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IOT Implemented Smart Aquaponics System Using Arduino with Fuzzy

Vinodh P Vijayan[1*], Neena Joseph[2], Neema George[3], Simy Mary Kurian[4]

[1,2,3,4]Department of CSE, MangalamCampus, Ettumanoor, Kottayam, India

[*]*Corresponding Author: vinodhpvijayan@yahoo.com, Tel.: 9961687007*

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Abstract— Aquaponics is an emerging region in food manufacturing technique which combines traditional hydroponics with aquaculture in a symbiotic surroundings that enables a sustainable machine with essential input as all of the water and nutrients inside are re-circulated in order to develop terrestrial plant life and aquatic lifestyles. When aquaponics gadget meets with technology it appears to produce some first rate outputs which makes it green and productive generation. In Iot Based Smart Aquaponics System with Fuzzy Logic, we take specific readings regarding the pH stage, temperature, moisture content and the extent of the water by using using distinctive sensors. Readings from every of these sensors are stored in the server for destiny use. Also these values are utilized by the bushy controller which controls the overall working of the system in drastic condition. Iot removes the gap between the physical world and digital international. In order to introduce technologies to the conventional aquaponics machine, we use of Arduino, Fuzzy controller and Internet of Things.

Keywords— Aquaponics, Arduino, IOT, fuzzylogic, MachineLearning, SVM, Matlab

I. INTRODUCTION

Aquaponics is a brand new cultivation generation and so lots of us are not more aware about that. It is an rising generation which mixes each aquaculture (rearing of fish) and hydroponics (the method of cultivation of vegetation without soil) together right into a single machine. How it is viable? This is a system which includes a fish tank as a part of aquaculture and a developing bed for cultivation of vegetation. Excreta of the fish are used as fertilizer for the boom of flora. For that, water from the fish tank is exceeded to the growing bed. In the growing mattress, microorganisms gift inside the roots of vegetation breaks the toxic contents present inside the waste water, purifies it and get pumped returned to the fish tank. This is a cyclic procedure. The trouble is that, as it is a cyclic system we have no concept about the pleasant of water. It does no longer give any assure that the water which gets pumped back into the fish tank is free from poisonous contents. If there exist any presence of dangerous substances within the water then it consequences for the demise of aquatic animals within the tank. In the paper "IoT primarily based Aquaponics Monitoring System" via Abhay Dutta,[1] they used one-of-a-kind functions to display pH price, temperature and humidity stage, water level using the unique sensors has been accomplished and then after perceiving those values from the sensors, the values were displayed thru a 16*2 Liquid Crystal Display in addition to on the net with the aid of the software of Internet of Things. To connect the sensors with the net, the database server and application server can be controlled with a view to display the data regarding the sensors. In order to introduce generation to the traditional aquaponics gadget, they use Raspberry Pi microcomputer and Internet of Things within the machine has been achieved.

Aquaponics is a food production method that combines the traditional hydroponics with aquaculture in a symbiotic relationship that facilitates a sustainable system with necessary input as all the water and nutrients within are re-circulated in order to grow terrestrial plants and aquatic life. This technique of agriculture can possibly replace other traditional methods if brought in use effectually. And when traditional Aquaponics meets the technology, remarkable outcomes could become visible. The IoT based Aquaponics Monitoring system features to monitor pH value, temperature and humidity level, water level using the specific sensors has been done and then after perceiving those values from the sensors, the values were displayed through a 16*2 Liquid Crystal Display as well as on the web by the application of Internet of Things. A new technology, Internet of Things has been introduced that bridges the gap between the physical world and the digital world and that starts with things. To connect the sensors with the internet, the database server and application server can be managed so as to display the information regarding the sensors. In order to introduce technology to the traditional aquaponics system, use of Raspberry Pi microcomputer and Internet of Things in the system has been done.

In "IoT Fuzzy Logic Aquaponics Monitoring and Control Hardware Real-Time System" by way of Adnan Shaout and Spencer

G. Scott [2], they delivered fuzzy common sense for the assessment of input and to generate their precise output. Instead of Raspberry Pi, they used Arduino Uno R3 board for their hardware. In our paper we're combing Aquaponics device with fuzzy good judgment and Internet Of Things at

the side of gadget getting to know for choice making. SVM classifier is used as the classifier. Also we're the use of the equal Arduino Uno R3 board as our hardware. Here we use different sensors for studying values like pH value, Temperature degree, water level and Moisture content material. These values may be monitored with the aid of the purchaser (person) over cell utility thru Internet Of Things.

Figure 1: Simple Aquaponics System

II. LITERATURE REVIEW

Dr. J Rakocy alongside along with his buddies started out a studies inside the utilization of deep water tradition hydroponics grow mattress in an in depth aquaponics device and determined fast boom of root inside the machine. Also they located that the system runs in shape with low pH value [3]. Aquaponics is an inexhaustible manner for cultivating natural veggies and end result with out the usage of any chemical fertilizers. It is technique that is definitely green [4].

Aquaponics is one of the growing technology whose foremost aim is to reuse the nutrients pulled out through fishes in the fish tank and is applied for the growth of vegetation. This will facilitates to avoid the use of poisonous insecticides, fertilizers and insecticides [5]. An Arduino Uno Microcontroller will provide an accurate manipulate over the aquaponics cycle. It will allows us to manipulate the system from anywhere within the global [7]. Wang proposed a way about one of a kind sensors and about their controlling. This is an interactive software in which the records is occupied through a webcam. Also as stated that this is an interactive technique, the customers can constantly reveal and manage the gadget.

Arduino is used in its hardware device [9]. Cho Zin Myint and his friends present a new sensor interface tool for monitoring the best of water. It works in an IoT environment. It also include Zigbee based totally wi-fi communique module. FPGA (Field Programmable Gate Array) is the core aspect in his proposed system [10].

There are several advantages according to our needs, the aquaponics systems offer the possibility to grow small spaces in urban areas and a closed-circuit production with a fairly large water saving (according to sources 80% to 99% less water than the conventional method), moreover, the above-ground watering implies reduce the problem concerning plant diseases so more healthy food, for example, the chemical treatment and disinfecting agents are used limitedly or exclude, a better control growing because the controlling of temperature, pH, water, and nutrient. Furthermore, very little maintenance and weeding compared to the conventional method so no more than 5 to 10 Maximum of minutes per day to check the correct operation and feed the fish.

Besides, aquaponic can be used, for example, as an educational tool for university students, who can be apprentice the different fish and plants in aquaponics, so integrate the student in a deep environment and offer him a rich and concrete experience in technology. The implantation of plants and the fish's rearing used in certain research laboratories such as biology, nutrition, etc. Moreover, even the medical plants intended for the biology laboratory to enrich the experiments and tests carried out by those laboratories. And finally, the possibility of having different models and types according to the space and the system can be installing regrouped or separated.

This paper is organized as follow, the second section is dedicated to present a balance of sheet of regarding existing of aquaponic solution regrouped in the related works section, the third part is dedicated to present the health and economic benefits of an aquaponic system, section four is dedicated to the presentation of our proposition of a smart aquaponic based on phytotron solution, and finally the last section consist to present the conclusion and perspectives of the paper at hand.

III. ARCHITECTURE

Coming to the architecture side we have a fish tank, different sensors, grow bed, embedded section, fresh water tank etc. As we mentioned earlier water in the fish water gets contaminated due to the presence of fish waste material.Therefore we need to purify them for the healthy growth of aquatic lives in it. Also we need to maintain a particular water level in the tank. An ultrasonic sensor is connected with the fish tank which checks the water level which is connected to an Arduino UNO R3. Also it contains other sensors like pH sensor, Temperature and Humidity sensors. Senses read the data in every 30seconds. All the readings are passed into the Arduino board. Inorder to provide more reliability Matlab is used for programming phase.

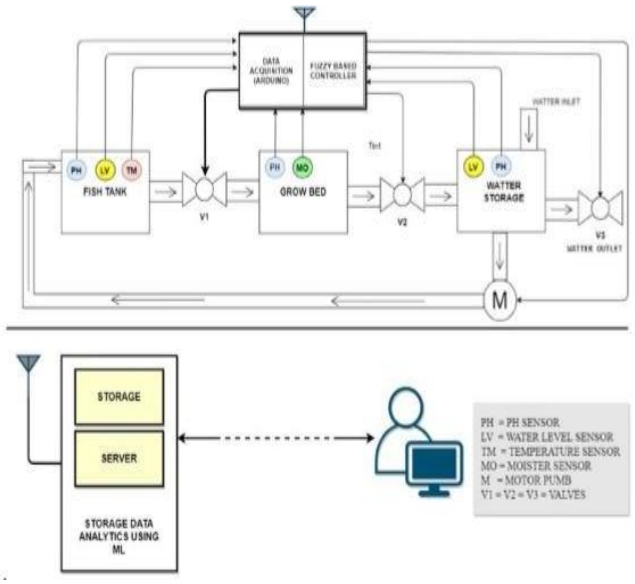

Figure 2: General architecture of the system

At first consider the situation in a fish tank. Sensors read the price of water level, pH and temperature from the fish tank at each 30 seconds. These values are evaluated with the aid of fuzzy based controller and the results get displayed within the 16*2 liquid crystal display display. Valve is placed outside the fish tank. Whenever the pH of the water is excessive, a buzzer sound could be produced as the output and a trigger message is brought about to open the valve so the water will flows in the direction of the grow bed for purification. In the same time, ultrasonic sensor senses the water stage and if it is under forty% a notification could be send to the person each thru the liquid crystal display show and to their telephones.

Thus the user can robotically deliver instruction to pump water from the second one water tank which has purified water to the fish tank. Plants inside the grow bed will absorb the water coming from the fish tank. It breaks down the toxic content present in it thereby manipulate its pH content material. Moisture sensor senses the moisture content within the soil. When the quantity of water inside the soil is underneath the desired cost then water is sprayed into the soil. After purification pH of the water is again calculated before leaving them to the tank. Water is allowed to pass within the 2d tank simplest it satisfies the required pH price.

Machine gaining knowledge of is an idea to learn from examples and revel in without being explicitly programmed. Instead of writing code we feed facts to the time-honored set of rules and it builds common sense primarily based on the statistics given. Working of the machine relies upon at the output of Fuzzy device. Output information gets stored within the server. As the sensor senses the facts at every 30seconds, big quantity of records gets saved within the server. Machine studying makes prediction on the basis of this information and makes changes by way of giving a brand new rule circumstance to the fuzzy gadget.**Block Diagram**

All the values are evaluated by the fuzzy inference system (Fuzzy based controller). Their output from the fuzzy inference system is displayed in an LCD monitor, which helps the user to monitor and to take necessary actions if they are around. Also the values are stored in the server so that the user can also monitor and control the system from anywhere around the world.

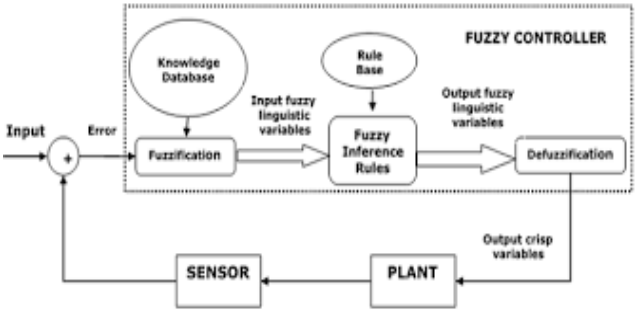

Figure 3: Block Diagram

An LED mild (mild), buzzer, water spray and a heater is also been located within the device for representing the outputs. PH of the water from the fish tank could be labelled by way of three club capabilities in the fuzzy inference gadget. It can be acidic, impartial or fundamental. Most typically the water from the fish tank can be acidic in nature.

Buzzer will get brought about as soon as when the pH stage is acidic and two times when it suggests primary in nature. It does now not provide any sound whilst the pH is of required form. Similarly while the temperature of the water and moisture of the soil is also represented using 3 club functions (excessive, regular, low). Temperature is controlled the use of a fan and if the moisture cost is beyond the expected value inside the soil then it is cleared by way of using a water sprayer.

For knowing the water stage we're the use of ultrasonic sensors. LED's are used to decide their values. They are represented in percentage. We don't forget five special stages of club feature for representing the water levels. So while the output is forty% ie., simplest forty% of water is left in the tank then 2 led lights will glow every indicating 20%.

A. Internal Design

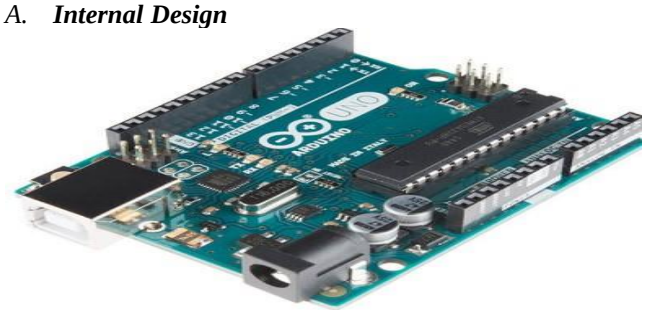

Figure 4: Arduino with sensors

Thinkspace server is an open source cloud platform that's specifically used for tasks which fits with the utility of

Internet of Things. It will assist us to acquire and keep sensor records in cloud platform. It can also been defined as an software of IoT. Our device or software can speak with ThingSpeak the use of a RESTful API, and we can either hold our facts non-public or public. In addition to this, ThingSpeak can also been used to research and act on our records. The primary use of this utility is to accumulate information from sensors and retrieve it every time user wishes.

The Arduino is a widely used controller board with ATMEL328P microcontroller. It has 20 enter/output pins. The Arduino has a substantial assist network, which makes it a completely easy manner to get commenced operating with embedded electronics. The R3 is the 1/3, and present day, revision of the Arduino Uno.PH Sensor, we will use pH1000 polycarbonate pH sensor. It is sensor that's typically utilized in laboratories. They provide reliable and stable readings.

Ultrasonic Sensor (HC-SR04) along with the assist of some LED's, we are able to feel the quantity of water present in a tank in percentage. LED's represents the proportion of water in the water tank. Here we are using 5 LED's. Each one will represent a percent of 20%.Temperature and Humidity Sensor / module (DHT 22) are very reasonably-priced in cost with amazing overall performance. It is a sophisticated model of DHT11. Its temperature measuring range varies from -forty to +one hundred twenty five diploma Celsius with zero.Five diploma accuracy. It also has higher humidity measuring range from zero to a hundred% with 2 to 5% of accuracy. DHT22 encompass a humidity sensing factor and an NTC temperature sensor or Thermistor an IC for measuring the humidity. The thermistor is a variable resistor that adjustments the resistance with the change in its temperature.

Moisture Sensor, FC-28 is used to measure soil moisture. It assessments the moisture content at the roots of flora which get cultivated in the growing mattress. It can be used to shop water that's found in grow bed with the help of Arduino. It consists of two elements, a first-rate sensor and a control board. The main sensor board is two-layered that goes into the soil. It additionally has 2 male headers which are related to the manipulate board. The control board is an amplifier or a converter which convert analog signal into digital signal. Digital data is controlled with the aid of a potentiometer which is in-built inside the control board. The output of the sensor can be either zero or 1. This output is handed into the Arduino. The control board additionally consist of 2 LED's. Among them one is a strength-on LED and the opposite one works with the digital output pin.

IV. EXPERIMENTATION AND RESULTS

According to our task we are able to finish it through the subsequent outcomes. Every residing component within the Aquaponics gadget, whether or not it be the fish, the plants, or the micro organism, they calls for an most efficient pH price, Temperature price, water degree and the right humidity variety for its life. Therefore non-stop tracking of these values are important for their survival in any other case it can result for the demise of aquatic organisms.From the task we are able to locate that the correct pH fee required lies in between 6.Eight and seven.Four. We want to consistently monitor and regulate the pH degree to make sure that our machine works well. When pH is low then we want to increase the alkalinity of the water. This can be performed by means of combining calcium carbonate and potassium carbonate in identical quantity of water. If pH is high then increase the acidity of the water to reduce the pH price.

Adequate water deliver ought to be there in the gadget. About forty% of water need to be there within the tank else the amount of oxygen dissolved within the water receives decreased which influences the existence of fish in tank considerably.

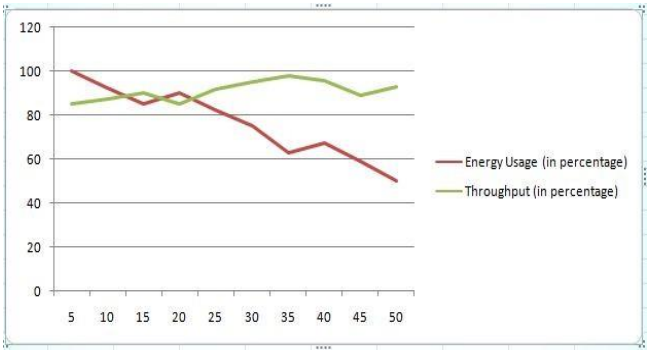

Figure 4: Graph displaying strength utilization and throughput of the system

Fishes can be categorized into 3 sections; cold water living fish, cool water fish and warm water fish. Tropical fishes can sustain their life with a temperature value of 22-32 degree Celsius. But for cold water fish they vary to 10-18 degree Celsius. Rise in temperature as well as intensity can cause for the solubility of many toxic contents in water. Dissolved oxygen is largely inclined by various factors like pH, temperature and water quality. The optimal temperature required for an aquaponics is the following; for fish it should be 10-32 degree Celsius and the temperature required for the grow bed will be a value around 22 degree Celsius. The relative humidity required will be 45-55%.

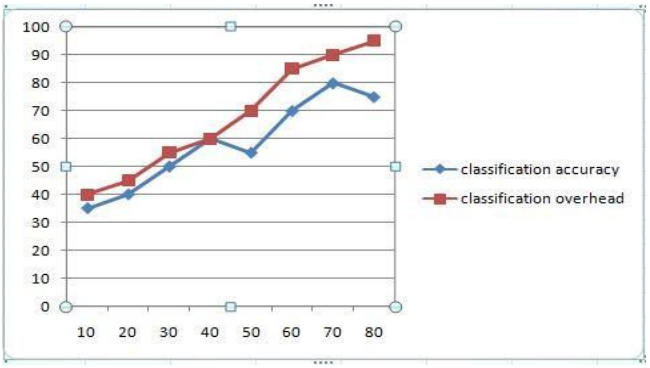

Figure 5: Graph displaying accuracy and overhead in percent

Figure 4 shows the overall energy usage and throughput of the system with a time period of 5 minutes in the x-axis and percentage of its utilization in the y-axis. We can see that as time increases energy usage decreases as well as the throughput will increases. Figure 5 shows the graph of overhead and accuracy of the system with Machine Learning in percentage. As the amount of data trained gets increased, its accuracy and overhead also gets increased.

V. CONCLUSION

IOT enabled aquaponics gadget may want to improve its actual time monitoring because of stay capturing of facts through sensors. The water stage, pH, temperature content material are immediately stabilized through fuzzy primarily based choice making machine where human professional knowledge is incorporated inside the decision making algorithm. The big information accrued thru a long term tracking is used for prediction via utility of svm based in stepped forward normal system overall performance for a protracted period of time. The measured parameters like power intake and throughput (fig four) indicates that machine posses stepped forward load balancing. The dimension of classification accuracy and classification overhead is an evidence for advanced system prediction and it ultimately yields a steady aquaponics device.

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AUTHORS PROFILE

Mr. Vinodh P Vijayan, Head of Department, Computer Science, Mangalam College of Engineering, Kottayam, India has completed Bachelors Degree in Electronics and Communication Engineering, Post graduation in Computer Science Engineering His area of interest includes Soft Computing, Robotics, Bio-inspired computing, Fuzzy systems.

Ms.Neena Joseph working as an Assistant Professor in Mangalam College of Engg,Kottayam,Kerala.Masterof Engineering in Computer science and Engineering (M.E CSE) from:M S University.Bachelor of Technology in Computer Science and Engineering (B.Tech-CSE) from MG University, kerala.Her Area of interest Cloud Computing, Theory of Computation

Ms.Neema George working as an Assistant Professor in Mangalam College of Engg,Kottayam,Kerala.Masterof Engineering in Computer science and Engineering (M.E CSE) from:Anna University Chennai.Bachelor of Technology in Computer Science and Engineering (B.Tech-CSE) from MG University, kerala. Her Area of interest Cloud Computing,Machine learning,Artificial intelligence.

Ms.Simy Mary Kurian working as an Assistant Professor in Mangalam College of Engg,Kottayam,Kerala.Masterof Engineering in Computer science and Engineering (M.E CSE) from: Karunya University Chennai. Bachelor of Technology in Computer Science and Engineering (B.Tech-CSE) from MG University, kerala.Her Area of interest Image Processing,Machine learning,Artificial intelligence.

