Hydroponic a Sustainable Agriculture Production System

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Abstract - High yielding and high grade of crops are essential in modern day agriculture, this can only be achieved by smart farming technology which is used for making farms more intelligent in sensing its controlling parameters. Manual monitoring is in practice which is a very trivial task because the plants may die out if there is no proper care is taken. The architecture of this hydroponic system which is fully automatic that can be integrated into the agricultural curriculum while introducing business skills. The automatic monitoring and control of the environmental events such as light intensity, pH, electrical conductivity, water temperature, and relative humidity is carried out by lodging sensors and actuators onto the system. The maintenance and automated monitoring are done by the intervention of the IoT that are used to transfer and retrieve data to the internet (mass storage) and a mobile app is used to communicate the current status of the hydroponic system to the user through the use of internet to their mobile phones. This futuristic system can use high data analytics and prolonged data gathering to improve the accuracy of reckoning.

***Key Words*: IoT Module, Humidity Sensor, pH Sensor, Temp Sensor, Hydroponic Farming**

1. INTRODUCTION

1.1 Introduction

Hydroponic is a method where the crops are grown in the absence of soil the nutrients that are acquired from the soil are given to them artificially. The term Hydroponics was acquired from the Greek words 'hydro' means water and 'ponos' means labour. This soil less culture of originating crops often involves their roots to be immersed in the nutrient solution along with some gravels or perlite medium. The maximum yield is achieved by the supply of sufficient quantity of nutrients and optimum microclimatic conditions are the main goal of hydroponics. Since soil is excluded from production process there will not be any problem related to soil borne diseases, pests and weeds. By the exclusion of these problems, there will not be any usage of harmful plant protection chemicals, so that there is a fresh and healthy yield of crops by the hydroponic method. The set-up of hydroponic only Demands limited space and limited quantity of water as they recirculate and reuse the water. This eliminates the problems that are caused by soil. This limited space requirement also favors hydroponic as it can be accommodated in terraces, balconies and courtyards. So, there is a high probability of growing crops in urban areas, where cultivable land is limited. Hydroponics does not cause any adverse effect on the quality of fruits and flowers produced by it Hydroponics is an agricultural method of producing plants in an artificial environment without using soil – nutrients which are provided through water – and by optimizing the growing conditions to improve the production. Hydroponically cultivated plants have a growth rate that is much faster and highly yielding than that of plants grown in soil. Because they are cultivated in containers, pest and disease control is at an optimum. In natural conditions, soil itself acts as a mineral nutrient reservoir but it is not essential for plant growth. The roots can easily absorb the mineral nutrients in the soil if it is dissolved in water. If the minerals are present in the supply of plant's water 11 artificially, then the plant no longer requires soil to thrive. We can grow any terrestrial plant by this method. The method for growing plants by using mineral nutrient solutions, in water, without planting in soil is known as hydroponics. For simplifying and automating many complex real-world tasks the information and communication technology methods are used. The internet plays a major role in implementing information and communication technology sectors. Communications in the internet mainly involve client server connections. The information and communication technology moves to the next stage on creating and sharing information where the humans rely on machines such as weather monitoring system, etc. At this time the machine-to-machine (M2M) communication is also in a peak where one machine receives the information of other machines. In future, everything around us could be connected and they are able to sense and cooperatively communicate over the Internet, thereby giving birth to the Internet of Things (IoT).

1.2. LITERATURE REVIEW

Dr. D.K. Sreekantha et.al [1] analysed that the Internet of things (IOT) is remodelling the agriculture enabling the farmers with the wide range of techniques such as precision and sustainable agriculture to face challenges in the field. IOT technique helps in collecting information about conditions like weather, moisture, temperature and fertility of soil, Crop online monitoring. It enables the detection of weeds, level of water, pest detection, and animal intrusion in to the field, crop growth, and agriculture. IOT leverages farmers can get connected to this farm from anywhere and anytime. Wireless sensor networks are used to monitor the farming conditions and micro controllers are used to control and automate the farming processes. To view the conditions remotely in the form of image and video, wireless cameras have been used.

Foughali Karim et.al [2] reviews that, as water supplies become scarce because of climatically change, there is an urgent need to irrigate more efficiently in order to optimize water use. In this context, farmers' use of a decision-support system is unavoidable. Indeed, the real- time supervision of microclimatic conditions is the only way to know the water needs of a culture. Wireless sensor networks play an important role with the advent of the IoT and the generalization of the use of web in the community of the farmers. It will be judicious to make supervision possible via web services. The IoT cloud represents platforms that allow to create web services suitable for the hardware integrated on the Internet. In this paper they proposed an application prototype for precision farming using a wireless sensor network with an IoT cloud.

Jumras Pitakphongmetha et.al [3] analysed that, the effects of the global warming, and the plants are affected with UV rays. For this reason more difficult to planting in uncontrolled environment. On the other hand, the yield does not match customers' needs. For these reasons, planting in a greenhouse is easy to maintain and to control important factors such as light, temperature, and humidity. Using of sensors in a greenhouse as Wireless Sensor Networks System are the efficiency of technology used in agricultural development by sending data to the cloud and controlling values such as temperature, light, etc. The results of his study will be useful for the farmer and related organizations applying in the farm.

Srisruthi.S et.al [4], analysed that Agriculture requires the dedication of many natural resources, including land, water, and energy. So, they adopted sustainable agriculture which supports careful management and cultivation of crops involving less use of fertilizer, pesticides, calculated use of precious natural resources like energy, water through controlled irrigation and fertigation practices with the help of green sensor technology and electronic control systems.

Tsung-Han Wu [5], developed an Intelligent Plant Care Hydroponic Box, From the experimental measurement results of IPCH-Box, the developed environment driven control methods include light, water sprinkler and water pump which can effectively lower the CO2 concentration, the temperature and increase water level, respectively. (about milk quality).

2. PROPOSED SYSTEM

This The IoT plays a major role in the automation process. Automating this hydroponic system is the most crucial part, this can be easily achieved by integrating the hydroponic system with the IoT. Cloud database acts as the hub for the whole automation process; this database contains all the information on the hydroponic system that is it has the information on the data that has been retrieved from the crops and the water tank. Sensors and actuators are used in order to automate the hydroponic system, these sensor values are sent to the cloud database from which the user is updated with the real time information about crops condition. The user can also adjust the configuration of the sensors and actuators from the developed mobile application. The mobile application has all the specification about the hydroponic system; the user must have a unique login ID. The user name and the password are registered with the cloud database; by this the user can operate with his crop field without any interruptions. Through this mobile application the user can select which seed are to be planted in the crop bed, the water flow can also be controlled with the help of this mobile application. The user can control the flow of water from one tank to other tank with water level sensors and solenoids.

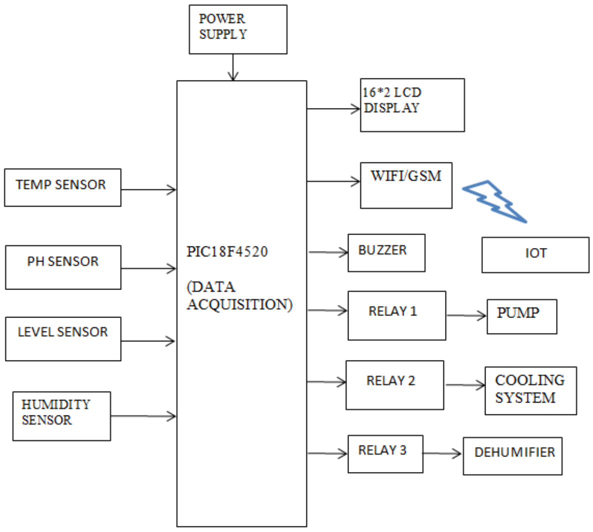

Fig -1: Block Diagram

2.1 PIC 18F4520 microcontroller:

It is an 8-bit enhanced flash PIC microcontroller that comes with nano Watt technology and is based on RISC architecture. Many electronic applications house this controller and cover wide areas ranging from home appliances, industrial automation, and security system and end-user products. This microcontroller has made a renowned place in the market and becomes a major concern for university students for designing their projects, setting them free from the use of a plethora of components for a specific purpose, as this controller comes with inbuilt peripheral with the ability to perform multiple functions on a single chip.

- This microcontroller version comes with CPU, timers, 10-Bit ADC and other peripherals that are mainly used to develop a connection with external devices.
- This PIC version, like other models in the PIC community, contains everything that is required to make an embedded system and drive automation.
- The PIC18F4520 contains 256 bytes of EEPROM data memory, 1536 bytes of RAM, and program memory of 32K.
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- It also incorporates 2 Comparators,10-bit Analog-to-Digital (A/D) converter with 13 channels, and houses decent memory endurance around 1,000,000 for EEPROM and 100,000 for program memory.

Fig -2: PIC 18f4520 Microcontroller

2.2 16*2 LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs.

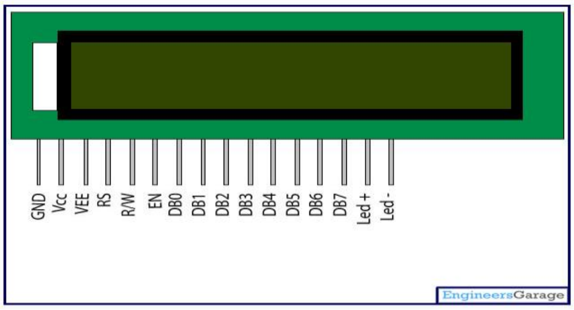

Fig -3: LCD Display

The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

2.3 PH Sensor:

The Analog pH Sensor Kit is specially designed for Arduino controllers and has a built-in simple, convenient, and practical connection and features. It has an LED that works as the Power Indicator, a BNC connector, and a PH2.0 sensor interface. To use it, just connect the pH sensor with the BND connector, and plug the PH2.0 interface into the analog input port of any Arduino controller. If pre-programmed, you will get the pH value easily. Comes in a compact plastic box with foams for better mobile storage.

1. Module power supply: 5 VDC.
2. Measuring temperature: 0-50 ℃.
3. Response time: ≤ 1min.
4. pH sensor with BNC connector.
5. Gain adjustment Potentiometer.
6. Power indicator LED

Fig -4: Analog PH Sensor

2.4. Humidity Sensor:

DHT11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller like Arduino, Raspberry Pi, etc. and get instantaneous results. DHT11 is a low-cost humidity and temperature sensor which provides high reliability and long-term stability. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and outputs a digital signal on the data pin (no analog input pins needed). It's very simple to use, and libraries and sample codes are available for Arduino and Raspberry Pi. This module makes is easy to connect the DHT11 sensor to an Arduino or microcontroller as includes the pull up resistor required to use the sensor. Only three connections are required to be made to use the sensor - Vcc, Gnd and Output. It has high reliability and excellent long-term stability, thanks to the exclusive digital signal acquisition technique and temperature & humidity sensing technology.

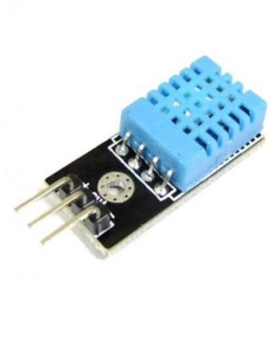

Fig -5: Humidity Sensor

2.6. Temperature Sensor (DS18B20):

This is a 1 Meter Long Waterproof, sealed and pre-wired digital temperature sensor probe based on DS18B20 sensor. It is very handy for when you need to measure something far away, or in wet conditions. Because they are digital, you don't get any signal degradation even over long distance.

These 1-wire digital temperature sensors are fairly precise (±0.5°C over much of the range) and can give up to 12 bits of precision from the onboard digital-to-analog converter. They work great with any microcontroller using a single digital pin, and you can even connect multiple ones to the same pin, each one has a unique 64-bit ID burned in at the factory to differentiate them. Usable with 3.0-5.0V systems.

The only downside is they use the Dallas 1-Wire protocol, which is somewhat complex, and requires a bunch of code to parse out the communication. When using with microcontroller put a 4.7k resistor to sensing pin, which is required as a pullup from the DATA to VCC line.

DS18B20 Sensor Technical specs:-

- Usable temperature range: -55 to 125°C (-67°F to +257°F)
- 9 to 12 bit selectable resolution
- Uses 1-Wire interface- requires only one digital pin for communication
- Unique 64 bit ID burned into chip
- Multiple sensors can share one pin
- ±0.5°C Accuracy from -10°C to +85°C
- Usable with 3.0V to 5.5V power/data

Fig -6: DS18B20sensor

2.8. **GSM Module**:

SIM900A Modem is built with Dual Band GSM based SIM900A modem from SIMCOM. It works on frequencies 900MHz. SIM900A can search these two bands automatically. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. SIM900A is an ultra-compact and wireless module. The Modem is coming interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The onboard Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem, you can make audio calls, SMS, Read SMS, attend the incoming calls and ect. Through simple AT commands.

Fig -8: GSM SIM900

3. CONCLUSIONS

Production of terrestrial crops by the usage of hydroponic system is beneficial in proper resource management and can yield much larger amount of healthy crops than traditional farming. Integration of this type of farming with internet and IOT opens up multiple opportunities to study the benefits of this system in many different regions of earth which further helps in improving the process of the system. The features of news feed or links to buy hydroponic system and its components helps to add another factor for a full, IOT backed system, for the user. Community building with the help of IOT web server can help to spread the awareness of hydroponics and also a platform for people to get connected and to share ideas and thoughts.

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