**“IOT BASED AQUAPONIC MONITORING SYSTEM FOR FOOD PRODUCTION”**

**Savita Soma1, Padmavati2, Sukeshini3, Sumavati4**

1Faculty, Department of Electronics and Communication Engineering,

Guru Nanak Dev Engineering College, Bidar, Karnataka, India.

2,3,4 UG Students, Department of Electronics and Communication Engineering,

Guru Nanak Dev Engineering College, Bidar, Karnataka, India.

**ABSTRACT**

***Agriculture is the art of nurturing the plants and cultivation of soil for the production of food. In India the major amount of food production is depended on the agriculture. But now days use of chemicals like sulfur dioxide and fluorine etc. for protecting the plants against the pesticides and also the use of other chemicals for the fast growth of the plants have caused damage to human health as well as soil pollution. The soil pollution results in the decreased fertility of soil which affects the growth of the plants. So the solution for this is the growing the plants without using soil and with the help of only water. The development and growth of the plants with the help of only water is called as Hydroponic system. As the plants require nutrition's for their growth, instead of using other sources we are using the natural fish extract by fish farming which is called as Aquaculture. As the plants are growing with the help of water and fish extract it is called as Aquaponic system. When the pH level of water exceeds more than it's desired level it becomes harmful for the aquaculture and also for the plants as well the variation in the temperature, humidity, TDS causes harm to the aquaponic system so by using pH sensor, TDS sensor, DHT11 sensor all the required parameters are managed and monitored with the help of the IOT. All the parameters are displayed on the Blynk app.***

1. **EXISTING SYSTEM**

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.

1. **PROBLEM STATEMENT**

Due to artificial use of fertilizers and chemicals the soil has lost its originality. The farmers have no idea about soil pollution and It has become difficult for farmers to grow the crops, as they are dependent on nature of soil and climatic conditions. Always this has created problem, so it is necessary to find out solution for this.

1. **LIMITATIONS**

The system is being developed humanly with the help of various components. It is possible that some components may fail to give the accurate result over the period, so it is necessary that when such failure of components fail to work then it needs to be replaced. Also, the feeding of fish needs to be on time which is not automated so it will consume small amount of time for feeding fish.

1. **SCOPE**

The scope of the project is in the places where soil erosion and fertility of the soil is the main problem. Also, the monetary issues of the farmers get resolved. In this way we acquire natural food by this system, also the use of pesticides and other chemicals are avoided so anyway this also keeps a proper health among the people. So, in the end we acquire natural food, good health and extra source of income with the help of this system.

**V. LITERATURE SURVEY**

**[1] Title: IoT fuzzy logic aquaponics monitoring and control hardware real-time system || Authors: Adnan Shaout, Spencer G Scot || 2017.**

The author Adnan Shaout, Spencer G Scot have made research on the Aquaponics is a growing field in which fish and plants are grown together and mutual benefit each other. Fuzzy logic is used to evaluate the inputs and automatically provide the proper output The system will monitor water temperature, pH, air temperature, and luminance. The system will control a light, heater, and alarm. The Arduino Uno R3 board was selected to be the hardware interface for inputs/outputs. Selecting the Arduino was based on MATLAB having a support toolbox to interface with the Arduino (ATMEGA8U2-MU) microcontroller. Updating of the input value and triggering twitter alerts was all done through using the free Thingspeak server tool that connects nicely with MATLAB via a toolbox.

**[2] Title: An autonomous aquaponics system using 6LoWPAN based WSN || Authors: N Hari Kumar, Sandhya Baskaran, Sanjana Hariraj, Vaishali Krishnan||2016.**

The authors N Hari Kumar et.al stated that Aquaponics is a groundbreaking food production technique that combines both traditional methods of aquaculture and hydroponics to grow both fish and crops in a single integrated system. Aquaponics system uses fish wastes to provide essential nutrients to the plants. In return plants serve as a bio-filter for the fish in a symbiotic relationship. The purpose of this paper is to showcase how to build an efficient Internet of Things (IoT) application for aquaponics in order to create an autonomous, self-regulating system with the help of Wireless Sensor Network (WSN). An open standard of WSN called 6LoWPAN is being used in this system which helps us to construct a global infrastructure. The designed aquaponic system is composed of sensor devices that can sense and collect information of the various dimensions of the water quality involved and store it in a cloud database. This means that the human intervention would be considerably less when compared to the traditional methods of aquaponics. In addition to the traditional technique, with the help of Next-Gen Telco technologies, i.e., using their high bandwidth and low latency, infected fishes are detected automatically on time and treat them to ensure the balance in our aquaponics ecosystem. In this paper we propose an end-to-end system to enable "Connected Aquaponics" which includes WSN and Next-Gen Telco to increase the crop yield and provide organic sustainable food to the world community.

**[3] Title: Enhancing aquaponics management with IoT-based Predictive Analytics for efficient information utilization || Authors: Divas Karimanzira, Thomas Rauschenbach || 2019.**

The author Divas Karimanzira et.al stated that the modern aquaponic systems can be highly successful, but they require intensive monitoring, control and management. Consequently, the Automation Pyramid (AP) with its layers of Supervisory Control and Data Acquisition (SCADA), Enterprise Resource Planning (ERP) and Manufacturing Execution System (MES) is applied for process control. With cloud-based IoT-based Predictive Analytics at the fore marsh, it is worth finding out if IoT will make these technologies obsolete, or they can work together to gain more beneficial results. In this paper, they discussed that the enhancement of SCADA, ERP and MES with IoT in aquaponics and likewise how IoT-based Predictive Analytics can help to get more out of it. An example use case of an aquaponics project with five demonstration sites in different geographical locations will be presented to show the benefits of IoT on example Predictive Analytics services. Innovative is the collection of data from the five demonstration sites over IoT to make the models of fish, tomatoes, technical components such as filters used for remote monitoring, predictive remote maintenance and economical optimization of the individual plants robust. Robustness of the various models, fish and crop growth models, models for econometric optimization were evaluated using Monte Carlo Simulations revealing as expected the superiority of the IoT-based models. Our analysis suggest that the models are generally tolerant to the temperature coefficient variations of up to 15% and the econometric models tolerated a variation of for example feed ration size for fish of up to 4% and by the energy optimization models a tolerance of up to 14% by variations of solar radiation could be noticed. Furthermore, from the analysis made, it can be concluded that MES has several capabilities which cannot be replaced by IoT such as responsiveness to trigger changes on anomalies. It act as proxy when there is no case for sensors and reliably ensure correct execution in the aquaponics plants. IoT systems can produce unprecedented improvements in many areas but need MES to leverage their true potential and benefits.

**[4] Title: Urban aquaponics farming and cities-a systematic literature review ||**

**Authors: Rahmita Wirza, Shah Nazir || 2021.**

The author Rahmita Wirza et.al discussed that an aquaponic system is considered to be a sustainable food production solution that follows circular economy principles and the biomimetic natural system to reduce input and waste. It is the combination of two mainly productive systems, a recirculating aquaculture system consists of fish and crustaceans farmed in a tank and hydroponic cultivation consists of vegetable cultured in medium other than soil. Both these systems are well-known around the globe by their performance of production, quality, and verified food safety. An aquaponic system is an industrious mechanism which incorporates impeccably with sustainable growth of intensive agriculture. The existing literature regarding the aquaponic production covers different species of vegetables and fish, a variety of layouts of system, and climate conditions. However, there is a lack of knowledge that can systematically present the existing state-of-the-artwork in a systematic manner. To overcome this limitation, the proposed research presents a systematic literature review in the field of urban aquaponics. This systematic literature review will help practitioners to take help from the existing literature and propose new solutions based on the available evidence in urban aquaponics.

**VI. INTRODUCTION**

Agriculture is the art of nurturing the plants and cultivation of soil for the production of food.In India the major amount of food production is depended on the agriculture. It contributes about 17% to the total GDP of India and also plays a very important role in providing the employment to over 60% of the population.Now days we can see that for the fast growth of the plants, people are using chemicals which are the harmful for the human health and also causing the soil pollution and as well the agriculture food production is decreasing due to the narrower lands. So we have introduced this system Aquaponics by combining aquaculture and hydroponics. The proposed system mainly aims for the development and growth of the plants with chemical free and produce large amount of food naturally with the help of fish extract. The Aquaponics term is the combination of the two terms Aquaculture and Hydroponics. Aquaculture refers to the farming in the water, breeding and harvesting the fishes for the commercial, recreational, and scientific purposes.The hydroponic system is the technique in which plants are grown with the help of water based nutrients, instead of soil based nutrients. So the fish fertilizers offer a source of burn-free nitrogen, along with the other primary nutrients of phosphorus and potassium. Phosphorous is used by plants to help form new roots, make seeds, fruit and flowers. It's also used by plants to help fight disease. Potassium helps plants make strong stems and keep growing fast.

**By using combination of Aquaculture and hydroponics, user will be benefited by the following**

* In the proposed system the water is substituted for the soil, so there might be a misconception that it may require lot's of water for the growth of the plants but it requires less water even than the soil based farming.
* This system requires less space and also when the system is built in the vertical manner it requires 90% less place than the traditional farming.
* The plants growing here are not dependent on any climatic changes, instead they can have their own microclimates. So that farmers are not affected by the environmental changes.
* Here the plants receive direct nutrients to root so produces high yield and also the crops grow faster.
* It requires no soil, additionally few plants require some particular soil preferences for a particular type of soil, with hydroponic system there is no concern for soil and also for the type of the soil.
* In the traditional farming method the ethylene gas is used to artificially ripen food that has been picked too early, with the help of aquaponics we can grow fresh fruits and vegetables etc. naturally which consists of the higher nutrients and better taste too. It produces the high quality of food.

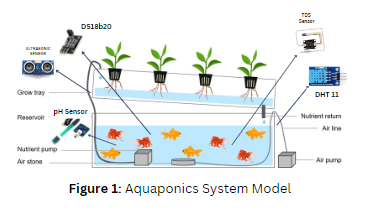
**VII. COMPONENTS**

* **DHT11 :** it's a digital sensor which is used for measuring humidity and temperature. It uses combination of capacitive humidity sensor and thermistor. For this sensor no analog pin is needed.
* **DS18b20 :** This is the temperature sensor which can measure the temperature between -50 to 125C . The main advantage of this sensor is it can measure minimum amount of temperature to maximum.
* **pH sensor** : pH stands for potential of hydrogen it refers to the concentration of hydrogen ion in any solution. Which measure the acidity and alkalinity of a solution in the pH value ranges from scale 0 to 14.
* **TDS Sensor :** TDS refers to total dissolved solvent. This sensor is used to indicate the total dissolved solids in solution.
* **Moisture Sensor :** Measures relative humidity from 0% humidity to 100% humidity.
* **Rain Sensor :** A rain sensor is activated by rainfall.
* **ESP8266 NodeMCU :** open-source LUA based firmware developed for the ESP8266 wifi chip

**VIII.** **WORKING PRINCIPLE**

* Firstly, the pipes designed for the hydroponic plants placed on the top and the pipe consist of one inlet and one outlet.
* Water is supplied through the inlet and the outlet is supplied to aquarium.
* The Aquarium consists of the fishes like Tilapia, Koi, pacu and carp.
* The main reason for using these specific fishes is they are resiliency against diseases and parasites and endure a wide range of water temperatures, 1-32°C (34-90°F), which is excellent, especially if we live in a place where the temperature fluctuates.
* The plant seeds are initially kept in a container with some water and cocopeat growing into sapling.
* The hydroponic pipes are connected to fish tank, Fishes will leave some extract and that is circulated to hydroponic plants pipes with the help of motor, The plants will get nutrients for its growth from fish extract water.
* The sensors are used to test the proper functioning of the system. For fishes acceptable pH range would be 6.5 to 9.0.
* Fish can become stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0, which may be harmful for fish life.
* So, here we are using pH sensor, the glass electrode inside the pH probe measures the difference in pH between the pH electrode and aquarium water.
* The pH level of water is displayed on the Blynk app through IOT, by this we can take safety measurements by Adding peat moss, driftwood, and almond leaves, to naturally lower the pH and baking soda can be added to naturally increase the pH level of water as soon as we see the change in pH levels.
* Along with the specific pH level The fishes also need a stable environment which have the same level of TDS.
* Different fishes require water with different TDS. 400PPM~450PPM TDS in the water are recommended for most freshwater fish living. The concentrations too high would cause the death for fish and permit a high volume of algae bloom.
* The low level of TDS in the water will affect fish growth. So the TDS sensor is used, it measures the conductivity of the solution and estimates the TDS from that reading, readings are displayed on the Blynk App.
* If the TDS level of water is not suitable for fishes we can take safety measures like changing the water frequently, using reverse osmosis water or deionized water.
* The best temperature for fish depends on the species, but in general, tropical fish are most healthy in the range of 75-80°F (24-27°C).
* Koi, Tilapia, Pacu, Carp fishes can tolerate temperature from 20-27°C, 24-32°C, 15-35°C, 20-25°C respectively.
* DS18B20 Sensor The waterproof sensor is selected to measure the temperature of the aquarium water. It provides temperature measurements in Celsius.
* DHT11 is used to check the environmental temperature.
* Rain is essential for the agriculture but sometimes can also lead to bacteria, fungus.
* Here rain sensor is used and it is activated by the rain fall.
* Moisture sensors are used to understand the root zone of a crop and the ultrasonic sensors are used to measure the water level.

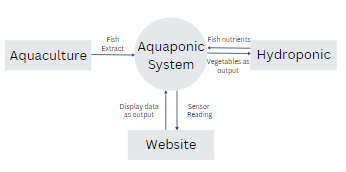
**IX. BLOCK DIAGRAM**



**Figure Labels:** pH sensor, Ultrasonic sensor, Moisture Sensor, Rain Sensor DS18b20, DHT11, TDS Sensor, Node MCU.

**DATA FLOW DIAGRAM**

A data flow diagram (DFD) maps out the flow of information for any process or system. The below data flow diagram represents the flow of the complete aquaponic system with IOT.



**X. IMPLEMENTATION DESCRIPTION**

The fish is fed with fish food in fish tank to leave extract, The fish tank has sensor like TDS to check the solvents(extract) in water and has pH sensor to check the pH of the water. . 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, The fish extract in the fish tank will be sent to the hydroponic pipes with help of motor. The ultrasonic sensor is kept to determine the water level and DS18b20 sensor is placed inside the aquarium to determine the water temperature. DHT11 Sensor is placed outside the aquarium to determine surrounding temperature and humidity. And all the details are displayed on the Blynk App.

**ADVANTAGES**

* Produces fresh and organic fish and vegetables with aquaponics
* Plants grow faster and taste better with aquaponics
* Aquaponic systems are easy to build and cheap to run
* It requires 6x less space than traditional farming
* It require 90% less water than classical farming
* Aquaponic systems are easily expandable for commercial purposes
* It’s sustainable and eco-friendly way of food production
* Aquaponics is an efficient way to produce out of season products
* It’s employing the whole family in sustainable farming

**XI. RESULT**

****

**XII. 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.

**REFERENCES**

1] Wanda Vernandhes, N.S Salahuddin, **Smart Aquaponic with Monitoring and Control System Based On IOT**, In IEEE, 2017.

[2] Analene Montesines Nagayo, Caesar Mendoza, Rodrigo S. Jamisola, **An Automated Solar-Powered Aquaponics System towards Agricultural Sustainability in the Sultanate Oman**, IEEE, pp.42-49, 2017.

[3] N Hari Kumar, Sandhya Baskaran, Sanjana Hariraj, Vaishali Krishnan, **An Autonomous Aquaponics System using 6LoWPAN based WSN IEEE**, pp. 125-132, 2016.

[4] Aquaponics:retrieved from **http://en.wikipedia.org/wikiiAquaponics**

[5] Megumi U. Leatherbury **Vegilab and Aquaponics Indoor Growing System** In IEEE ,2014.

[6] M.F. Saaid, N. S. M. Fadhil, M.S.A. Megat Ali, M.Z.H. Noor **Automated Indoor Aquaponic Cultivation Technique**, IEEE, pp 285- 289,2013.