SMART KITCHEN GARDENING SYSTEM

An IoT based garden

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Abstract : Smart kitchen garden system is used in the automatic control and monitoring of equipment and quantities such as screening installations, heating, cooling, lighting, temperature, soil moisture level and other quantities/conditions in a garden, with effective monitoring of all quantities therein, eliminating need for human monitoring. With an enhanced feature it integrates and automates by turning on or turning off all monitoring devices in the house. This is due to the micro-controller technology that can be easily modified and re-modified with portability.

IndexTerms – Internet of things (IoT), **Soil moisture, temperature**

I. Introduction

A kitchen garden is an integrated system which comprises the family house, a recreational area and a garden producing a variety of foods including vegetables, fruits and medicinal plants for home consumption or sale. In addition to supplying the food needs, the kitchen gardens help in biodiversity conservation as well as a platform of socializing the younger generation into the communities' norms as they interact with the older people while tending the gardens.

While it may not directly supply the cereals need for the family, the savings achieved from not buying fruits and vegetables would be used to buy additional cereals. The purpose of the kitchen garden project was to help employees in the village improve on family food supplies and nutrition year round, through sustainable exploitation of the land, water and other resources around the house including the idle household labor and skills. The villages were messy with poorly cultivated and eroded gardens, un-coordinated and dirty children play areas. By growing our own food we are also helping the environment by not importing food from around the globe.

Globalizations has broken both the physical and the mental barriers and brought unrealistic perception of access to food. The adverts in the media and in the market places of food from far lands look cheaper than they really are and tend to undermine local production. We are like a people in an ocean of food which is visible to us through a thick glass which can only be broken by monetary exchange. Widespread hunger exists today in a context of global oversupply of food as the chart below suggest.

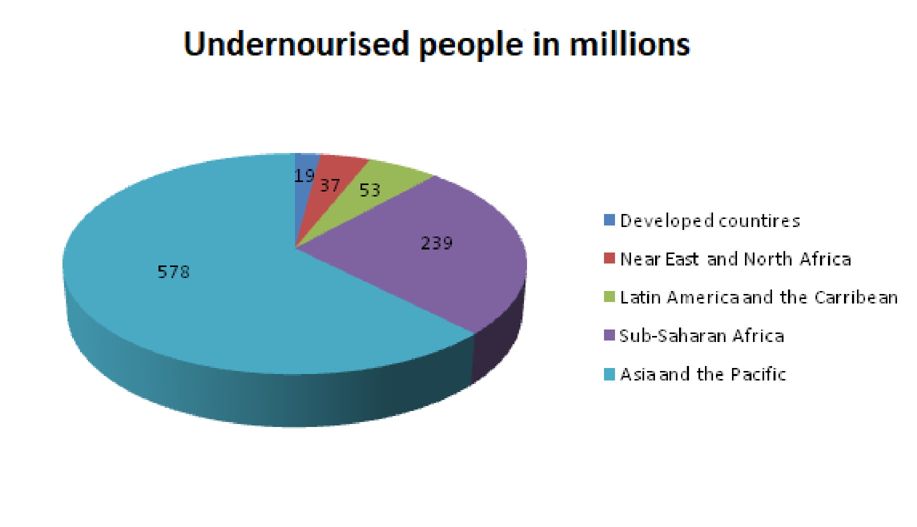


Figure 1: distribution of undernourished people in the world in millions

The proposed system is an embedded system which will monitor and control the microclimatic parameters of a greenhouse on a regular basis round the clock for cultivation of crops or specific plant species which could maximize their production over the whole crop growth season and to eliminate the difficulties involved in the system by reducing human intervention to the best possible extent using sensors. When any of the above mentioned climatic parameters cross a safety threshold which has to be maintained to protect the potato crops, the sensors sense the change and the microcontroller reads this from the data at its input ports.

The microcontroller then performs the needed actions by employing relays until the strayed-out parameter has been brought back to its optimum level. Since a microcontroller is used as the heart of the system, it makes the set-up low-cost and effective nevertheless. As the system also employs a virtual Liquid Crystal Display (LCD) in Blynk mobile application through internet for continuously alerting the user about the condition inside the greenhouse, the entire set-up becomes user friendly.

II. BLOCK DIAGRAM

The block diagram of the smart kitchen garden represents the components that are used and the connections which are made accordingly. The block diagram is depicted in the figure below.

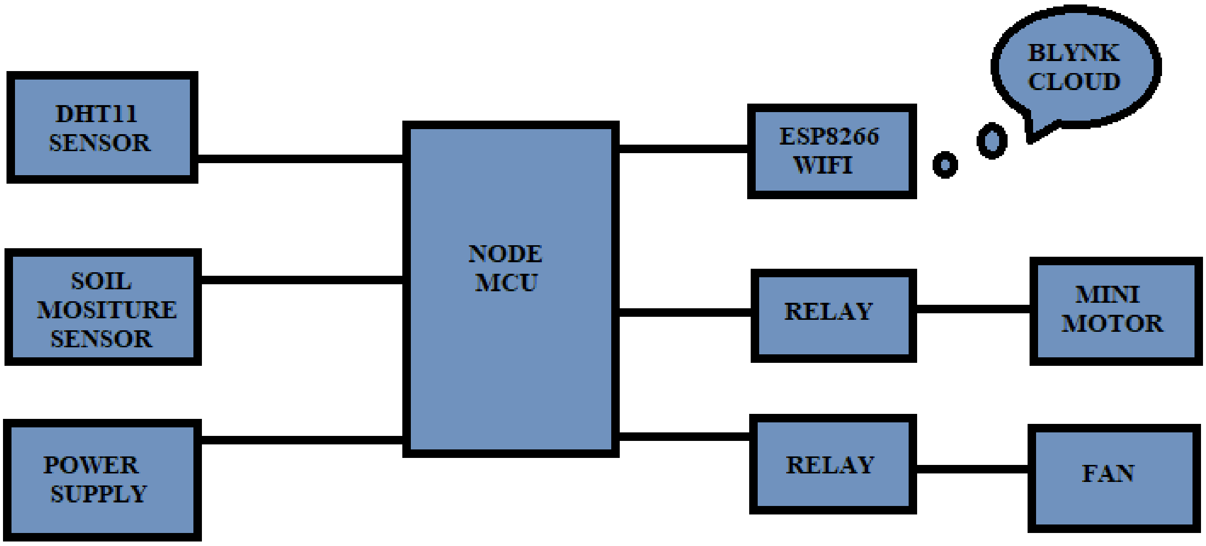


Figure 2: block diagram of smart kitchen garden

The above block diagram consists of the components like soil moisture sensor, DHT11 sensor which act as the inputs to the processing nodemcu unit. The power supply is used to supply the necessary power to make the board function. The relays help in automatic switching action which means turning on the motor pump and fan whenever required and turning them off whenever it is not necessary. The mini motor supplies water to the plants in the garden and the fan helps in cooling the temperature in the garden.

2.1 SOIL MOISTURE SENSOR:

Most soil moisture sensors are designed to estimate soil volumetric water content based on the dielectric constant (soil bulk permittivity) of the soil. The dielectric constant can be thought of as the soil's ability to transmit electricity. The dielectric constant of soil increases as the water content of the soil increases. This response is due to the fact that the dielectric constant of water is much larger than the other soil components, including air. Thus, measurement of the dielectric constant gives a predictable estimation of water content.

2.2 DHT11 SENSOR:

Digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Dedicated digital modules collection technology and the temperature and humidity sensing technology are applied to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and a temperature measurement device connected with a high-performance 8-bit microcontroller.

2.3 RELAY:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

2.4 MINI MOTOR:

A centrifugal pump is one of the simplest pieces of equipment in any process plant. Its purpose is to convert energy of a prime mover (an electric motor or turbine) first into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy changes occur by virtue of two main parts of the pump, the impeller and the volute or diffuser. The impeller is the rotating part that converts driver energy into the kinetic energy. The volute or diffuser is the stationary part that converts the kinetic energy into pressure energy.

2.5 FAN:

A fan consists of a rotating arrangement of vanes or blades which act on the air. The rotating assembly of blades and hub is known as an impeller, a rotor, or a runner. Usually, it is contained within some form of housing or case. This may direct the airflow or increase safety by preventing objects from contacting the fan blades. Most fans are powered by electric motors.

III. METHODOLY

The elementary idea behind using soil moisture sensor to control irrigation is simple: when plants use water, they take it up from the substrate, so the water content of the substrate decreases. Soil water sensors detect these changes and can be used to open an irrigation valve when the substrate water content drops below a user-determined set-point. This results in frequent applications of small amounts of water, and the frequency of irrigation is adjusted automatically based on the rate of substrate water depletion. This irrigation approach automatically replaces water that is used by plants or lost through evaporation and assures that plants are never exposed to drought stress.

By irrigating with the amount of water actually needed by the plants, water use and leaching can be reduced greatly. This minimizes pollution without using expensive recycling irrigation systems or large ponds to capture runoff. Soil condition is very important for plants for a great output. As far as we can see moisture of soil is depending on the water level of the soil. So, we prefer a soil moisture sensor to sense the condition of soil whether it is dry, humid or watery. If the soil condition is dry it is automatically switch on the water pump to on the water supply. When the soil becomes humid it will close the water supply automatically.

Plants need more than 70% humidity and temperature above 20ºC. For temperature and humidity readings we are using DHT11 sensor. We take the temperature and humidity condition as if temperature is less than 20ºC or the humidity is less than 70% then the relay will turn on the heating system.

The NodeMCU microcontroller using in this project has inbuilt Wireless Fidelity (Wi-Fi) shield named ESP8266 (ESpressif). Using this Wi-Fi shield microcontroller will connect to Wi-Fi through username and password specified in program. Through Wi-Fi microcontroller will connect to Blynk cloud using the authentication token specified in program. After this we can see the device online in our authentication token related project in Blynk app.

3.1 NODEMCU CONFIGURATION:

The NodeMCU (Node Microcontroller Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: central processing unit (CPU), Random access memory (RAM), networking (Wi-Fi), and even a modern operating system and software development kit (SDK).

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a Wi-Fi/Serial transceiver. It is recommended to use the very cool Arduino ESP8266 project, which is a modified version of the Arduino integrated development environment (IDE) that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE.

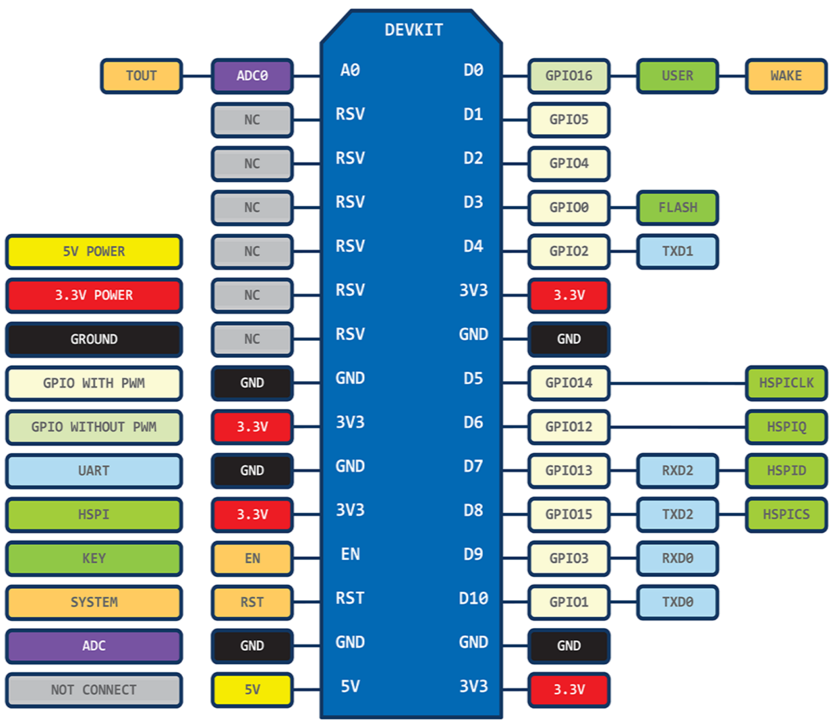


Figure 3: nodemcu pin details

The above diagram shows the general purpose input-output pins analogous to the digital pins. This helps while configuring the input and output digital pins in the Arduino program. A board that incorporates the ESP8266 chip on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi-Fi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board. An open source ESP8266 firmware that is built on top of the chip manufacturer's proprietary SDK. The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language with an established developer community. For new comers, the Lua scripting language is easy to learn.

IV. IOT CLOUD ARCHITECTURE

The Internet of Things (IoT) is one of the most exciting and most dynamic areas of Information Technology (IT) at the present time. IoT involves the linking of physical entities (things) with IT systems that derive information about or from those things which can be used to drive a wide variety of applications and services which may be directly or indirectly connected or related to those things. IoT covers a very wide spectrum of applications, spanning enterprises, governments and consumers and represents the integration of systems from traditionally different communities: Information Technology and Operational Technology. As a result, it is important for IoT systems to have architectures, systems principles, and operations that can accommodate the interesting scale, safety, reliability, and privacy requirements.

The cloud components of IoT architecture are positioned within a three-tier architecture pattern comprising edge, platform and enterprise tiers, as described in the Industrial Internet Consortium Reference Architecture. The edge-tier includes Proximity Networks and Public Networks where data is collected from devices and transmitted to devices. Data flows through the IoT gateway or optionally directly from/to the device then through edge services into the cloud provider via IoT transformation and connectivity. The Platform tier is the provider cloud, which receives, processes and analyzes data flows from the edge tier and provides API Management and Visualization. It provides the capability to initiate control commands from the enterprise network to the public network as well. The Enterprise tier is represented by the Enterprise Network comprised of Enterprise Data, Enterprise User Directory, and Enterprise Applications. The data flow to and from the enterprise network takes place via a Transformation and Connectivity component. The data collected from structured and non-structured data sources, including real-time data from stream computing, can be stored in the enterprise data.

IOT gateway acts as a means for connecting one or more devices to the public network (typically the Internet). It is commonly the case that devices have limited network connectivity – they may not be able to connect directly to the Internet. This can be for a number of reasons, including the limitation of power on the device, which can restrict the device to using a low-power local network. The local network enables the devices to communicate with a local IoT Gateway, which is then able to communicate with the public network. The IoT Gateway often has other capabilities, including the ability to filter and intelligently react to data, the ability to send and receive data or commands to and from the Internet, the ability to run application or service logic locally (processing data and executing control logic without the need to communicate to a central location). It can also provide operational efficiency by allowing multiple devices to share a common connection.

A cloud computing environment provides scalability and elasticity to cope with varying data volume, velocity and related processing requirements. Experimentation and iteration using different cloud service configurations is a good way to evolve the IoT system, without upfront capital investment. It provides core IoT applications and associated services including storage of device data, analytics, process management for the IoT system, creates visualizations of data and also hosts components for device management including a device registry.

V. BLYNK CONFIGURATION

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

There are three major components in the platform:

Blynk Application –It allows to you create amazing interfaces for your projects using various widgets we provide.

Blynk Server –This is responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. Its open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

Blynk Libraries –It is for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.

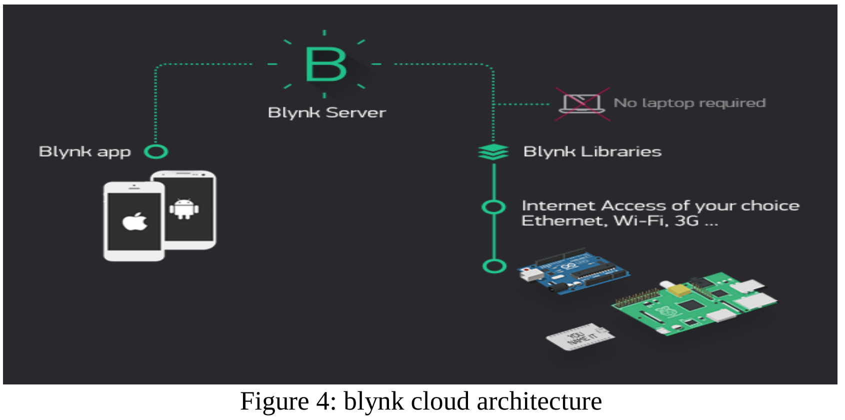


Figure 4: blynk cloud architecture

5.1 BLYNK WIDGETS:

Widgets are interface modules. Each of them performs a specific input/ output function when communicating with the hardware. There are 4 types of Widgets:

- **Controllers** - they send commands to hardware. Use them to c
- ontrol your stuff
- **Displays** - used for various visualizations of data that comes from hardware to the smartphone
- **Notifications** - are various widgets to send messages and notifications
- **Interface** - are various widgets to make your UI look better
- **Others** - widgets that don't belong to any category

Each widget has its own settings. Some of the Widgets (e.g. Bridge Widget) are used to enable some functionality and they don't have any settings.

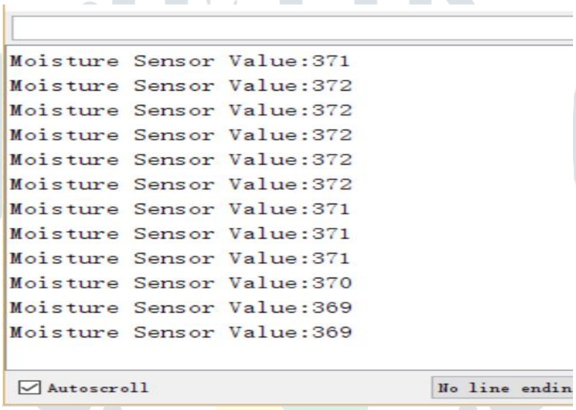
5.2 AUTHENTICATION TOKEN:

Authentication token is a unique identifier which is needed to connect your hardware to your smartphone. Every new project you create will have its own authentication token. You'll get authentication token automatically on your email after project creation. It's very convenient to send it over e-mail. Press the e-mail button and the token will be sent to the e-mail address you used for registration. You can also tap on the Token line and it will be copied to the clipboard.

VI. RESULTS AND DISCUSSION

Smart kitchen garden is designed and is programmed to automatically control the moisture content in the soil and temperature in the atmosphere of the garden. The values of moisture temperature humidity are displayed on the serial monitor and when the program is connected through wifi to the blynk cloud, the result also appears in the blynk apps project display.

The values of moisture are displayed on the serial monitor as shown in the figure below

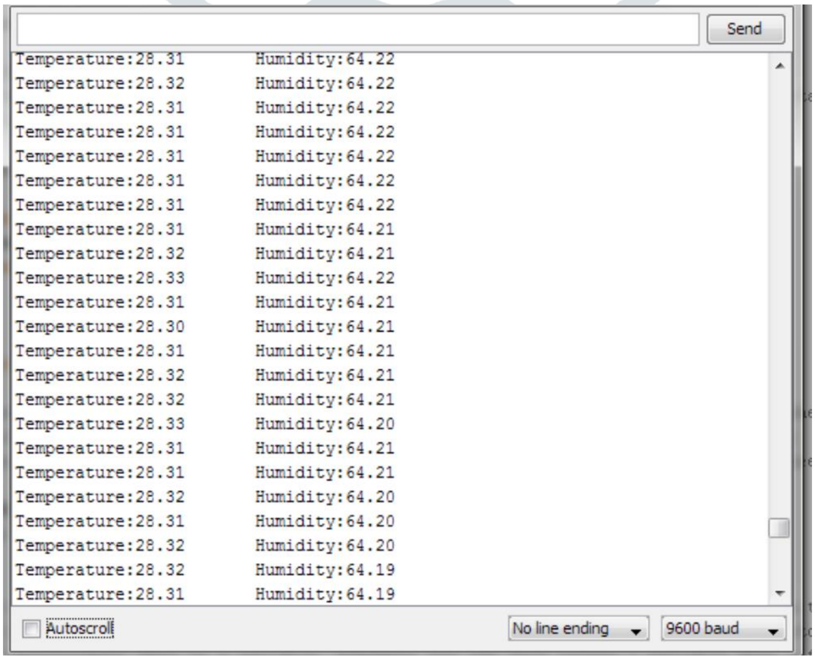


Moisture Sensor Value:371
Moisture Sensor Value:372
Moisture Sensor Value:372
Moisture Sensor Value:372
Moisture Sensor Value:372
Moisture Sensor Value:372
Moisture Sensor Value:371
Moisture Sensor Value:371
Moisture Sensor Value:371
Moisture Sensor Value:370
Moisture Sensor Value:369
Moisture Sensor Value:369
Autoscroll No line endin

Figure 5: moisture displayed on serial monitor

The values of moisture level in the soil varied from 369 to 371 units as shown in the figure.

The values of temperature and humidity in the atmosphere of the garden are displayed on the serial monitor as shown in the figure below



Send
Temperature:28.31 Humidity:64.22
Temperature:28.32 Humidity:64.22
Temperature:28.31 Humidity:64.22
Temperature:28.31 Humidity:64.22
Temperature:28.31 Humidity:64.22
Temperature:28.31 Humidity:64.22
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Temperature:28.31 Humidity:64.21
Temperature:28.32 Humidity:64.21
Temperature:28.33 Humidity:64.22
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Temperature:28.31 Humidity:64.21
Temperature:28.32 Humidity:64.21
Temperature:28.32 Humidity:64.21
Temperature:28.33 Humidity:64.20
Temperature:28.31 Humidity:64.21
Temperature:28.31 Humidity:64.21
Temperature:28.32 Humidity:64.20
Temperature:28.31 Humidity:64.20
Temperature:28.32 Humidity:64.20
Temperature:28.32 Humidity:64.19
Temperature:28.31 Humidity:64.19
Autoscroll No line ending 9600 baud

Figure 6: temperature and humidity displayed on serial monitor

The temperature in the garden varied from 28.30 to 28.33 and the humidity varied from 64.19 to 64.22 in the atmosphere of the garden as shown in the figure.

The values of moisture content in the soil and temperature and humidity in the atmosphere of the garden are displayed in the blynk app as follows.

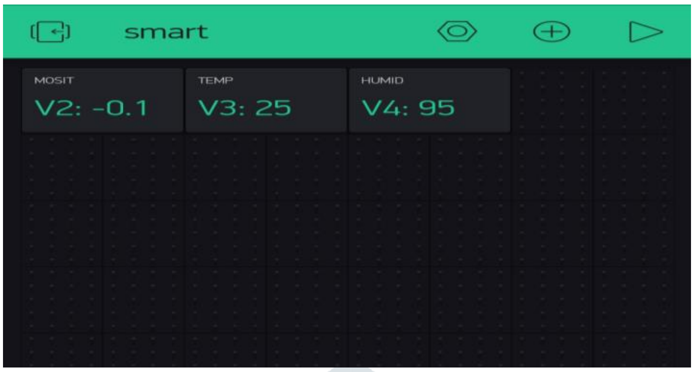

Figure 7: output displayed in blynk app

The moisture is -0.1%, temperature is 25 degree centigrade and humidity is 95%.Initially when it is recorded for the last time as shown in the figure.

Smart Garden is a plant environmental monitoring system. It monitors the soil moisture, air temperature, and air humidity of your plants and automatically waters the plant based on the data received by sensors. Other than that functionalities like artificial sunlight and camera to keep view on plants can also be added. Thing-speak and Blynk application is used to view those sensor data from remote location. With the help of Blynk app, notification service can also be added.

The smart kitchen garden is built such that there is no need for human monitoring and enables automatic watering of plants through the motor pump whenever the detected moisture level are low and helps in automatic control of atmospheric temperature in the premises of the garden through the fan which is turned on when the detected temperature levels are high .These detected values are printed on the serial monitor and also displayed in the blynk app through the esp8266 wifi module.

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