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Implementation of IOT based Aquaponics Farming System

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ABSTRACT:

Agriculture is one of the important sectors in India. Food is a basic need of every person. But traditional farming has drawbacks of being dependent on soil quality, climate conditions, chemical fertilizers and pesticides water. To overcome the problems of traditional farming problem there is one technique called Aquaponics which is combination of aquaculture and hydroponics. Aquaculture deals with growing of fish and hydroponics deals with growing of soilless plants by providing with necessary nutrients. Aquaponics system which will provide natural food for the country. It will provide fish as well as plants too for humans. As using this technique water is reused, it requires less space, user gets natural food. Aquaponics can be automatically managed and controlled by making use of IOT technology with the help of sensors like pH, temperature and humidity, dissolved solvents, water level sensors. Operating the sensors on microcontrollers like NodeMCU and Arduino UNO whose reading can be obtained on Blink application for monitoring purpose. This technique can be built indoor as well as outdoor system. Sensors reading can be further used for research purpose.

KEYWORDS: Aquaponics, Hydroponics, fish, IOT, farming

I. INTRODUCTION

Agriculture has provided the most of the population with natural food but nowadays the use of pesticides has been increased for fast growth of the crops because of which it has caused damage to human health and the problems related to soil also increased in the past few years[4]. Because of which we have introduced aquaponics system for the growth of the plants naturally with the help of fish extract [6]. Hydroponics is used to supply nutrient to plants without soil [8].and aquaculture is just growing of fish naturally like fish farming. Also, most of the people prefer fish in their diet so its beneficial for them too as growth of fish also takes place in this system with proper and natural care. Years before everything was natural so to bring up the same natural food, we have introduced this aquaponics system that resolves soil and natural food issues together [5]. The purpose of the contribution statement is this system is automatically getting monitor by using IOT domain. Water temperature, surrounding temperature, humidity. pH factor, total amount of dissolvent and water temperature can be monitored using sensors. Grow light and Water pump get automatically turn on- off using relays. User gets notification of all data about via message using BLYNK application [11]. Using combination of Aquaponics and IOT user will be benefited by following:

- Less water is required as water get reused. So, farmers don't have to depend on rainwater.
- Less space is required as layer wise farming is done.
- Farmers don't have to worry about soil related problem as it is soilless planting. Nutrients for plant are provided using fish extract.
- Profit percentage is increased.

This project focuses on making the agriculture soilless as well as making it feasible to use anywhere. For which we will be using all the knowledge of hydroponics and aquaponics. The aim is to make an aquaponics system that will help grow fishes and plants together indoor. The sensors are used to take certain readings which will let us know whether the system is normal or not. That will go to Blynk cloud, which will keep the readings on the cloud, then send the readings to the Blynk application on the smart phone [11]. Using the knowledge of Arduino and the cloud, we will send the data to the cloud that will display the results. Using the readings, we will be able to know the system is working properly or not. Sensors, Arduino and Cloud is used to take readings and display the readings too. This is the main paper of this research, this paper totally focuses on recent development in soilless farming, hydroponics and aquaponics making it feasible for farming at individual level or even can be used by farmers. Also, the system once automated then it will reduce most of the manual work of farming and will help in having the natural growth of plants. The system was developed taking the idea of hydroponics and aquaculture. The fish extract contains ammonia and the nutrients needed by the plants too that's why it became helpful in developing the system combining this both. The system is built keeping in mind that the fish should be grown naturally and the plants too simultaneously. The plants extract nitrogen which is needed from the fish and then it will grow naturally without any use of artificial chemicals and fertilizers. In fact, the system eliminates the use of artificial use of chemicals and other fertilizers. Information obtained from cloud is used to give accurate readings to determine the readings that affects the system. The system presented in this paper aims to highlight the soilless farming with the help of plants.

II. RELATED WORK

In today's time the world has faced many health issues because of unavailability of natural food. Also, the artificial fertilizers and chemicals are used for the fast growth of plants due to which the soil loses its original nature and it takes years to regain that back. Farmers have no alternative than to grow plants artificially with the help of chemicals and fertilizers available.

III. METHODOLOGY

Aquaponics system consists of hardware components like DHT11 , DS18B20, ph sensor, TDS Sensor, Ultrasonic Sensor, ESP8266 nodemcu, 5V Relay, Water Pump, Arduino UNO, Wires, Breadboard, Resistors(4.7k), 3 Carters(Growbed, Fish Tank, Sump Tank), Air Bubble Stone, Bacteria(Nitrosomonas), Clay Plates, LED Strips(Red, White as growlight), Growbox, Sponge, Fish(Koi, Tilapia), Fish food, plant seeds(Cucumber, Spinach, Tomato), Pipes, Sunmica Sheet and Software Requirements are Arduino Sketch, Blynk Application.

Firstly, all 3 carters are placed one above the other in the order Sump Tank, Fish tank and Growbed. All three carters are connected with pipes in vertical manner. The sunmica sheet is placed above the last growbed with holes for growbox fitting. The plant seeds are initially kept in a sponge with some water for growing into sapling. After one week of growth of sapling, it can be kept into the growbox which is placed in last growbed. The sump tank below will have clay plates for filtering of water to some extent. The fishes in the fish tank , that is, the second tank will be fed with fish food for fish growth. Fishes will leave some extract which will settle down the tank and with help of pipes this wastewater will come into the sump tank which is having motor to circulate the water to the plants in the growbed. The sump tank will have clay plates which will help storing some amount of water.

The plants will get nutrients for its growth from fish extract water and with LED strips placed above the plants will help the plants to do photosynthesis process as well. More the water is recycled more efficient the system will be for future. The sensors are used for testing whether the system is working properly or not. The ph of the water in which fish exist can change which may be harmful for fish life. Also, the temperature of water shouldn't exceed a certain limit which is necessary to be maintained. The ultrasonic Sensor is used to check the height of water in fish tank.

Blynk app is freely available in Google Playstore which is used to show sensor readings in graphical format which makes it easy to read it[11]. Also, the TDS sensor is used to check the dissolved solvents in the fish tank and its readings is taken by the Arduino which is interfaced with Blynk App to get readings. Also, the relay is used to interface the Arduino for switching on and off automatically so that motor supplies water efficiently to the plants. DS18B20 is used to check the temperature inside the water and DHT11 is used to check the temperature outside the carter. All this sensors will be interfaced with NODEMCU to Blynk app. Also, the aquaponics system require PH of 6.8. The air bubble stone will be used to supply oxygen for the fishes.

IV. EXPERIMENTAL RESULTS

A. Algorithm:

- Collect the information of the aquaponics system from various available sources.
- Study of all hardware components and software requirements for project from IOT point of view.
- Finding the estimated cost of components for the project.
- Designing a basic outline for implementation purpose.
- Preparing an aquaponics system:

Gathering of all hardware components.

- Establish model of Aquaponics system.
- Interfacing of sensors, components (relay, led light, air pump, water pump, grow light etc.) with microcontroller.
- Testing of connection.
- Achieving Readings and data.
- Processing it to finding out trends.

B. Block Diagram :

The components below shown are used in functioning of the aquaponics system, also the sensors are used to handle the worst-case scenarios.

Component used are mostly the sensors for the proper functioning of the system as if there are any inappropriate conditions rising then the sensors will always give the readings for awareness.

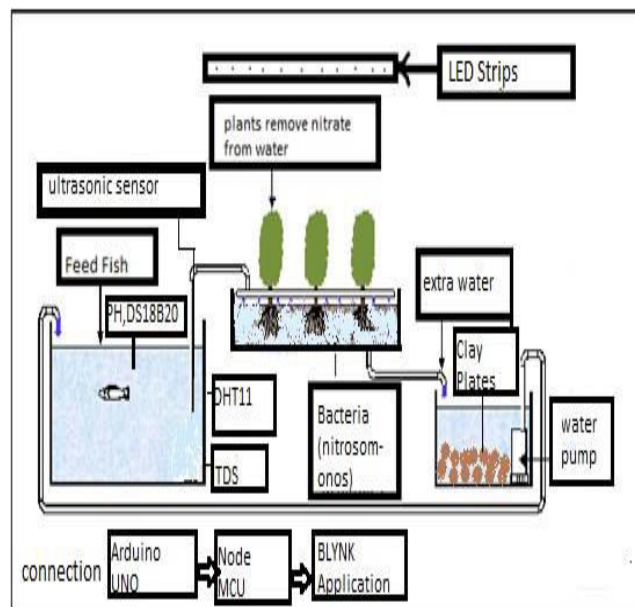
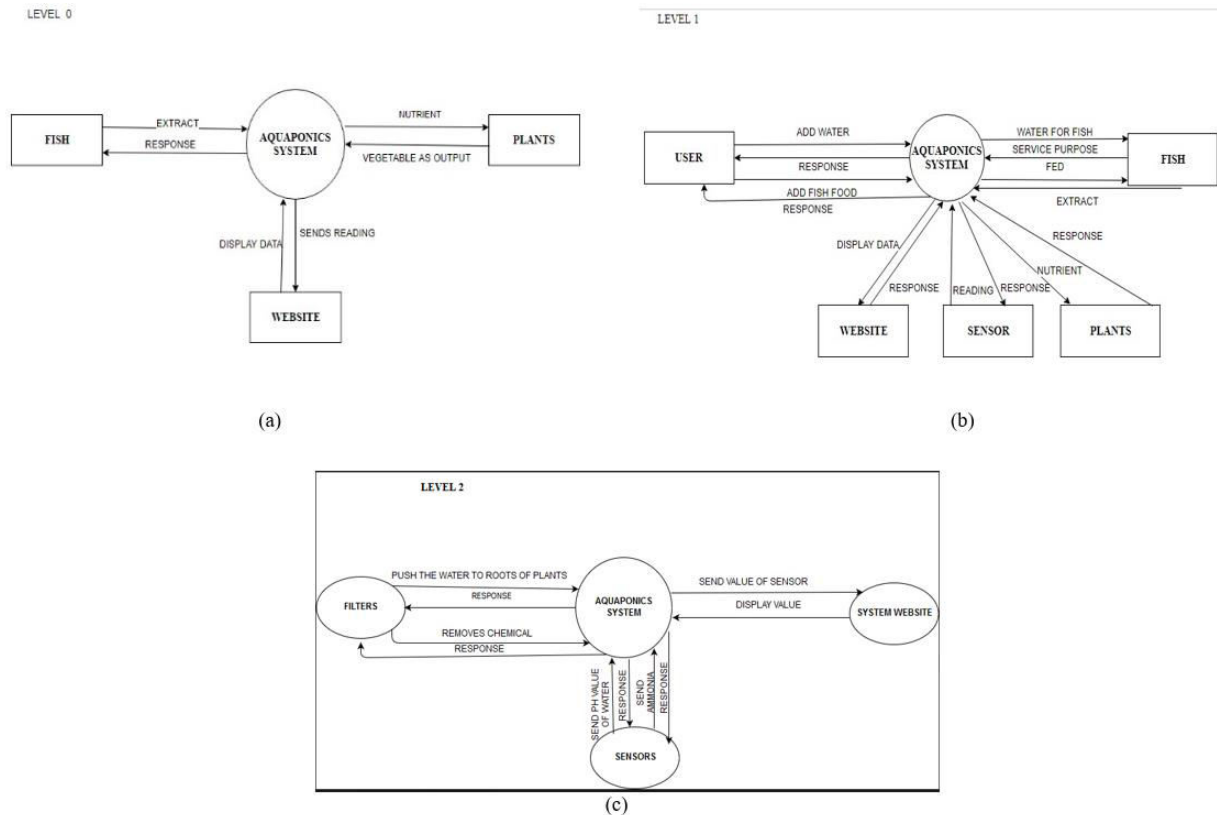


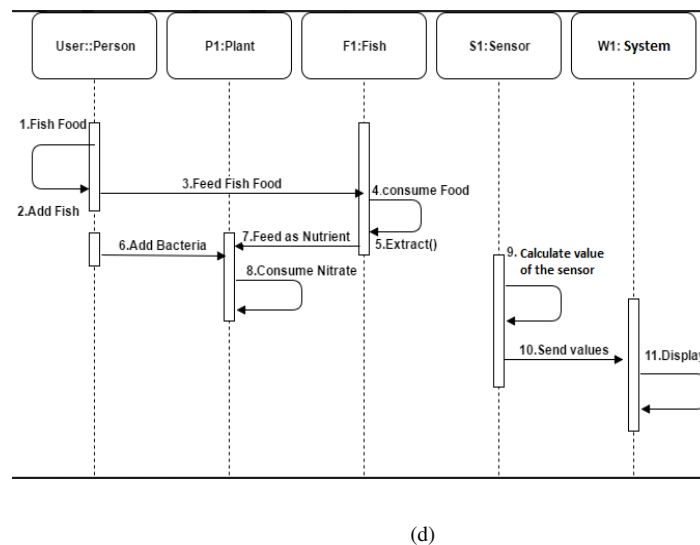
Figure Labels: Ultrasonic Sensor, Feed fish, pH, DS18b20, DHT11, TDS, plants remove nitrate from water, Bacteria (Nitrosomonas), LED Strips, Extra water, Clay Plates, Water Pump, Arduino UNO, Node MCU, BLYNK Application.

C. Data flow and sequence Diagram

A data-flow diagram (DFD) is a way of representing a flow of a data of a process or a system. The DFD also provides information about the outputs and inputs of each entity and the process itself [10]. Level 0, level 1 and Level 2 DFD for aquaponics system is shown in figure (a), (b) & (c).



A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario [9]. Sequence diagrams are typically associated with use case realizations in the logical view of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios. Figure d shows sequence diagram for aquaponics system.



D. IMPLEMENTATION

The fish is fed with fish food in second carter (fish tank) to leave extract. The fish tank has sensor like TDS to check the solvents(extract) in water. Also, the carter has pH sensor to check the pH of the water. The fishes needs pH between 6 to 7. Also, the fish extract will go into the sump tank with help of pipes in the fish tank. The sump tank consists of clay plates which will keep the water cool and will also act as filter. The fish extract in the sump tank will

be sent to the first carter (Growbed) with help of motor in the sump tank. The ultrasonic sensor is kept in sump tank to determine the water level and DS18B20 sensor is placed inside the tank to determine the water temperature. Also, the plants in the first carter will absorb the fish water obtained from the sump tank and will start growing. The LED light is placed above the plants as the plants need to do photosynthesis process. The DHT11 Sensor is placed outside the carter to determine surrounding temperature and humidity.

This tank consists of clayplates which keeps the water cool and acts as filter. The tank consists of ultrasonic sensor to determine the water level and consists of DS18B20 sensor to determine the temperature of water. The tank consists of motor to draw water from sump tank to the growbed.

The fish tank consists of fishes which is fed with fish food to leave extract for plants. The fish tank consists of pH sensor to determine the pH level of water and consists of TDS Sensor to determine the dissolved solvent (extract).

The growbed consists of sunmica sheet with holes in which growbox is kept with clayplates. The plants are placed in the growbox and the LED light is placed above third carter which will keep in photosynthesis process.

Koi fish is easily available and is cheaper than other fishes. Also, this fish is less prone to diseases compared to other fishes. The fish extract is rich in Nitrates and nitrites which is required by the plants. And the extract contains magnesium, phosphates, carbohydrates, sulphates in a very small amount which is also needed for plants. A koi's diet should consist of six main building blocks: protein, fats, carbs, fiber, vitamins, and minerals. A young koi needs more protein than an older one. Koi will get their fats from wheat germ, fish meal, and corn oils in prepared foods. Avoid koi food made from rice, wheat, and corn they contain too many carbs. Instead, look for ones deriving carbohydrates from vegetables and fruit. Spinach plant can grow fast easily. It requires nutrients which is already available in fish extract. Spinach requires soil in the pH range of 6.2 to 6.9. Spinach plants require a fertilizer that is rich in nitrogen when they are about halfway through the growing cycle. Hence instead of using artificial fertilizer we can use fish extract which is natural fertilizer.

The carters are placed one above the other and are having holes in first two carters which is fitted with pipes to height of carter. The last tank is not having any hole and is filled with water till half. It contains clayplates to keep water cool and to also filter water. And the motor is also placed in the tank to draw the water from sump tank to the first tank which is the growbed. The sump tank consists of the ultrasonic sensor to determine the height of water level. The DS18B20 sensor is also placed in sump tank to determine the water temperature. The second tank is filled with water for fishes and the fish is given fish food to leave extract. The TDS sensor is placed in second tank to determine the dissolved soluble like extract of fish and contains the pH sensor to determine the pH of the fish tank. Also, DHT11 Sensor is placed outside the carters to determine surrounding temperature and humidity. The sensors are controlled with the help of microcontroller. The sensors like DHT11, DS18B20 and Ultrasonic are controlled with help of NodeMCU and sensors like TDS and pH is controlled with help of Arduino UNO microcontroller. The first carter contain pipe from sump tank for the supply of water. The carter is placed with sunmica sheet which is used to keep growbox by making holes. The growbox contains some clayplates and plants placed between them. The bacteria named Nitrosomonas is being sprayed for two to three times in a week for its proper growth. The fish water contains ammonia which needs to be broken down into smaller and simpler molecules by plants and nitrosomonas help in that process. Figure 6 shows implementation of aquaponics system.

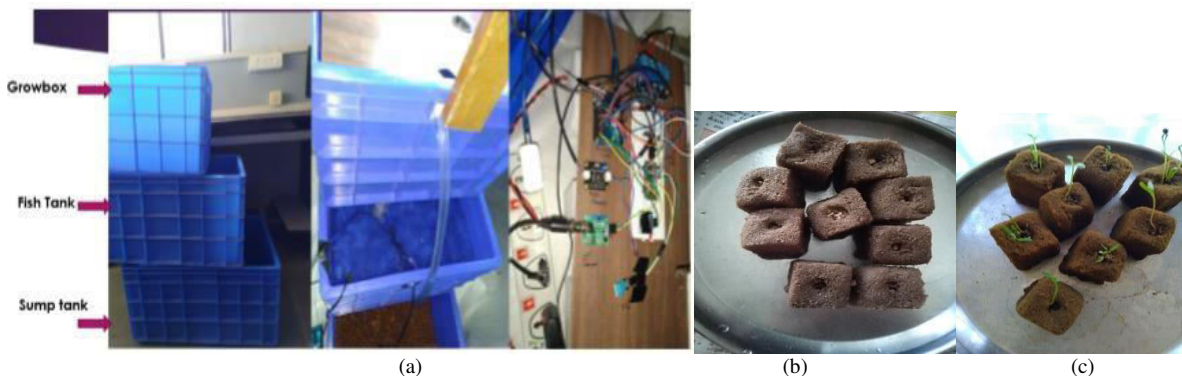
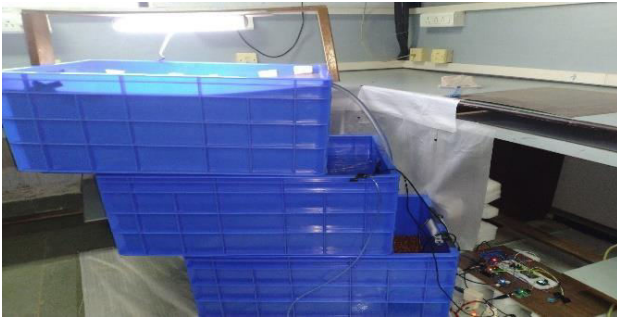
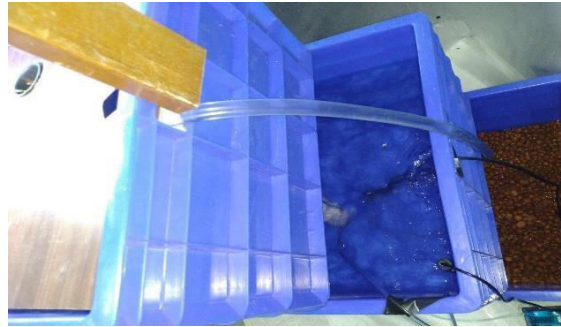


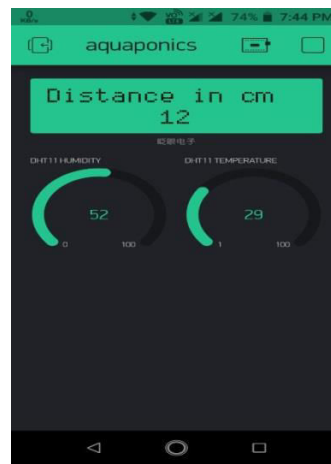
Figure a shows seeds added in sponge to grow it into sapling and shows how after 8 days seeds grow into sapling. Sponges are given water regularly and kept into sunlight. Figure b shows actual implementation setup of the aquaponics system. Figure c shows the internal structure of the system. All three tanks are visible over here.



(a)



(b)



(d)

Figures shows the results of text detection from an image and inpainting by using exemplar based Inpainting algorithm. Figs. 2, 3, 4 (a) shows the original image. (b) is the image obtained by applying first set of criteria. All objects whose area greater than 10000 and filled area greater than 8000 are eliminated and major axis lengths are in between 20 to 3000 are considered to be text. Still, some small non-text objects are detected.

V. CONCLUSION

This system is developed to avoid the use of artificial fertilizers and chemicals that is used to grow the crops. The farmers who face this issue of growing natural food will get solved using this system. The fish extract used here is natural nutrient for the growth of the plants. In future the farmer will make profit out of this and the loan issues might get resolved to certain extent.

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