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Smart Aquaponics Farming Using IOT & Mobile Computing

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Abstract: In this technical era, farming or agriculture industry in our country India is still working on the traditional ways it can be modernized with the help of the new technology available, to the livelihood as well as distribution & price control. With the help of this technology it will be easier to monitor farming productivity and also increase the profits in farming. IoT in the next few coming years will be the top connectivity in the farming field. This will offer a very precise crop controlling, automation water pump & pesticide spraying and many more advantages will be there of network farming. In this paper we developed a sensible and smart aquaponics farming monitoring system with the key technologies likes: IoT, Mobile computing (Application), different sensors, WIFI Module, GSM Module. This aquaponics system is the combination of both hydroponics and aquaculture concerning vertical farming. An important aim of this project is that it is beneficial for both fish and plant growth. In this model, the same fish tank water is used for the plant growth where the bacteria in water will act as fertilizer to plant as the same plant water will be filtered and transferred. This fish tank makes reusing of water which will become cost-effective. This framing can be done anywhere as it doesn't have any size or place limit. This can also increase the revenue of both fish and plant farming. It is very easy as it can be managed by anyone in a small place with the help of technology.

Keywords: Aquaponics farming, hydroponics farming, fish farming, crop irrigation.

I. INTRODUCTION

Aquaponics is be related to the combination of both hydroponics (plant framing) and fish farming with reuse of water. It can also be refereed has Organic farming has it doesn't contain any chemical fertilizer instead of that it uses the bacteria and waste of fish as fertilizer through the water. Ammonia in fish waste is broken down by bacteria and converted into nitrites and then nitrates to be used as fertilizer for the plants. Our project implements an IoT system in Aquaponics to check the parameters of water so that it can be used for nourishing the plants and the fishes growing in them. The one of important parts is the bacteria which converts the fish waste into manure for plants. The entire system is monitored as variation in the levels of from optimum range will lead to the death of plants and fish. The project includes IC AT mega 382p, Sensors like Ultrasonic, PH, Soil Moisture, temperature & humidity s ensor for transmitting data over the internet. The value transmitted by the microcontroller is shown on LCD as well as on mobile application can control the water pump through it. The detected value is sent as a message to the farmer.

II. LITERATURE SURVEY

In 2015, Sharad surnar proposed research on innovation farming, where it discussed regarding an increase in the economical & sustainability of indoor and outdoor fish farming. Keeping in mind the aspects like sustainability, development & efficiency of the farmers to improve their health they reconsidered the agricultural science and by that they understood that they should involve environment free technologies. It combined the aquaculture and hydroponics and bought the name as aquaponic. It also has an idea regarding crop selection and how much the fish should be feed according to their size. They also have shown water quality measures. The result of the proposed research showed how it will increase economic efficiency with more production.

In 2014, RIGERS BAKIU1 proposed a paper on Aquaponic systems as excellent agricultural research instruments in Albania. It had the information regarding Aquaponic systems that are Recirculating Aquaculture Systems (RAS) that incorporate the production of plants without soil. Lots of vegetables have been grown in aquaponic systems. Pesticides were not be used to control insects on aquaponic plant crops. The result of the proposed research paper showed an excellent scientific research environment inside the greenhouses.

The very first study regarding the aquaponic system was done is Albania and the research paper on the same was proposed in 2017. The idea for that research came from the 1970s research regarding Aquaculture farming. There were challenges of recirculating water to maintain the nitrogen, ammonia & Oxygen. It also has a comparison of aquaponic farming with traditional farming for plant and fish growth. The result of the proposed research paper showed how it will control water pollution and water use can be done. It was done without using pesticides.

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III. PROCEDURE

A. Assembling of Aquaponic System

The fish tank and grow bed is used. There are 2 pipes used in this system.1st pipe is attached from the fish tank to the grow bed and 2nd pipe is attached from grow bed to fish tank this 2nd pipe will be connected to the filter system. Grow bed consist of some soil as well as the pebbles with plant in it.

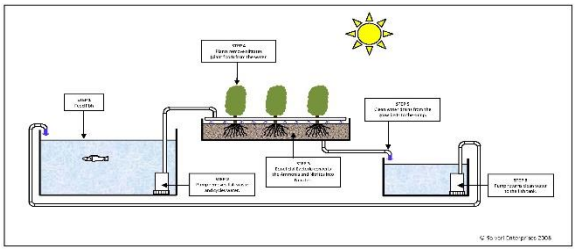

Fig.1-Aquaponics system representation

B. IoT & Mobile Computing

With the help of the different sensors and internet and WIFI connectivity all the valued are sensed from the sensor. The sensed valued are send to the farmer who doesn't have internet connectivity to their mobile. An AquaAgroTech mobile application is developed through which the farmer can see the value of the sensed sensor and the same can be controlled through the mobile application itself.

IV. AQUAPONIC SYSTEM

A. Existing System

The Existing system developed was full-on manual bases, where there was a lack of information regarding fish health and plant. There was no medium to connect the system with the internet or data server.

B. Water Quality

Water Quality of the system should be maintained properly as the reused water is recirculated from growing bed to the fish tank to ensure the proper health of the fish and plant too. This water needs to test continuously with the help of a different tester. In this model the PH sensor is used to check the quality of water.

C. Different Fish used & Fish Feeding

1) Tilapia

Tilapia is a great and tasty edible fish that adapts easily to most environments. It is a hard fish and has a different diet. They can survive on algae, worms, insects, and even fish. Tilapia is one of the fish for aquaponics, simply because it is so hardy. They require a temperature range of 28° – 30°C but can survive outside of this range. The preferred pH value required is 6.5 to 9. They die when the water goes lower than 10°C

Fig.2-Tilapia Fish

2) Catfish

Catfish are great for the aquaponics system. After adapting to the tanks, they will grow fairly quickly. They are fast-growing fish. They require a temperature range of 24° – 30°C but can survive outside of this range. The preferred pH value required is 7 to 8.5.

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Fig.3-CatFish

3) Goldfish

In case if you are not planning to eat fish from your system, you can also use ornamental fish. Goldfish is a great choice as aquaponics fish, and it is easy to take care of. They require a temperature range of 25° – 27°C but can survive outside of this range. The preferred pH value required is 6 to 8.

Fig.4-Gold Fish

This is mostly used fishes instead of that there are many more fishes that are used in the aquaponic system like Prawns & Shrimps, Tetra Fish, etc. Fish food needs to be well balanced in terms of amino acids, proteins, fats, vitamins, minerals and carbohydrates. Algae, worms, insects, and even small fish can also act as fish food for all these fish.

D. Grow Media

Grow media serves as a support structure for the plants in an aquaponics system. Not only does the media keep plants in a stationary and upright position. Aquaponics grow media serves as an interchange for oxygen and moisture and gives worms a comfortable habitat to live in. The optimal PH range if the system is 6.5 to 7. The depth of growing media should be approximately 12-inch. It should be PH-Neutral. It should not be so heavy as well not to light that it will float or clog up the system.

E. Pebbles

The different type of pebble is used in grow bed which helps in the filter process. Pebble material like clay pebbles (L.E.C.A), Lava Rock, Gravel. This pebble can be mixed with the soil too.

1) Clay (L.E.C.A)

Clay pebbles are lightweight but heavy enough to provide good support to a plant. These pebbles are also pH-neutral, non-degradable, and release almost no additional nutrients into the water. Their highly-porous composition and spherical shape help to maintain beneficial oxygen to water balance while also providing gardeners a smooth surface to work.

Fig.5-Clay Pebble

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2) Lava

Lava rocks have been used as hydroponics and aquaponics growing medium for decades. They are lightweight and porous and provide beneficial drainage, aeration, water retention, and even trace elements to the system. And, like any good growing medium, lava rocks are pH-neutral.

Fig.6-Lava Pebble

3) Gravel

Gravel is the least expensive aquaponics grow media, but it's also the most problematic. For one, it's denser than the alternatives. This may be acceptable for supporting taller plants (like corn), but not so well with smaller plants. It can be a challenge to locate the proper size gravel, but pea size and river gravel are the best options.

Fig.7-Gravel Pebble

F. Crop Selection and Their Nutrition

Lots of plants can be grown successfully using this technique. Firstly, it was said that leafy vegetables and herb only can be grown through this but after few types of research it concludes that fruit crop, vegetables, flowers, etc. different plant requires varies different nutrition or nutrient. However, in aquaponics system plants requires at least 16 main nutrients for their maximum growth. These nutrient likes oxygen, hydrogen and carbon come from water which is supplied. Carbon dioxide and atmospheric air contain many more nutrients.

V. OBJECTIVE

The main objective of this project is to increase the livelihood of aquaponics farming technology. There various objectives of this project:

1. Revenue can be increased.

2. Both crop cultivation & fish farming can be done.

3. Real-time information can be taken.

4. It can be controlled using a mobile application.

VI. METHODOLOGY

This model contains methodology to create a unique or smart aquaponics system that is suitable for every atmosphere as well as the economic strata of the country. This project is principally implemented on agriculture and production using traditionally with technical ideas. It's an innovative technique that is brought into the scenario by a combination of hydroponics and aquaculture. With the help of electronic media, it will increase the productivity and also the quality is maintained. it'll also create interest for Next Generation Youngsters within the field of Agriculture. As traditional techniques of agriculture were very tedious and time taking process so Aquaponics farming may be a solution with the incubation of IoT and Mobile Application. Where the data sensed will be shown on the mobile application however in rural areas same data can be received through a text message.

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A. Circuit Diagram

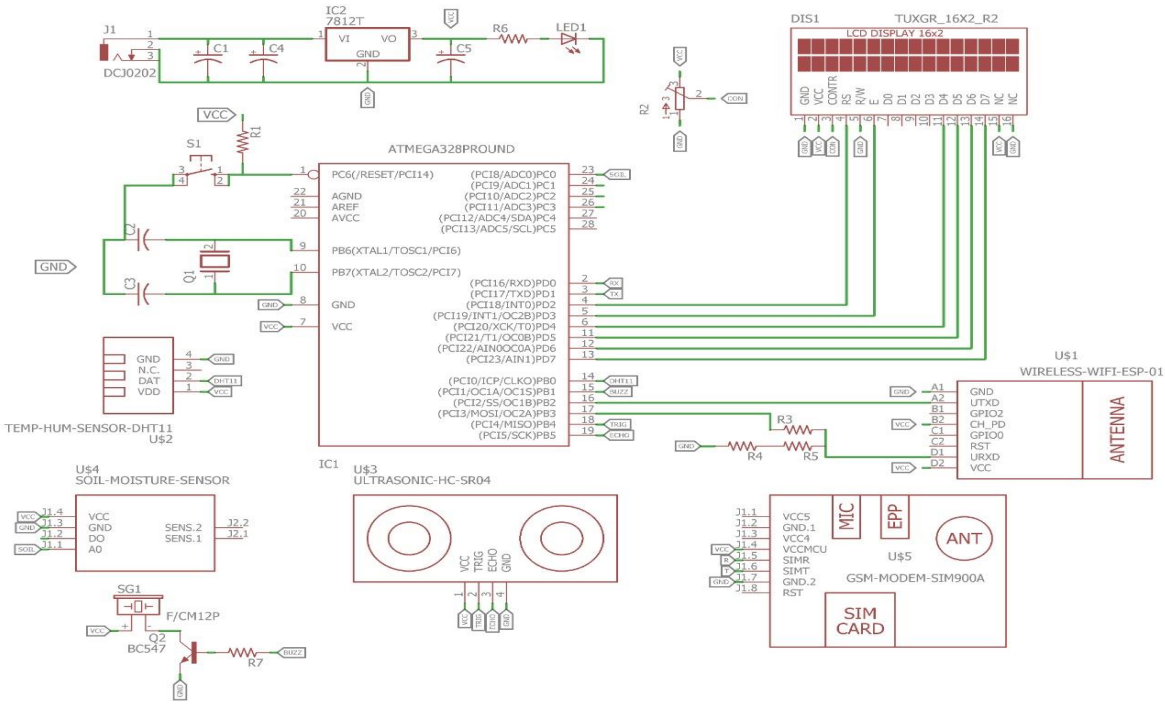

Fig.8-Circuit Diagram

B. Hardware Component

- IC Atmega 328p

Fig.9-IC Atmega328P

The high-performance Microchip Pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash with read-while-write capabilities. The board has 14 digital input and output pins, 6 analog inputs, 16 MHz quartz, USB, an ICSP circuit and a push button. The microcontroller may be programmed with the Arduino software.

- Soil Moisture Sensor

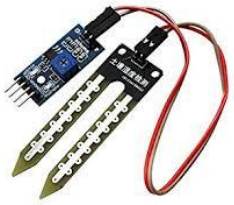

Fig.10-Soil Moisture Sensor

The Soil Moisture Sensor uses capacitance to measure the water content of soil (by measuring the dielectric permittivity of the soil, which is a function of the water content). When the sensor value will be higher than the threshold value, then the digital pin will give us 5V and the LED on the sensor will be turned on and when the sensor value will be less than this threshold value, then the digital pin will give us 0V and the led on the sensor will be turned off.

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- DHT11

Fig.11-DHT11

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It also uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed).

- Ultrasonic Sensor

Fig.12-Ultrasonic Sensor

The ultrasonic sensor (or transducer) works in the same way as a radar system. An ultrasonic sensor can convert an electrical signal into acoustic waves and in the other form. The ultrasonic signal is an ultrasonic wave traveling at a frequency above 18kHz. One of the HC SR04 ultrasonic sensors generates ultrasonic waves at 40kHz frequency.

- PH Sensor

Fig.13-PH Sensor

PH sensor is mostly used for water measurements, it a measure of acidity and alkalinity, or the caustic and base present in a given liquid solution. It is generally determined with a numeric value ranging from 0-14. The value 7 represents neutrality. The value of the sensor increases with increasing alkalinity, while the value of the sensor decreases with increasing acidity.

- GSM Module

Fig.14-GSM Module

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SIM800 is an instrument with a quad-band GSM/GPRS module designed for the worldwide market. It works on frequencies 850MHz GSM, 900MHz EGSM, 1800MHz DCS and 1900MHz PCS. This module as features like multi-slot class 12/ class 10 GPRS (optional) and it also supports the GPRS coding schemes CS-1, CS-2, CS-3, and CS-4.

- ESP8266 (WIFI Module)

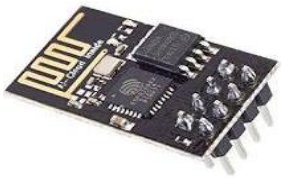

Fig.15-ESP8266

ESP8266 is a Wi-Fi providing system on chip (SoC) module it also has integrated TCP/IP stack. It is mostly used for the development of IoT (Internet of Things) and embedded applications. This is a 3V Wi-Fi module very popular for its Internet of Things applications. ESP8266 works on a maximum voltage of 3.6V and its very important.

- LCD Module

Fig.16-LCD Module

An LCD is a display module that uses liquid crystal to produce a visible image. The 16×2 LCD is a very basic module commonly used in DIYs, circuits and many projects. The 16×2 can display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7-pixel matrix.

C. Tolerance range

Table- I: Tolerance range of Water Quality Parameters in Aquaponics System

Parameter	Temperature	PH	Ammonia	Nitrite (mg/L
Aquaponics	18-30 degree	6-7	< 1	< 1

VII. RESULT AND DISCUSSION

The existing problems seen in the traditional aquaponics system can be overcome by introducing technical & electronic approaches in the system. This also encourages the young farmer as well as common people for doing this farming and producing organic and healthy food. With this model farmers will be able to monitor their aquaponic farming from anywhere. The real-time value will be shared with them using message service as well as through the mobile application. This will also increase their revenue and there would be a change in their livelihood. Aquaponic farming is not that difficult to do. Using this Smart and technical system will make it easier to use the system. This makes it easier for the farmer to connect with the aquaponic system.

In this project Temperature sensor, Ph sensor, soil moisture sensor, ultrasonic sensor is interfaced with IC 328p. The This value is detected from the microcontroller and is displayed on 16x2 LCD. with this Farmer can do aquaculture and hydroponics farming together so this will increase efficiency, development and productivity and profitability. This same can be used by the rural area farmer where they can be informed regarding fish and plants through an SMS system.

VIII. CONCLUSION

Significant reduction in the usage of water will be observed when compared to traditional aquaculture and enhances the economic stability of the farmers by providing a yield of both fishes and plants and also reducing the resources spent for water. Aquaponics grown vegetables are bigger and healthier than when grown in soil. There is no need to use artificial fertilizer to feed the plants. SMS Facility will be available to farmer regarding their crop and database will be available if they are of urban/Rural area and an applet will be developed.

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BIOGRAPHIES

Janavi Ravindra Chavan is the Student of last year Electronics and telecommunication Engineering of Pillai Hoc College of Engineering and Technology. She completed her diploma in EXTC. Currently she is member of the IETE Student forum and was the Vice-chairperson of the IETE student forum on campus for academic 2018-2019. Performed mini project on IC 741 &555 Tester, Person Detector using PIR Sensor, app development of a calculator. Diploma Last year project developed was the home automation system.

Kiran Prakash Jangam is the student of last year Electronics and telecommunication Engineering of Pillai Hoc College of Engineering and Technology. He has completed his diploma in EXTC. Currently a member of IETE Student forum. Performed mini project on app development of a calculator. Diploma Last year project developed was Eye Writer.

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Dr. Divya Y. Chirayil, Associate Professor at Pillai HOC College of Engineering and Technology, Rasayani.She is having 19 years of teaching experience and guided many Master's Degree students. She has received her Ph.D. in Electronics and Communication Engineering from Gandhi Institute of Technology and Management (GITAM) University, Visakhapatnam and Master's Degree from Mumbai University. Her specialization area is Wireless Communication. She has completed various research projects funded by Mumbai University. Her research areas include satellite communication, optical fiber communication, wired communication and artificial intelligence. She has contributed more than 20papers in peer-reviewed International, National journals and conference proceedings. She is a life member of ISTE