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Sustainable and Portable Low Cost IOT Based Terrace Model to Grow True Organic Greens

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Abstract*: *In today's urban life where we have limited space for our gardens and limited time to monitor the needs for the growing organic greens, a perfect solution would be an Automated IOT (Internet of Things) based Terrace Model. This can certainly provide the best performance, since it may employ decentralized data processing to make important decisions in greens management in a smart manner. This automated system helps in ploughing the soil, sowing seeds, automatic watering to control the moisture level in the soil, observe the live streaming of greens growth in our smart phones until harvesting. It also ensures that Organic Greens receive ideal attention, best agricultural conditions, natural fertilizers and compost (derived from kitchen waste) without any human intervention. This will encourage in growing our own organic greens in an automated way within limited space. In low-expense, this sustainable system can perform plowing of the soil, injecting the seed's, irrigation process along with the live streaming of plants. In addition to this, the end-user can monitor the parameters recorded by the sensors such as soil moisture level, humidity value, temperature level etc. The user will get messages about which plants need to be growing based on the soil conditions along with that they get a message about the intruder. The entire data about the sensors and the system will be stored in the database and time to time modified values will be updated. The modular system will reduce the human effort, labor cost, power consumption, water usage etc. The user can grow different species of leafy vegetables that can be easily maintained and monitored without any effort.

Keywords: Android Application, Arduino Mega2560, CNC shield, Terrace Garden, 3-axis Mechanical Frame.

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I. INTRODUCTION

In the present Scenario, peoples demand for Organic food and health consciousness has been increased. The Researcher's shown Interest to words the behavior of the consumer regarding organic products, its cultivation process, pricing etc, .According to the [1]. "Organic" Refers to How the Agricultural products are cultivated and processed. The motivation towards organic products depends on consumer labeling and their trust in maintaining the quality of the products that spread the knowledge to the buyers about organic food. It is necessary to evaluate buyer who pay for organic food with a concern of health issue, quality, nutrition's, taste, price etc. Organic Agriculture not only improves health but also prevents the environment. The [2]. explains the behavior of the buyer's to select the organic section in Grocery shops. Generally, the buyer chooses the product based on the knowledge, favorable and unfavorable attitude towards the products. In [3]. they coined the term "Organic food" is the product which is grown without the use of any man-made chemical fertilizers, form planting seeds to till harvesting. The regulations for buying the products vary from buyer to buyer due to attitude and knowledge on the product.

The rise in population leads to Deforestation which leads to having limited space and limited freshwater to grow organic green leafy vegetables. The Excessive use of chemical pesticide on greens is not only increasing the input cost, but it is taking a toll on the soil, environment and of course human health. Leafy vegetables are nutritional Goldbrick packed with Vitamins, Minerals, fibers, and phytonutrients. Many of the Employee's, household and forebear want to grow their Organic leafy vegetables but most of them fail in it, due to/because of less garden/growing/cultivating space, required more attention towards continuous monitoring of plants growth from plowing the soil to harvesting which includes injecting of seeds, watering the plants when and where required. This model helps the user in achieving both cultivation and irrigation process to grow organic greens within a limited space without any human intervention.

In most of the Area's in India, the leafy vegetables are being cultivated using polluted drainage water which directly affects the health of the people and indirectly leads to soil pollution. To avoid the consumption of such harmful leafy vegetables this sustainable and portable healthy system is designed that helps in growing of organic leafy vegetables at their specified location.

The Designed Automated System helps in maintain their Terrace garden within limited space where they can cultivate their needed leafy vegetables with natural compose that avoids the usage of chemicals Fertilizers that improves the number of nutrients in the productivity. The z-axis in the proposed model uses “conservation tillage” method to form the seedbeds by breaking the soil, which also helps in drainage and root growth. The seeds are drilled/planted directly inch below the seedbed surface by using seed drill. So, they have a better chance of germinating the plants. The soil moisture sensors measures/reads the water moisture/wet level in the soil based on the requirement conditional the Arduino supply the water through the pipe. The day to day growth of the plants can be observe/checked within the smart Mobiles from anywhere.

II. LITERATURE SURVEY

The fields are initially prepared with a plough to form a seedbed’s, seeded by throwing the seeds which are a manual process. The designed system[4]. uses solar panel which turns sunlight into electricity, that operates the system to saw the seed and fertilizers in rows at required depth and space along with that it covers the seed with soil and compaction. The disadvantage was the system is not automatic.

In Conventional seed sowing machine [5]. is designed with a bamboo tube, attached with funnel used to plough, when the device moves for plowing in the field the seed’s leaves the tube moves through the funnel which is kept at proper depth and space for pit the seeds into the furrows. The disadvantage is wastage of seeds and no proper germination of seeds.

In [6]. they designed an automated Sowing machine by using PIC 16F877A Microcontroller to sow the seeds at a required depth by maintaining the distance between seeds. IR sensor checks the obstacle and presence of seed within the pot. That result in reducing the labor cost and save the time and energy.

To grow any vegetables or any plants water is the main resource, due to the environment changes and isotropic climatic conditions we are getting the rain at a proper time hence we are facing water problem. The soil moisture irrigation[7]. uses the Tensiometer and volumetric sensors to find the moisture level in the soil needed to irrigate the specific type of soil. The sensor required routine maintenance for the proper performance.

The Irrigation control system [8]. developed by ARM7, LPC 2148 proved the required amount of freshwater for cultivating the fresh products which can be internally communicated and controlled by the application with the help of Wi-Fi module.

Drip irrigation system [9]. developed by using raspberry pi and Arduino which send’s the mail for both switches ON and switch OFF the water tap for a specific time which is mention within the mail. The System doesn’t use any soil moisture sensor to know the moisture level in the soil that leads to inaccurate utilization of water. Moreover, the System needs to be controlled by the user manually. Hence there is a chance of drying up of the plants if the user is not activated.

Smart Irrigation System [10],[19]. uses Raspberry Pi provides live streaming of plant growth along with fully automated irrigation process based on the soil moisture level. The growth and irrigation control can be seen with the android application.

Monitoring and irrigation system [11]. designed with the raspberry pi is integrated with DHT 11 sensor and soil moisture sensors to control and monitor the irrigation problem by finding out the temperature and moisture level in the field. The Smart crop protection system[12]. provides a solution for the crop vandalization from animals and birds etc. The PIR sensor detects the warm bodies passed by it and the Author (s) can send the paper in the given email address of the journal. There is two email address. It is compulsory to send a paper in both email address. Smart Agriculture Monitoring System[13], [17]. integrated with a microcontroller, buzzer, relay, ADC Converter, and all sensors to measure the temperature, soil moisture condition and intruder detection. The result is observed on the mobile phone. Smart farming [18]. designed a tool to monitor the plant diseases on fruits from plantation to harvesting using image processing.

III. PROPOSED WORK

In this paper we proposed an automated terrace gardening system that cut up the gardening area to gird layout, At Mega 2560 Micro Controller is connected to Nema stepper motor and integrated with CNC shield that help’s the linear actuator to plow the soil to form the seedbeds, then after moves to the selected grid location to inject the seeds based on moisture sensor value testing the sprinkling of water is done. The grid selection and the reading of the sensors and live growth of plants can be observed through the app for any were which is connected with the EPS8266 Wi-Fi Module. The live observation of the plants growth helps the users to know when to harvest their true organic green vegetables in their cooker.

IV. 2D MECHANICAL FRAME WORK

This 2D Automated Gardening frame as shown Fig 2 is designed by the concept of CNC Indoor Garden [14]. This rectangular frame is built with 4aluminum extrusion of 1000mm x 330mm, supported by 4 aluminum legs, 2 smooth aluminum rods, GT2 belt, Many Metal square brackets and screws are used for smooth motion of linear actuator that is held up with various 3D printing parts [15]. The main part of this system is Linear Actuator that plough the soil, find the moisture level in the soil and sprinkle the water when and how much required, z-axis is build with Acrylic sheet, shaft, Nema stepper motor , Cylindrical container to which plowing tool is fixed, shaft rotate 14,000 time in down-wards direction with the help of Nema 17 Stepper motor to plow the soil, seeding drill injects the seeds, at the same time soil moisture sensor rotate 160 degrees with the help of servo motor to check the moisture level based on threshold value accordingly the motor pump supplies the water [16]. The humidity and temperature values are recorded in the database. The camera is fixed to the 2D frame through which plants growth can be monitored via phones live streaming.

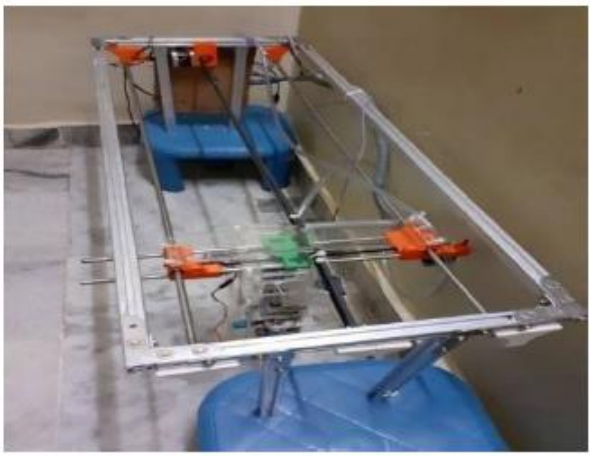

Figure 1: 2D Mechanical Frame

V. SOFTWARE DEVELOPMENT

This section describes how Arduino IDE is used and Android app designed. How the hardware and software components are collaborated to develop this automated system.

A. Arduino IDE

The Arduino is an open-source hardware-oriented software tool. That helps in connecting various microcontrollers, sensors and I/O devices. Embedded C language is used in the conversion of analog to digital. JAVA languages are used to design the framework to show the sensor generated values. The overall system is designed with concepts such as Conditions, Loops, Functions, Arrays, Threads coded and dump into the Arduino. The selection of grid location is implemented by using the concepts of threads and arrays. The water supply is done base on the loops, conditions and functions.

B. User Interface

The Android studio is to design the user interface with attractive GUI. The user can control and monitor the garden from any where with the help wi-fi connection. The app has an initial screen has welcome to the organic garden which asks the password for login and to activate other screens. The Second screen consists of two optional buttons namely user-mode and system mode.

- The user can choose any one button at a time. The user mode button navigates to user screen where we can see the garden area is divided into the grids, based on the selection of grid number the z-axis moves and plough the
- Soil and inject the seeds and check the moisture level also. This process will be continuing until the user exit

From that screen text.

- The system mode button navigates to the system mode screen, where the user can again select individual task at a time or all the task parallel.
- The individual task includes the formation of seedbeds, drilling the seeds and closing the soil, watering based on the moisture condition.

VI. IMPLEMENTATION

The Sustainable and portable system is monitored by the android app which is communicated with the help of Wi-Fi and Bluetooth.

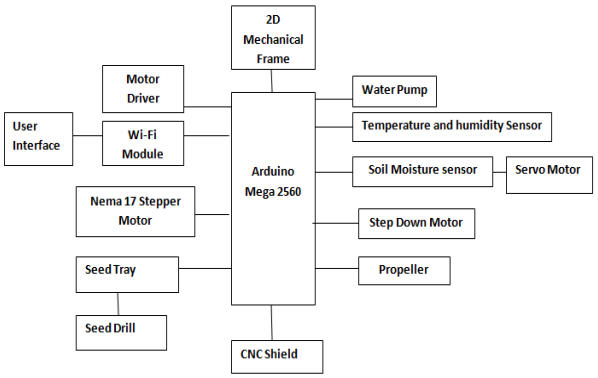

Figure 2: Proposed system

The proposed Automated System Fig 2 helps the user to grow various leafy vegetables within a limited space without any usage of chemical Fertilizers. The leafy vegetables are rich in various nutrients, helps in maintain the health condition along with the diet. The user will get the list of leafy vegetables names and images that are stored in the listing package. The user can select as many plants that they want to grow within the space. Fig 3 shows the number of grids divided by the land. The selection of grid helps in growing different verity of plants is less quantity. The formation of vertical seedbeds helps in growing few verities of plants in more quantity, Overall the system will reduce the wastage of water, excessive usage of power, wages cost etc.

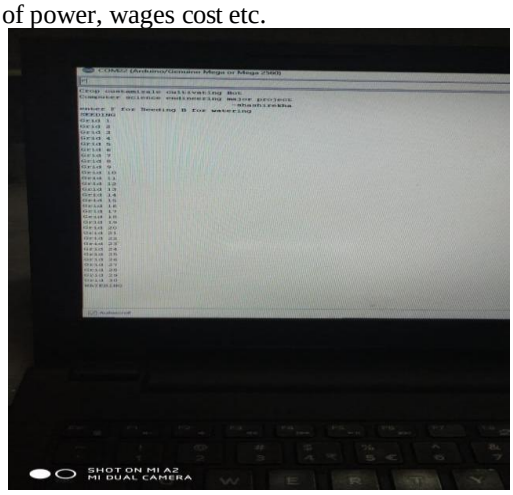

Figure 3: Division of 30 Grids

The sensor's measures the temperature and humidity values also. As the system can be dismantled whenever the user is not required, it can be easily carried from one place to another place. The information that is collected from the sensor based on various parameters send through the Bluetooth and the commands are received by the microcontrollers. In this paper, the proposed System is designed with the help of Arduino mega,

Components	Description
Arduino Mega 2560	Arduino Mega 2560 comes with in-build code and allows us to add new code without any extra hardware which consist of 56 digital i/o pins from which some pins are used to move the z-axis in forward and backward directions, few pins are used in connecting the water pump, Drill motors etc. To the Analog pins soil moisture sensor and temperature sensor is connected through which the values are shared to other pins and stored in the database.
L293D Motor Driver	L293D Motor Driver is Integrated Circuit used for enable and disable the current amplifiers which is in build with dual H-bridge.
Soil Moisture Sensor	Soil Moisture sensors calculates the wet level in the soil when it is inserted in the soil based on some soil properties. The Calculated values are send to Arduino through data pins.
Temperature and Humidity Sensor	DHT11 reads the input from the surroundings and gives the output has a digital signal .Even though the sensor is small in size but the signal can transmit up to 20 meters range.
ServoMotorSG90	Micro Servo SG90 has output shaft, used to set the angular position of the device by sending the coded signals. Here SG90 used to set the position of soil moisture sensor and seed drill.
CNC Shield	CNC Shield Board is used to control 3 DRV8825 stepper motors which make the system task easier
Step-down Regulator	Step down Regulator is use to generate less output voltage than the input voltage. The Buck is used to generate 5v of output dc current.

Table 1: components and description

The following hardware components are integrated to implement an automated gardening system, which is combine with the mechanical frame and operated with the help of software application. Where all the remaining components and controllers are connected to the Arduino through various Acrylic, miscellaneous, fasteners, etc. Initially the user need to login to the app from there onward they can control and monitor the whole system with the help of system mode and user mode. The task done by the System are Plowing, means Preparing the Seedbeds by turn over's the upper layer of the soil by using the tool called propeller which is associated with gear motor .Seeds tray is placed on the top of Acrylic sheet from which seed drill collect and inject the seeds through the pipe by using the stepper motor to navigate from each and every grid location along with moisture sensor, at every grid location the servo motor rotate.

The sensor in to the soil to check the moisture level shown in Fig 4. Based on the Moisture level the Arduino check the condition, ON the water pump to sprinkle the water through the pipe .The System uses the Web Came to the stepper motor to navigate from each and every grid location along with moisture sensor, at every grid location the servo motor rotate the sensor in to the soil to check the moisture level shown in Fig 4. Based on the Moisture level the Arduino check the condition, ON the water pump to sprinkle the water through the pipe .The System uses the Web Came to observe the live streaming growth of the plants in their mobiles. The notifications regarding type of plant that suits the soil and data about soil moisture, humidity, temperature are send to the user with help of Wi-Fi module. Here we have an advantage that the user can receive the messages even there is no internet connection also that is with the help of blue tooth.

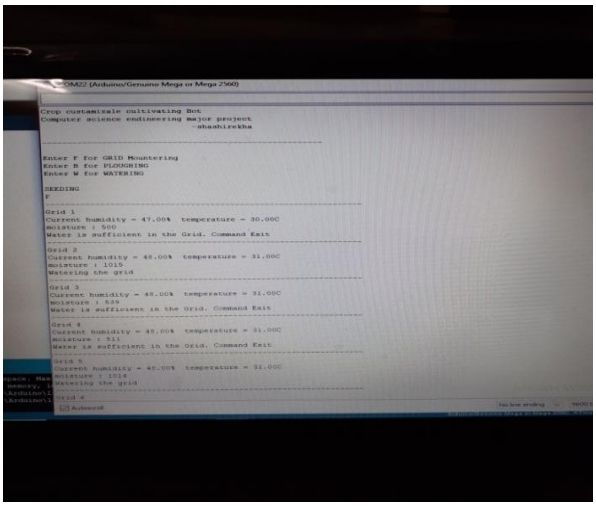

Figure 4: Humidity and Temperature values of individual Grid

The whole System can be monitor form any place and the live streaming of plants growth can be viewed without any interruptions. How the system will work can be seen in [20]. Monitoring, plowing, seeding, watering based on moisture values that makes the human task very easy to Control and monitor the garden.

VII. RESULT AND DISCUSSION

The system is tested successfully which provide the best solution to grown true organic greens in our terrace garden that improves the health and environment by reducing the usage of harmful fertilizers. The device is tested with in the gardening area of 30*90 Cm that divides the land into 30 grids along with the grid number, the moisture and humidity value of single grid is stored in the database. The system is experimented on mustard seeds the Fig 5 is the plants that grown within one week.

Figure 5: mustard plants grown using this automated system

VIII. CONCLUSION

In this paper, we proposed a new innovative of fully Automate terrace gardening system. That reduce human interaction with the gardening process by increasing the cultivation production (organic leafy vegetables) with rich nutrients, vitamins' etc. The system allows the user to grow their crops, they can grow more species of leafy vegetables within a limited space. This encourages people to maintain their very own garden even in their busy life and obtain Organic leafy vegetables with low cost that result in good and better health.

IX. FUTURE SCOPE

Our implemented system can be further enhanced by adding an ultrasonic sensor to check the height of the plants. The PH value and nutrients values in the water and soil can be noted to avoid usage of harmful fertilizers. Hence the vegetables can be grown in more organic way.

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