Smart Hydroponics

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***Abstract*— Agriculture is one of the most widespread activities in the world, but it is not uniform throughout. Agriculture plays a crucial role in the life of an economy. It is the backbone of our economic system. Agriculture not only provides food and raw material but also employment opportunities to a very large proportion of population. The reason that we have permanent civilization, is because of agriculture. Increasing concern about sustentation of environment as well as health hazards associated with agrochemicals and assure the consumer's engrossment to safe and hazard free food are the major factors that lead to the growing eagerness in different forms of agriculture in the world. Due to the effects of urbanization most of the farm lands is converting into residential areas. Optimal, viable and gainful use of our land and water resource has become critical. This project will look to tackle the disadvantages of agriculture and promoting soilless cultivation while bringing to the consumer a product that allows them to take all the benefits from their system, the main goal is to grow their very own, organic food in the comfort of their home with unprecedented accessibility to their system. This concern elevated the risks on emerging innovative new technologies and proficient of automating the entire agricultural systems. The purpose of this project is to build an efficient prototype for automation in portable vertical hydroponic system, creating an autonomous, self-regulating system.**

Keywords* — *Hydroponics, Raspberry PI, pH Sensor

I. Introduction

Agriculture is the human enterprise by which natural ecosystems are transformed into ones devoted to the production of food, fibre, and, increasingly, fuel. Agribusiness is the development of land and reproducing of creatures and plants to give sustenance, fibre, restorative plants and different items to support and upgrade life. Agriculture was the key improvement in the ascent of inactive human progress, whereby cultivating of tamed species made nourishment surpluses that empowered individuals to live in urban areas. Given the current size of the human population, agriculture is essential. Without the enhanced production of edible biomass that characterizes agricultural systems, there would simply not be enough to eat. The land, water, and energy resources required to support this level of food production, however, are vast. Thus, agriculture represents a major way in which human's impact terrestrial ecosystems. For centuries scholars have wrestled with the question of how many people Earth can feed. Agriculture involves the genetic modification of plant and animal species, as well as the manipulation of resource availability and species interactions. Scientific and technological advances have made agriculture increasingly productive by augmenting the resources needed to support photosynthesis and by developing plants and animals with enhanced capacity to convert such resources into a harvestable form. The outcome is that world food production has in fact kept up with rapid population growth.

A. ISSUES FACED IN AGRICULTURE

As the human population climbs towards its estimated peak of 10 billion, the environmental impacts of feeding so many people will increase. The factors that are responsible for our agriculture backwardness are traditional farming, lack of proper irrigation system, lack of transport and market, unscientific and undemocratic distribution of land, over pressure of man power, poor economic condition. Plants absorb the fertilizers through soil, they can enter the food chain. Thus, fertilization leads to water, soil and air pollution. But this challenge also offers an opportunity: by making agriculture increasingly sustainable, we can meet the goal of feeding the world's population while reducing associated environmental problems such as water pollution. The magnitude of future agricultural effects on the environment will be influenced by many factors, including: i) Availability of water and chemical fertilizers: The prices of these inputs are strongly affected by energy costs and competition for fresh water with other human activities. ii) Actual demand for food: Food demand will increase with population growth and rising income, which increases consumers' preference for animal protein. iii) Global climate change: Variable weather is a major challenge for farmers because optimizing for high yields becomes more difficult as the range of potential weather conditions that might occur in any season increases. In the coming decades, global climate change is predicted to alter temperature and precipitation patterns in ways that could modify major elements of Earth's climate system, due to these agricultural lands are affected most.

B. ALTERNATE FARMING TECHNIQUES (SOILESS CULTIVATION)

AQUAPONICS: Aquaponics is a controlled environment that creates a well-balanced ecosystem which mutually benefits plants and fish[1]. We've all seen those vases that grow a plant at the top and have a Chinese fighting fish swimming around the roots. That is the simplest example. In this process, the fish and plants have a symbiotic relationship providing nutrients to one another: the plants provide food for the fish and the fish poop gives plants their nutrients and fertilizer.

HYDROPONICS: Hydroponics allows plants to grow without soil and instead uses liquid, sand, gravel, coco, or various other materials. Terrestrial Plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as gravel. Nutrients are supplied to the roots by water that is enhanced with liquid plant food. The benefits of hydroponics clearly outweigh traditional farming methods. The basic needs of a plant are simple: water, sunshine, and nutrients. Since nutrients are directly supplied to roots from water plants in hydroponic system grow faster than the plants grown in the traditional agriculture Hydroponics allows the plant density to be quadrupled, which means four times more production for the space" [3].

AEROPONICS: Aeroponics is the process of growing plants in a moist environment and also rejects the normal use of soil. Plants are suspended in a somewhat enclosed environment and water that is mixed with plant food is sprayed onto the roots. A drawback to this type of environment is that the roots are exposed so pests and bacteria can become a problem if the roots aren't carefully protected. Aeroponics systems are often used in an enclosed environment like a greenhouse so that temperature and humidity can be meticulously regulated.

C. *OBJECTIVES*

This project will look to tackle the disadvantages of agriculture and promoting soilless cultivation while bringing to the consumer a product that allows them to take all the benefits from their system. The main goal is to provide the urban and metropolitan-based populous with a way to grow their very own, organic food in the comfort of their home with unprecedented accessibility to their system.

Project based goals include the following:

- Construct a compact, durable, and convertible hydroponics system for use in all environments and locations (indoor/outdoor).
- Climatic changes won't affect plants grown in hydroponics system.
- Horizontal hydroponics system occupies large amount space so we have proposed a vertical hydroponics system that occupies less space.
- Plants grown in hydroponics system will be chemical free.
- Since the proposed system is made automated it requires less man power.
- The proposed vertical hydroponics system is automated and controlled it will still be working when we are on a vacation.

TYPES OF HYDROPONIC SYSTEMS: When you think of hydroponics, you instantly imagine plants grown with their roots suspended directly into water with no growing medium. There are several variations of hydroponic systems used around the world [4].

WICKS SYSTEM: Seen as the most simplistic hydroponic system. The Wick system is described as a passive system, by which we mean there are no moving parts.

WATER CULTURE: This system is an active system with moving parts. As active hydroponic systems go, water culture is the simplest. The roots of the plant are totally immersed in the water which contains a Growth Technology nutrient solution. An air pump with help oxygenate the water and allow the roots to breathe.

EBB AND FLOW SYSTEM (FLOOD AND DRAIN): This hydroponic system works by temporarily flooding the grow tray. This action is usually automated with a water pump on a timer [5]. The nutrient solution from a reservoir submerges the roots before draining back to the holding tank.

DRIP SYSTEM (RECOVERY OR NON-RECOVERY): Dip systems are a widely used hydroponic method. A timer will control a water pump, which pumps water and the Growth Technology nutrient solutions through a network of elevated water jets [6]. A recovery system will collect excess nutrient solution back into the reservoir. A non-recovery drip system will avoid this allowing the pH of the reservoir not to vary.

N.F.T SYSTEM: The N.F.T system is at the forefront of people's minds when hydroponics is mentioned [7]. Nutrient Film Technique uses a constant flow of your Growth Technology nutrient solution (therefore no timer is required).

II. PROPOSED METHODOLOGY

Smart farming is seen to be the future of agriculture as it produces higher quality of crops by making farms more intelligent in sensing its controlling parameters. Analysing massive amount of data can be done by accessing and connecting various devices with the help of Internet of Things (IOT).

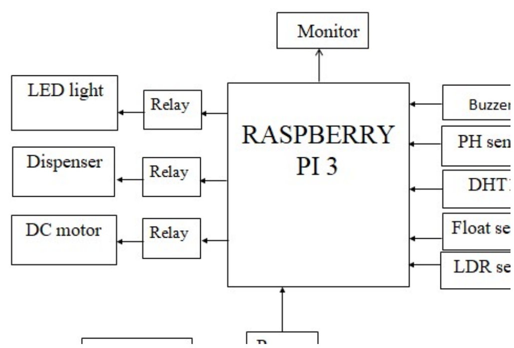

Figure 1: Proposed Vertical Hydroponics System

The sensors we are using in this prototype are cost effective. A detecting framework containing a Raspberry Pi and business sensor circuits and tests that measure pH, water level, temperature, humidity and light. Information gained from the sensor framework is logged into the notepad. Constant observing of this information, and influencing important alterations, will encourage the upkeep of a sound environment that is helpful for the development of plants, while using around 90% less water than conventional cultivating. Since it is a vertical hydroponics system the water flow has to be continuous, so water pump is used to pump water to the vertical channel. This designed vertical hydroponic system is composed of sensor devices that sense and collect information of various essential parameters and display on a screen and it is logged into the notepad along with time. The data is logged into the notepad every six seconds. This means that the human intervention would be considerably less when compared to other traditional methods. This vertical hydroponics system is automated by using all these hardware and software requirements that are explained in further topics.

III. Interfacing and Implementation

An Interface is a shared boundary across which two independent systems meet and act on or communicate with each other. A hardware interface is described by the mechanical, electrical and logical signals at the interface and the protocol for sequencing them (sometimes called signalling). There are several types of interfaces: user interface, software interface and hardware interface. Architecture used to interconnect two devices together includes the design of the plug and socket, the type, number and purpose of the wires and the electrical signals that are passed across them.

A. INTERFACING OF DC MOTOR WITH RASPBERRY PI

The dc motor is used to rotate the vertical channel. It requires 12volts voltage to turn on. The dc motor is automatically controlled by the raspberry pi through relay. Interfacing of DC motor with raspberry pi is shown in the Figure 2.

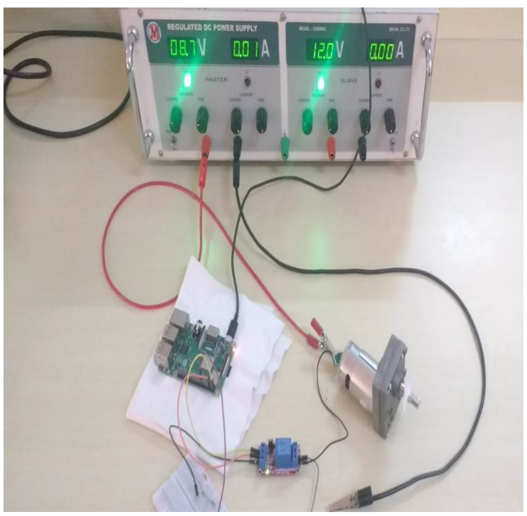

Figure 2: Interfacing of DC Motor with Raspberry Pi

Raspberry pi is used as the controller as it can control and perform multiple devices and functions. MCP3008 is used to convert analog values from sensors to digital values. Ph electrode reads the ph value of water in analog, it is converted into digital using MCP3008. As the system powered ON, the processor checks for the given time conditions. If the condition satisfy then, simultaneously water pumps are turned ON. Values from the sensors DHT11 and PH sensor values are taken by the processor [6]. PH, here we are using the range in which the PH level of reservoir should be maintained properly. If PH level is less then threshold then PH up will be added by dispenser 1 and vice versa. All the sensor values collected is logged into the notepad.

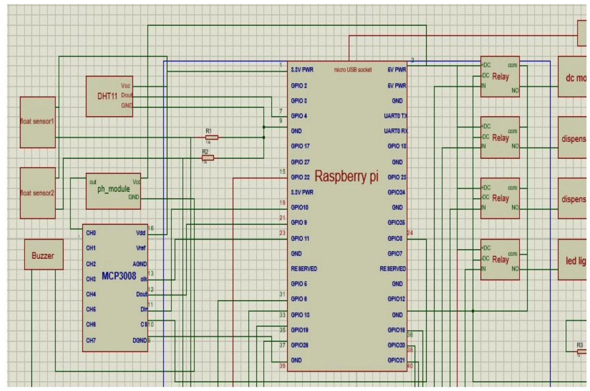

Figure 3: Schematic Diagram

IV. Results

A prototype of the vertical hydroponics system is developed that is shown in the Figure 4. It consists a fabricated stand on which dc motor is mounted that rotates the vertical channel. The vertical hydroponics system can be placed in balcony, terrace or it can be kept in any small space. If the vertical channel is stationary then the plants on one side of the vertical channel receive sufficient amount of sunlight. But plants on other side of vertical channel won't receive sufficient amount of sunlight. In the automated vertical hydroponic system the vertical channel is rotated so that all plants placed on the vertical channel receive sufficient amount of sunlight. Since it is a hydroponics system the water flow has to be continuous.

Figure 4: Vertical hydroponics system

The water tank has a water pump that continuously pumps water to vertical channel. There is a float sensor in the water tank to check the water level. If the water is less than the buzzer will turn on. It is the indication alert, once the water is filled into the water tank the buzzer will turn off. ph electrode is kept inside the water to check the ph value of water. Dispensers are mounted on the water tank. Based on the ph value appropriate dispenser will turn on. The ph sensor and dispensers are operated periodically, that is it operates from 8am to 9am. If ph value of the water is all most neutral the dispenser will turn off. The LDR sensor is placed on stand to check the intensity of light. If intensity of light is less then LED placed on the stand will turn on. If intensity of light is high then LED placed on the stand will turn off. DHT 11 sensor is used to check the temperature and humidity of surroundings where the vertical hydroponics system is placed.

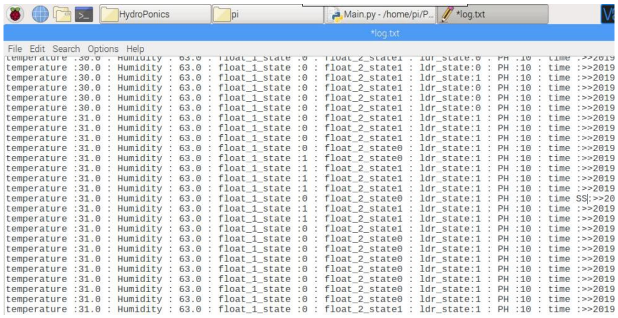

Figure 5: Data logged in the notepad

All the sensor values that are collected is logged into the notepad along with time. Whenever it is required it can be accessed. It is shown in the Figure 5.

CONCLUSION AND FUTUREWORK

The proposed vertical hydroponic system is end-to-end connected and controllable and is observed that the system will be much more efficient compared to the existing hydroponic system by both functionality and performance dimension. And thus this proposed vertical hydroponics system will produce vegetative growth in a sustainable ecosystem with spectrum targeted LED lighting and electronic monitoring and automatic alerts. The system is useful in hydroponics cultivation and suitable for small space, low cost, low power and able to recycle the nutrient solution which is already used by plant. However there is need to make this system more advanced more accurate and cost effective so that farmers can use this system in large scale which is challenge that must be addressed in a future, and hence system become fully automatic by controlling the other parameter such as pH, temperature, light intensity, ambient humidity, oxygen level in water. The designed prototype ensures of high rate of production. This system effectively makes the rural and urban household self-sustained in plants consumption[10]. The proposed vertical hydroponics system occupies less space. It can be implemented in small scale for home gardening or terrace gardening. It can be implemented in large scale for cultivation of plants.

Methodology to handle contamination in the surroundings can be incorporated. The system can be extended to real time hydroponics farms. Vertical hydroponics farming can be incorporated to increase productivity. A concept such as this always has room to advance further. The scope of this project proposes a system where the temperature and humidity values can be changed by using foggers, sprinkler, cooler and exhaust fans. A procedure can be identified to know the faulty sensors. As technology develops further, faster ways to transfer information are developed, this system can further be improved. Eventually, a standalone, big data, system can be created to implement this on a very largescale farm environment.

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