not very beneficial for good production. | Here we use LED grow lights which helps to plants for photosynthesis, gives lights, helps plants for production, fruits, blooming, develop chloroplast, adding lux, make fruits mature by consistency and reduce diseases. |
| 4 | Most of the work we have seen uses one layer for gardening which does not reduce much space whether needed very much space. | Keeping in mind our system we use it vertically where we have made three or four layers for gardening and try to save space. |
| 5 | Use normal electricity. | Solar energy. |

# CHAPTER 4

# RELATIONAL STUDY

## 4.1 Work Related on This

Over time, hydroponics has changed and become more popular. This technique is being used for agriculture all over the world since it has become so successful and valuable in today's society. It has helped to eliminate all prior restrictions on farming. We no longer require big agricultural plots or very fertile soil thanks to hydroponics. In addition, compared to conventional agricultural methods, hydroponic agriculture produces far better growth results. However, the challenge still exists because agriculture is still physical labor, and few younger folks in coming generations are eager to take it on in today's highly competitive and digitized society. Due to this issue of avoiding hard labor, there is a food scarcity in many parts of the world. In certain areas, there are people who work in agriculture, but traditional agricultural methods pollute the land and water supplies, making them unfit for use in the future. All of these issues push us to create an automated solution that does not require manual labor in the fields yet does not harm the environment. People are now focusing on creating agriculturally automated systems as a result of all of this. These systems mostly depend on hydro farming.

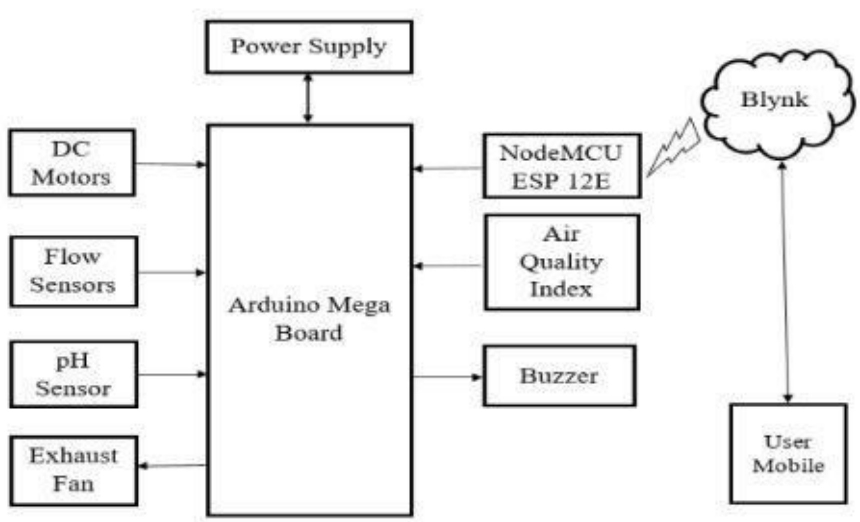


Fig 4.1: Hydroponics System Block Diagram

## 4.2 Open Agriculture Initiative at MIT (Open-AG)

One of the earliest automated hydroponic farming systems was called Open-AG. The business was started by Caleb Harper in 2015. The MIT Media Lab is where the product's design process began (Massachusetts Institute of Technology). This project aims to create a framework for agriculture in a controlled environment. This project, or the systems created for this agriculture platform, is known as "Food Computers." These food processors operate on a range of scales. These specialized systems can be used for a variety of tasks, including as experimentation, private use, and even instruction. Both the hardware and software used in this project are open source. All of this information is then used to control all the internal and external factors necessary for plant growth. Experts and researchers carefully monitor and scrutinize every other component of the food computers [4].

Participants may keep records of their situations, data, and study on the open-source platform, and the predefined formulas for each plant's roots can be shared to anyone who is interested. The fact that anything may now be cultivated in these constrained spaces regardless of temperature or other factors suggests that this is a clever technique to improve climatic conditions while simultaneously lowering transportation costs. Large agricultural holdings are no longer necessary for us to rely on. With the help of these food computers, we can buy fresh veggies even in the middle of a city [4].

Fig 4.2: City Farm at MIT

- **Food Computer**

As previously mentioned, the Food Computer enables us to design a stable environment in urban agriculture that employs a large number of mobile bots to monitor and regulate external factors like energy and climate. Additionally, these food processors keep a close check on how the plants are growing in the chamber. Carbon dioxide, hydrogen prospective, atmospheric temperature, electrical properties, humidity, underlying cause temperature, and dissolved oxygen saturation are among the climatic elements that need to be controlled and monitored. In addition to the functions already described, detectors and electromagnetic meters are used to track the levels of minerals, metabolic rate, and water. Most of these properties may be changed during the study and experiment using sensors and chemical doses provided to the plants [5].

Now that we have considered all of the aforementioned characteristics, we may put together a number of advantageous arrangements, and any such advantageous configuration can be viewed as a meteorological recipe. Each of these formulas will result in a different agricultural production for a particular plant. The same type of plant may differ in terms of height, production, taste, nutrients, texture, and rate of development when grown in varied climates. This helps the researcher find the best recipe for a particular plant. In order to evaluate plant growth and health, these food processors may also be used to mimic drought or other comparable conditions.

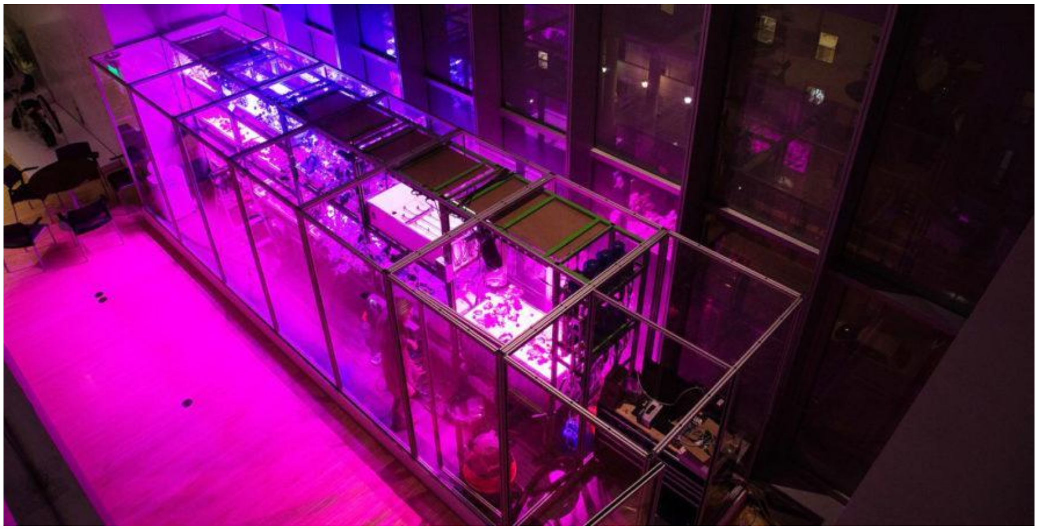

Fig 4.3: Food Computer

Figure [4.3] depicts a food computer that is now in use.

We may make food computers in a variety of sizes, and they can be grouped into the following categories based on their size:

- **Mini Food Computer**- The purpose of this, the smallest food computer, is to construct miniature environments for experimentation and research in biology, chemistry, botany, and environmental sciences. These gadgets can be used for leisure activities or by students to learn [5].

- **Food Server**- The intermediate size is intended for people who want to begin a little research endeavor. They can be used by small-scale producers, such owners of cafeterias or restaurants, to cultivate modest quantities of fresh produce that can be included into the food they make and serve.

- **Food Datacenter**-

The objective is to produce enormous food computers that can actually aid in the restoration of agricultural fields, albeit this magnitude is still under development. Because it will resemble a huge warehouse where food may be produced without restrictions for industrial purposes, it is referred to as a datacenter. The land will be divided up into several subdivisions in order to allow different crops to be produced in each area according to their own needs for maximum growth [5].

- **Environmental Recipes:**

As the world becomes more globalized, food production and distribution has grown in importance. Today, all food producers rely on monocrop farmlands, which produce and distribute massive volumes of product all over the world. Almost all of the time we are unaware of it, yet the food we consume is normally grown hundreds of kilometers abroad and arrives days, if not months, after it was harvested. Importing goods from where it is produced increases the cost and, as a result, lowers the food quality [5].

The system comes with a number of standard climate recipes that may be imported by the user. Almost all of these recipes have indeed been studied and tried for the provided plants to ensure the greatest results, but they can be modified and changed by the user as needed to achieve the desired outcomes. As previously stated, the environment inside these chambers may be precisely regulated, allowing for higher yields. The system also keeps track of the growth and outcomes obtained using a fresh climate formula. All of the revised recipes are recorded in an open-source database, and new users from all around the world can access them as needed [5].

Vertical farming in a food computer using hydroponics helps in growing food in urban places while also reducing carbon emissions. The amount of water utilized for agriculture has also decreased significantly. Because the transit period is substantially decreased, the food given to the end consumer is much fresher. It also aids in the reduction of risk from external variables such as climate change, droughts, and so on [5].

- **Ecosystem Grove**

A fresh idea called The Grove Ecosystem has only lately entered the market. With a few minor variations, the idea is similar. It is less constrained than Open Ag and concentrates more on the daily needs of the user. At MIT, The Grove Environment was also developed. Its designers assert that it is the first intelligent indoor garden ever created.

The Grove environment uses aquaponics, a technique for implementing an indoor agricultural system. Similar to hydroponics, aquaponics grows plants using minerals and water from aquariums rather than simply water and minerals. The bacteria and fish excrement in the aquarium provide the minerals, while the aquarium's water helps the plants grow. This combination of aquaculture and plant farming generates an ecosystem in which every component of the system is interdependent. The fish as well as other aquarium residents eat the plants that have grown in the system, while the plants depend on the tank and its occupants for their needs in water and minerals.

This method may be used to grow small quantities of lettuce, tomatoes, peppers, and other similar plants and fruits. The system has its own plumbing and LED lighting, which is very energy-efficient and makes sure that everything works as it should. For monitoring and managing the Grove ecosystem as well as assisting users in the growing process, there is also a Grove System and a mobile app. The Grove Ecosystem may help individuals develop and fulfill at minimum all of the daily salad needs when it is utilized to its fullest extent. Customers are welcome to use this system as a decorative element in their houses because it was built with aesthetic considerations in mind. It also makes it possible for fish lovers to have aquariums and pets [6].


Fig 4.4: A prototype of the Grove Ecosystem

In Figure 4.4, a model of a grove ecosystem is displayed. The developers of this system assert that it may be utilized in the bed, dining, or even in the living space [6]. It can be seen that it looks to be a quality cabinet. The system's lighting emits light at wavelengths that are most advantageous to crops. These lights are intended to match the light wavelengths that plants would get throughout the year should they be grown outside. You could control the illumination and watering schedules using a smartphone app. Users of the apps may access extra lessons to help them learn about the requirements of different plants and systems. Upon release onto the market, Estimated retail price for the Grove Ecology is $4,500. The company intends to start shipping in March 2017 [7]. Even though the Grove Ecosystem is very user-friendly and extremely promising, there are some things to be cautious about. You will need to pay $4,500 for the system. Some people are unwilling to invest so much money in a gardening system. Additionally, a pre-configured kit is provided, and customers are not allowed to modify or explore with the system [7].

### 4.3 Hydrobase

With the two planned systems mentioned above, there are a number of problems, the majority of them are related to how user-friendly the applications are. This is where Hydrobase started. Both Open-AG and Grove Ecology have systems in place which make it available to its customers. As a consequence, if a user wants to build their own little indoor garden from scratch, then they might not be able to. These systems are unable to be adjusted in or out to accommodate user demands. Additionally, the Ecosystem offers the user a selection of certain hard-coded fundamental plant characteristics. Additionally, due to security concerns, the user's information is frequently either inaccessible or missing, making it difficult for them to utilize the system. With the use of open source, low-cost technology from Hydrobase, anybody can build their own hydroponic growing garden. The user can start with the most fundamental sensors and then add more as necessary. The only expenses related to the system are the sensors and setup.

# CHAPTER 5

# METHODOLOGY

## 5.1 Methodology

Here in this, project we have proposed a system which is very effective and user friendly and its purpose is to make indoor gardening easy. Our proposed system consists of some components:

Specification and Activity:
Smart indoor gardening builds a model of the project.

Table 5.1: Hardware and Principle of adoption

| Hardware | Principle of adoption |
|---|---|
| Arduino Uno R3 | To control our whole smart indoor gardening. |
| pH Meter | It justifies the water quality that we use for plants. |
| Sonar Sensor | Uses it for monitoring plant growth and the other use of this sensor is measuring water level of the reserve water tank. |
| LED Grow Light | Uses it to help plants for production, fruits, blooming, develop chloroplast, adding lux, make fruits mature by consistency and reduce diseases. |
| Humidity and Temperature Sensor | Uses it to measure the humidity and temperature of the system. |
| Soil Moisture Sensor | Use it to detect soil's moisture. |
| Adjustable Cooling Fan | Use it for cooling the temperature and humidity in the system. |
| Water Pump | Use it for watering the system. |
| Solar Panel | Use it for electricity as a power supply. |

## 5.2 Hardware description

**i)Arduino Uno R3:** The Arduino Uno R3 microcontroller uses a detachable component called a dual (DIP) ATmega328 AVR microprocessor. It contains 20 input and output digital pins, of which 6 are PWM output and 6 are analog inputs. It may be programmed using the subscriber Arduino computer software. The Arduino is widely advertised, making it a simple way to start experimenting with embedded electronics. The third iteration is the Arduino Ide R3, which is the most recent.

**ii)pH Sensor:** A pH scale is a scientific tool used to determine the acidity or alkalinity of hydrogen-ion solutions in water by expressing the results in pH. By using electrical potential, it simply compares the differences between the pH electrode and the reference electrode. The ionic transport range is between (10–6) and (10–8) mol/cm2. It uses the DIN 19263 standard meter. The range of the pH meter's parameter (0–14), where a pH of less than 7 indicates acidity and a pH of more than 7 indicates alkalinity. pH meters are used in a variety of industries, including agriculture for measuring soil, municipal water supply water quality, swimming pools, environmental cleanup, brewing wine or beer, manufacturing, healthcare, and therapeutic research like blood chemistry.

For pH measurement in our system, we utilize a digital pH sensor with the following specifications: interface type pH 2.0, length 43 mm, width 3200 mm, weight 68 gm, measuring range 0-14pH, measuring temperature 0-60°C, accuracy +-0.1 pH(25°C), response time 1 min. Here, we utilize it to determine whether the pH level of the water used to grow plants is rising or falling because if it is, the output of plants will never be grown adequately. This sensor is primarily made for Arduino controllers, gravity connections, and a number of other characteristics that make it easy to use. It offers various advantages, including easy usage, low cost, and water quality testing. We utilize it in our system because of this.

**iii)Ultrasonic sensor:** It is an electronic gadget that uses ultrasonic sound waves to identify the distance of the specific item before turning the signals into electrical ones. We use it in our system to know the wavelength of the plants whether the plants are growing or not properly and also detect the water level if it is in the proper level or not. Here we have used an HC-SR04 ultrasonic sensor whose operating voltage is 5V, frequency is 40000 Hz, weight 9 gm. We use it because it has many benefits like its better performance, high density, small blind density, accurate distance measurement.

**iv)LED grow light:** It is called LED grow light because it produces growth of plants through lights of LED chips which is very modern and efficient in absorbing dignitary. We use LED grow light because it helps plants for production, fruits, blooming, develop chloroplast, adding lux, make fruits mature by consistency and reduce diseases. LED grow light is a combinational set of (red, blue, white, infrared, ultraviolet) lights. These lights have many advantages in plant growth and food production. Normal LED lights only help to produce photosynthesis for growing plants but LED grow lights do many things for plant growth.

**Red light:** In red lights 40 pieces are attached to an LED grow light which is (610~720) nanometer. Red lights are very important for plant growth and improvement. Red lights help plants to bloom and fruits which indicates plants growing properly. The peak wavelength for photosynthesis and photoperiodism is 660nanometer.

**Blue light:** In blue lights 14 pieces are attached to an LED grow light with a range of (400~470) nanometers. Blue lights are important for photosynthesis, increase chloroplast for plants' fresh leaves so that plants grow swiftly and also help increase plants' growth rate.

**White light:** In white lights 14 pieces are attached to an LED grow light which range is (400~700) nanometer. It helps plants to contribute full-spectrum/Wide Kelvin to supply the lost spectrum and also add lux.

**Infrared light:** In infrared lights 2 pieces attached in LED grow light which range is 730nanometer. Infrared light has heat enforcement which helps suppliers for crops growth and improvement and make fruit persistent mature.

**Ultraviolet light:** In ultraviolet lights 2 pieces attached in LED grow light which range is 380nanometer. It helps plants for sterilization function properly, reduce plant diseases, long irradiating seeds, and the growth of plants can be controlled by less ultraviolet rays.

**v) Temperature sensor:** It is a gadget that measures how cold or hot something is and turns that information into an electrical signal. A thermistor is employed in this system to gauge if the surrounding environment is ideal for plants by measuring the temperature.

**vi) Soil moisture sensor:** The water content of the soil is measured using a soil moisture sensor. Many soil moisture sensors make up the sensor probe. A frequency domain sensor, including a capacitance sensor, is a typical form of soil moisture sensor in commercial applications. Sensors that are inexpensive—often used for the resistivity of the soil is measured by two electrodes in the residence. Sometimes this consists of various bare (galvanized) cables, however probes with wires also available in gypsum are embedded.

In order to operate their irrigation systems more effectively, farmers in the agricultural industry must evaluate the soil moisture. By properly controlling soil moisture throughout critical plant growth periods, farmers may increase yields and crop quality while using less water overall. Other than agriculture, many different applications employ soil moisture sensors. A growing number of golf courses are utilizing sensors to increase the effectiveness of the irrigation systems and stop overwatering as well as the leakage of fertilizers and other chemicals off-site.


Fig 5.1: Sensors Using in Smart Indoor Gardening

## 5.3 Software description

Table 5.2: Software and Principle of adoption

| Software that we Use | Principle of adoption |
|---|---|
| Mobile App Blynk | Cloud service which belongs to Internet of Things |

Blynk is an IoT based software which is based on a framework using Raspberry pi and Node-MCU. It is used to build a prototype subsist of sensors, actuator, Raspberry pi, Node-MCU and smartphones. Sensors using here to detect the conditions and actuators using here to move the device. For connecting as a bridge and as a server to the internet here Raspberry pi is used. Node-MCU microcontroller is used here as a link between equipment and sensors. It reads the sensor's data and sends it to the server. Then the server responds to it through a request sent by smartphone which installed the Blynk application and it is used for automatic work.

## 5.4 Block Diagram

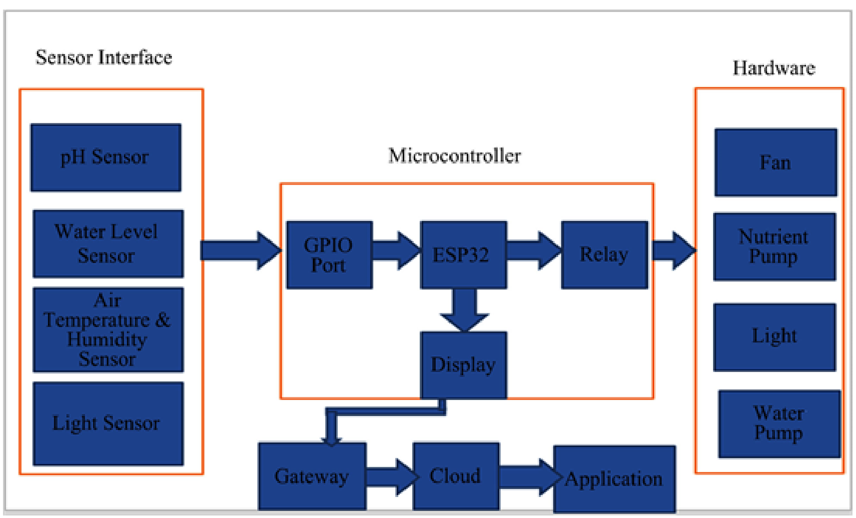


Fig 5.2: The Smart indoor Gardening's Overall Block Diagram

**System Analysis and Configuration:**

Transformation of sunlight precisely into electricity most of the people used solar panels. In our system we used Monocrystalline solar panels which absorb energy and produce electrical fields. Here the mechanized range commits heat also current as well as produce electricity which is precisely used in potential machinery at direct current (DC). As every solar panel size the estimation is given below. In Bangladesh where the top out sun hour is normally 7 to 10 hours, taken away 6 am to 5.45 pm. Established the estimation determined by in the Table 3, the design demand around 210W like Monocrystalline Solar Panel.

Table 5.3: The Energy Consumption of Our System

| **Appliance** | **Calculation** | **Consumption** |
|---|---|---|
| Arduino Uno | 5V * 3A * 22 hours | 330 Watt Hours |
| Grow LED Light | 20 Watt * 16 hours | 320 Watt Hours |
| DC Power Source (Water pump, Fan) | 6W*24 hours | 144 Watt Hours |
| Entire | | 824 Watt Hours |

Entire Energy Consumption / Time when the sun is at its strongest

= 824Watt hour / 4hours = 210Watt

A solar panel produces photovoltaic energy, which is stored in the battery. This project makes use of a SLA rechargeable battery. In any prototype, the SLA battery is the most prevalent general-purpose battery. SLA batteries have the advantages of being inexpensive, long-lasting, and requiring little maintenance. The battery calculation is as follows:

Ah = Watt hour / V = 824Watt hour / 12V = 68.67Ah

Due to the lack of a 68.67 Ampere hour (Ah) SLA battery on the market, a 70Ah SLA battery was used for this project.

**Flow Chart:**

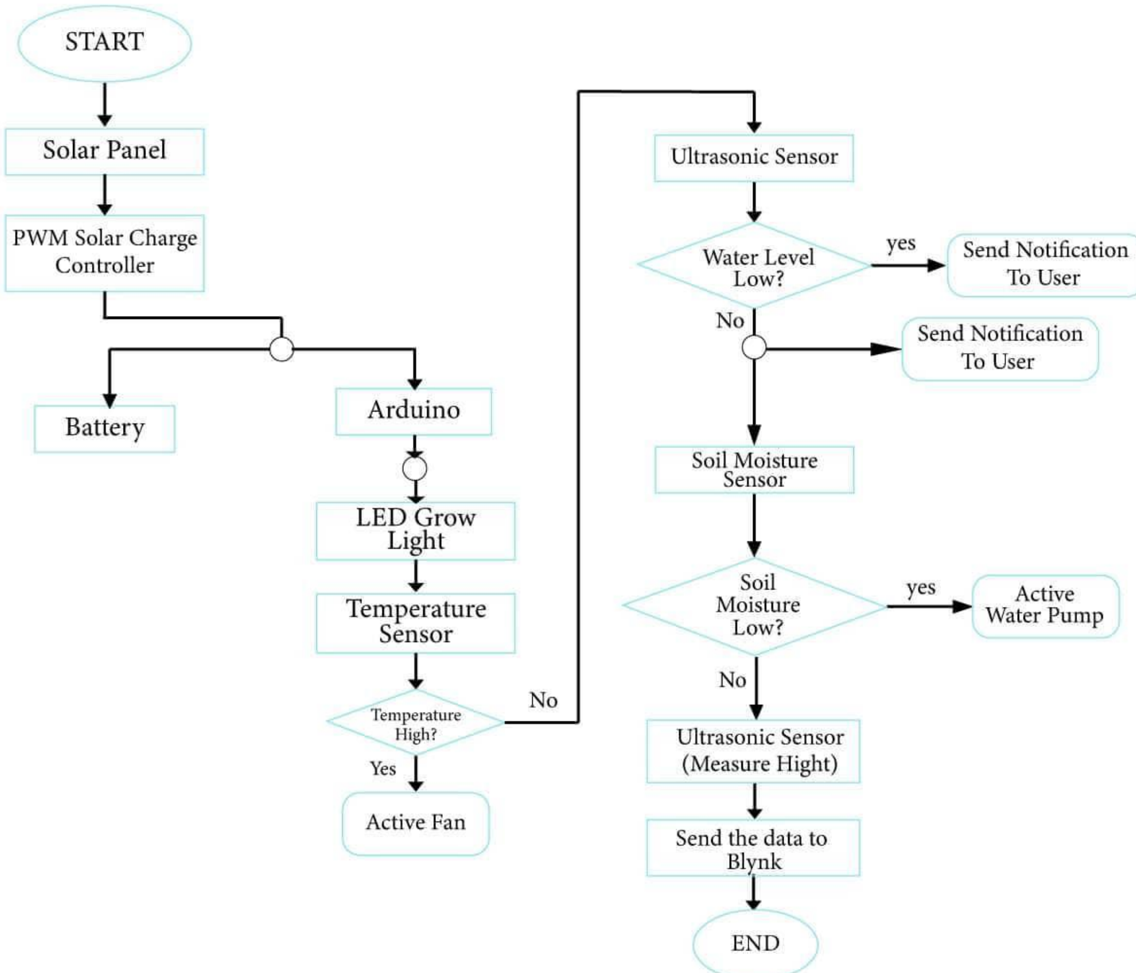


Fig 5.3: The Flowchart of Smart Indoor Gardening

In this flowchart, we are seeing the solar panel which is the source of sunlight that converts to electrical energy. Then the converted electrical energy will go to the PWM solar indictment organizer. It performs like a doorway in the system. It funds the battery and also the Arduino at the same time. Whether the battery is totally owed or not again the electrical energy definitely does not give every performance into every battery beside it will give performance to the Arduino to its capacity.

The smart indoor gardening system will start with LED grow light. For plants to properly grow it will need 16 hours of light and this system will automatically turn on the lights whenever it's needed such as-it turns on every-day at 8 am to 11.59 pm and closed off whenever it gives notification to the user through email. Next is a temperature sensor which will indicate the temperature of the plants. In indoor gardening the ideal temperature is 70degree F-80degree-F day and 65degree F-70 degree F night. And if the value goes down below the threshold value then the system will automatically turn on the fans which will try to cool down the temperature and also send notification to the user and when the temperature is cool down then again send proclamation into every customer. Also, a group of data will be gathered to every cloud. Next is an ultrasonic sensor which is held in the water tank of the system so that it can detect when water is full or not for the plants. If the water level is lower than 50% then it will automatically notify the user. And if the water is full then it will also notify the user. After that it will go to the soil moisture sensor to check whether the soil of the plants is high or not. If the soil moisture is low then the water pump will automatically turn on via email which will notify the user. If the soil moisture is not low then it will go to the Ultrasonic sensor which will measure the height of the plants and send the data to the Blynk and store it.

# CHAPTER 6

# EMBODIMENT AND ADVANTAGE

## 6.1 Mythology

We began by completing surveys for a broad range of people, which enabled us to create a number of personas based on their preferences and expectations. The project's aim was to build a platform that would support small- to medium-sized urban gardeners, therefore the opinions of non-growers were unimportant, and only individuals with some growing experiences were allowed to join. It is difficult to find a sizable pool of qualified respondents since the targeted user group of amateurs and tiny professionals is somewhat limited. The bulk of the long, open-ended questions in our survey were. This gave us access to a lot of knowledge. The issue with this survey design is that it took perhaps too long for many participants to finish.

## 6.2 Implementation

All electronic devices are put together in our system. The solar power smart indoor gardening is shown in Fig 4.3.

Wood and acrylic were chosen as the materials for that prototype's construction. The prototype’s basic construction is made of wood, with acrylic serving as a shield and roof. Both wood and acrylic are ideal for a budget, and they are both suitable for a project on a tiny scale. The Arduino Microcontroller module, relays, and PWM solar charge controller were all used in this project.

Fig 4.4 and 5.1 illustrate how to put everything together in a tiny package.

## 6.3 Benefits of Indoor Gardening

The benefits of gardening for general health, quality of life, physical fitness, mental acuity, and socializing are well documented [34]. Particularly, indoor gardening may enhance air quality by

and eye discomfort. A relationship to plants enhances productivity and mental health in humans, and research in environmental psychology also implies that it raises empathy and compassion levels [35]. Additionally, modern housewives are becoming more concerned about food safety. Fresh food for the kitchen may be obtained from indoor gardening, lowering the danger of chemical consumption.

# CHAPTER 7

# OUTPUT

## 7.1 Result

Fig 10 depicts how the user may access the smart indoor gardening system details cybernatedly about absolute-time. The recordings contained warmth and moisture data, supervision whereas the water drain, ventilator, and grow light of LED, level of the water hunting, along with plant peak statistics. The user might check the gadget situation statistics all in five minutes in turn assuming an incident, similarly a water drain failure and other things.

Turning it on the data was kept by Blynk in a cloud storage facility. Information may be viewed in a variety of ways. It is possible to recover a time-series graph.


Fig 7.1: shows how the Blynk app works on a mobile phone

Fig 7.2: Chili developing on smart indoor gardening.

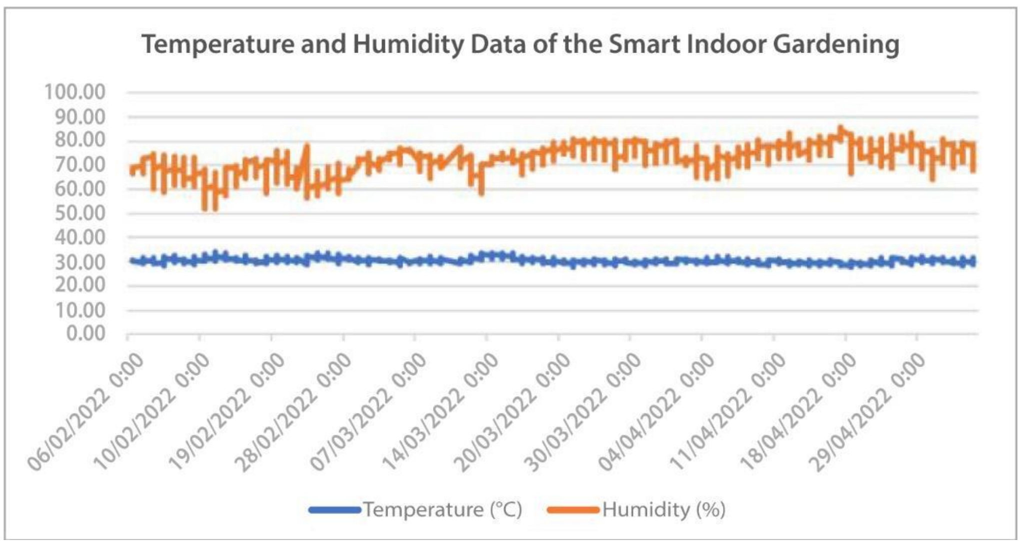


Fig 7.3: Smart Indoor Gardening warmth as well as moisture statistics

Based on every warmth along with moisture statistics here Figure 5.2, they can claim a particular temperature and humidity are optimum for two months, from February 1, 2022 to April 29, 2022. This type of setting has the potential to help the plant thrive. Temperatures and humidity levels seldom exceed the threshold limit. Here with smart indoor gardening, the temperature holds greater all along every day and slightly low at night, at the same time moisture is becoming low during every day and also appearing at night.

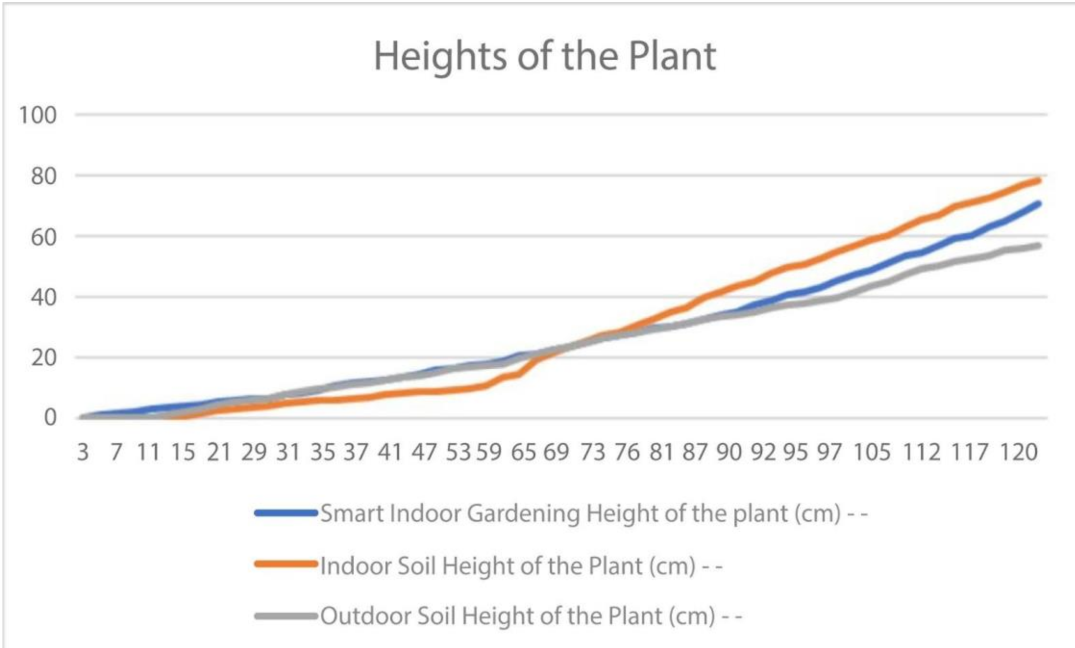


Fig 7.4: Distinct Portrayal about Comprehensive Peak Amount as Entire three Chili Categories Estate

Figure 5.3 shows that chili germinates quicker at our smart indoor gardening system than in the private clay gardening along with rustic gardening systems. In second agile was outdoor soil, which was chased aside by private clay gardening. With time, chilis here in private gardening catch every edge and also grow to be the biggest of every crop. Indoor farming chilis achieved a height of 78.3cm, with hydroponic chili coming in second at 19.6cm and outdoor farming chili coming in third at 13.7cm. This research shows that indoor farming is more capable than classical gardening.

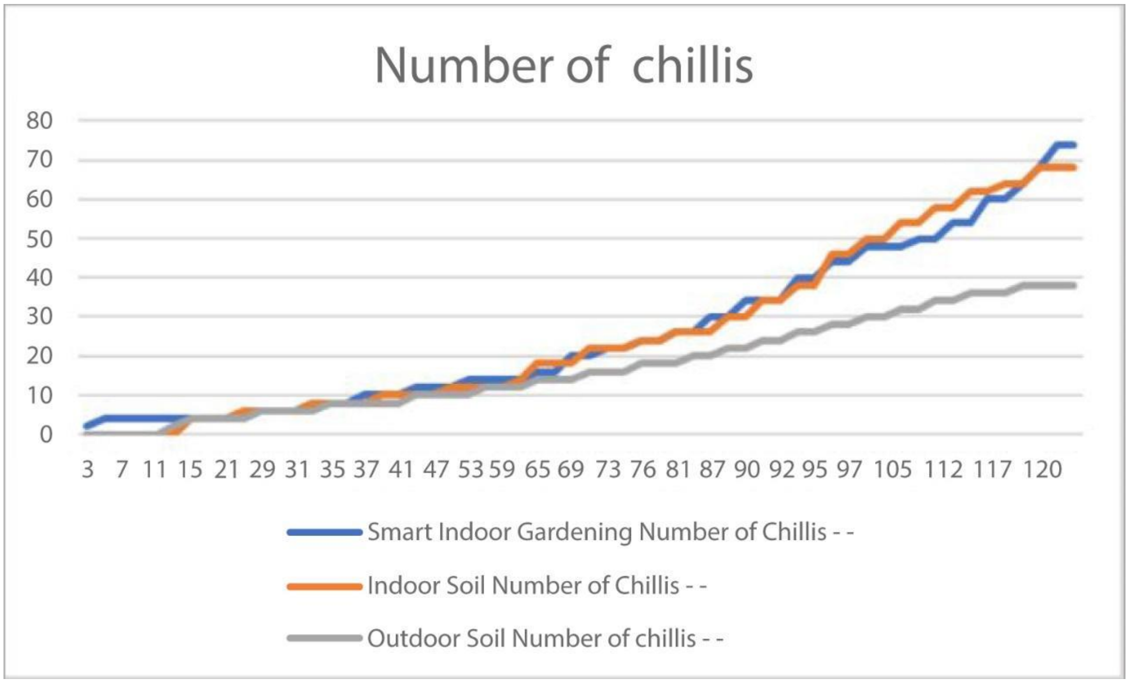


Fig 7.5: Distinct Portrayal about Absolute Sum of Leaves in the Chilis Plantation for All Three Types

Although chili is the tallest of the smart indoor farming plants, it is unable to develop new leaves. Figure 18 shows that the chilis grown in a smart indoor garden produces one of the most leaves, with 37 leaves in 120 days. The second is chili from hydroponics farming, which has 34 leaves, and chili from outdoor farming, which has just 19 leaves. According to the research, chili in hydroponic and outdoor farming produces leaves quicker than chili in indoor farming during the germination stage. Even though it has been irrigated every day, the chili in outdoor farming has a poor crop yield over time.

(i) (ii) (iii)

Figure 7.6: Harvested chili; i) hydroponics, ii) smart indoor farming, and iii) traditional farming.

Table 7.1: For all types of chili plantations, the size of the chilis is measured shown in below

| **Plantation Type** | **Height(cm)** |
|---|---|
| Hydroponics | 4.6 |
| Smart Indoor Gardening | 5 |
| Traditional Outdoor Farming | 4.4 |

# CHAPTER 8

# DEDUCATION

## 8.1 Conclusions

Finally, the goal of this study is to compare the performance of smart indoor gardening with traditional agriculture utilizing IoT technology. As we all know, the Internet of Things (IoT) makes things or lives easier and more pleasant. The results presented in this study show that the productivity of smart indoor gardening utilizes IoT technology which is larger than traditional cultivation since it takes fewer time and resourcefulness. Aside from a certain, plants grown held down LED light that generate greater crops also goods more than those grown beneath sunshine.

According to the research, hydroponics and LED lighting are the most efficient ways to cultivate plants. Smart indoor farming is the best answer in our period since it produces no pollution, uses no pesticides, and is pest-free, making it highly safe to eat. In an enclosed space, you may cultivate a daily supply of fresh green veggies. Consumers can monitor plants from afar using IoT technology, and a smart indoor gardening design does not require a lot of room to cultivate food. Those who work in major cities and have little time for gardening but like it might profit from the solar-powered smart indoor gardening. They will cultivate their plant in their home or workplace and use IoT technologies to monitor it.

It will help make the smart indoor gardening energy-efficient with the use of solar energy, albeit the initial set-up cost will be expensive. The agriculture business will gain from the initiative in the future. The project's intended outcome demand has an influence on every recession along with society. According to all findings, our scheme is a success since it met all of its goals.

## 8.2 Future Scope

In terms of suggestions, a future researcher may expand on this experiment by including more sensors such as a pH sensor. This might improve the smart indoor gardening's control and monitoring system. Aside from that, the researcher might utilize a different IoT platform to create the smart indoor gardening system. The Blynk cloud service in this project frequently goes unavailable owing to poor internet access. Aside from that, the researcher integrates Google Assistant and Alexa into the system. The user will be able to monitor and operate the smart greenhouse by talking to the smart gadgets, which will make it much easier for them. Finally, the aquaponic system may be used to implement all of these IoT technologies. Aquaponics is a cross between aquaculture and hydroponics in which fish and plants are grown in the same system.

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