Smart Aquaponic IoT

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***Abstract*— The aquaponic system is a cutting-edge method of farming that makes multi-domain farming possible. For optimal fish health, fish farming calls for routine water content analysis and periodic maintenance. Cleaning the water is a critical element that influences fish health along with feeding schedules. The timely monitoring tasks that go along with raising chickens for poultry include feeding and waste cleanup. The soil-less plant growth technique, in which nutrients are fed directly to plants, is a recent innovation in crop production. Fish tanks and poultry farms produce waste that can be immediately applied to plants since it contains concentrated nutrients. The multi-parameter monitoring sensors used in the proposed aquaponic system in this research demonstrate simple**

Keywords—Smart Aquaponic system, Soilless crop, Chicken Coop Automation, Fish Tank Automation, Web interface

I. INTRODUCTION

Due to the growing population, crops are cultivated using chemical fertilizers and pesticides. As a result, several diseases have developed, including cancer. As a result, nations like the United States, the United Kingdom, and Japan have outlawed the use of such fertilizers and pesticides in favor of growing without residues, sometimes known as "Organic Farming." Therefore, in the agricultural sector, organic farming is the way of the future.

Since everything used to be natural years ago, the proposed endeavor helps to resolve issues with soil and natural food while also reviving the natural age. The suggested system is aquaponics, a hybrid of aquaculture and hydroponics. While hydroponics is concerned with growing plants without the use of soil by providing the required nutrients, aquaculture is concerned with the creation of fish.

More fish feed in an aquaponic system could result in ammonia production. Ammonia is harmful to fish growth because bacteria break it down and turn it into nitrates. This will be applied to the plants as fertilizer. Hens will be used as a by-product, and the manure they produce will be applied to plants as fertilizer. As a result, no more iron is needed for the fish tank..

This mechanism will maintain order throughout. Temperature, humidity, pH, total dissolved solids, dissolved oxygen, and water level can all be monitored by sensors in the IoT space. Water pumps, artificial lighting, feeding controllers, and sunlight will all be automatically turned on or off. A smartphone app will be developed for it, and all parameters will be shown on an LCD. The complete system is constructed using an Arduino microcontroller. Since it uses little fertilizer and water (eggs), it not only produces organic crops but also three different types of yields: fish, veggies, and hens.

II. LITERATURE SURVEY

[1] shows a contemporary aquaculture system in which RP serves as a back office for all data in a corporation and provides an integrated picture of crucial business processes that is always up to date. ERP offers IoT in the cloud, but it is based on transaction data and is not data-analytics or adaptable. Understanding the IoT can be achieved by identifying root causes and creating a foundation for future activities. Thanks to cloud-based IoT, ERP gains real-time agility, flexibility, and predictability. [1] Traditional farming relies on a variety of factors, including the quality of the soil, the climate, chemical fertilizers, pesticides, and water. Traditional farming concerns are addressed using aquaponics. Aquaponics is the term for the fusion of hydroponics and aquaculture. Providing nutrients for the growth of soilless plants is the focus of hydroponics, whereas fish farming is the focus of aquaculture. Aquaponics will be used to supply the nation with organic food. An aquaponics system that produces both fish and plants will be advantageous to people. Water is reused in an aquaponics system, which uses less space and gives the user natural food. Aquaponics may be handled and controlled automatically using IoT technology and sensors including pH, temperature, humidity, dissolved solvents, and water level sensors. Node MCU is used for monitoring. It is possible to build an interior and outdoor system using this technology. The sump tank, fish tank, and grow bed are all stacked on top of one another in this configuration. Over the final grow bed, a sun mica sheet with holes for grow box fitting is positioned. Water and a sponge are used to develop plant seeds into seedlings. The residents of the aquarium will receive fish food to support their growth. To assist, pipes were employed. Some extract will be excreted by the fish and settle in the tank. This sewage will enter the sump tank and then be cycled through the grow bed's plants by a motor [2].

Scholars and industry professionals are becoming more interested in the contributions made to hydroponics and aquaculture research. The ultimate goal of the project is to become proficient in electrical and biological engineering so that aquaponic development can be utilized as a sustainable food source. The author brings together the technical expertise of automation, Internet of Things, and smart systems from aquaponics experts with the biological processes that take place in aquaponic systems from automation experts. The field will progress more quickly if a connection is made between economic viability and scaled-up aquaponics systems [3].

A wide range of vegetables and water- and land-saving technologies are crucial for maximizing production because agricultural output is decreasing due to diminishing land. One kind of sustainable farming is aquaponics. aquaculture and hydroponics combined in a single setting. This water-planting substance filters the water and gives plants nutrition. Sensors were added to the aquaponics system in order to retrieve data. Via a real-time internet network, data can be sent to the Ubuntu IoT Cloud server. The data showed that the temperature sensor

had a measurement success rate of 97.91%, the pH sensor had a measurement success rate of 92.35%, and the ultrasonic sensor had a 99.94% measurement success rate. The smart aquaponic system's temperature range for plant and fish growth is 25 to 30 degrees Celsius, the pond's pH is between 7 and 7.5, and fish are fed three times a day [4].

This promotes the production of healthful organic food by both novice farmers and common people. With the Aquaponics approach, farmers will be able to keep an eye on their aquaponic farming from any location. This will change their way of life and increase their revenue as well. The practice of aquaponic farming is easy. The microprocessor determines the value and shows it on a 16x2 LCD. Aquaculture combined with hydroponic farming will increase development, productivity, profitability, and efficiency. Farmers in remote places can use the same method to get information by SMS about fish and plants [5].

Aquaponics is a low-impact food production method that combines aquaculture and hydroponics to grow fish and crops without the use of soil. The fish and plant's symbiotic partnership is a low-cost symbiotic interaction. In an aquaponic system, fish waste (ammonia) is fed to the plant bed, which acts as a bio-filter, absorbing the nitrate required for flora development. The cycle is then repeated by refilling the fish tank with fresh water. An aquaponic system, in comparison to typical irrigation systems, has the distinct advantage of conserving water more effectively. Water conservation is accomplished by continuously transferring water between the plant bed and the fish habitat. Organic Another advantage of aquaponics is the use of dissolved fish faeces to fertilize plants. Plants, as a natural filter, require less water quality monitoring than other filters. The long-term purpose of the Aquaponics system is to produce food while conserving water in a more efficient and environmentally responsible manner [6].

Aquaponics blends aquaculture and hydroponics into one profession. Aquaponics is a method of bringing food closer to people in urban areas. Both the hydroponics and aquaculture businesses will gain from this. Methods and equipment are used in commercial aquaponics. Even the poorest, landless or near-landless individuals garden on small plots of homestead land, abandoned lots, roadside or field edges, or in containers. Traditional farming can be done digitally with locally accessible planting materials, green manures, "living" fences, and indigenous insect control methods if there are no commercial resources. To gain a better understanding of the aquaponics business so that future commercial operations can be strengthened [7]. Early alerts in the form of email, SMS, and push notifications are sent to the user when the sensor detects any abnormal condition, ensuring a healthy growing environment for fish and plants. Without the need for human intervention, the corresponding actuator will intervene and correct the abnormal state. For data analysis, all system operations and real-time sensor measurements are recorded in the cloud. Additional graphical user interfaces were created to link the aquaponics system to the user-friendly online and mobile apps. This aquaponics system can appeal to both commercial farmers and home growers because of its cost-effectiveness and environmental friendliness [8]. Because the sun-based load up creates imperativeness during daylight hours, it is also necessary to charge a battery and fill a vacuum device in the middle of the night. To get the most out of the light, the tilt borders of the sun-based board should be precisely positioned. In Perlis, Malaysia, the overall sun-fueled irradiance on the tilt edges of photovoltaic modules was dissected. Because of its highsun-based irradiance potential, which ranges from 1061 to 995.38 watts per square metre from January to July [10], they decided that Perlis is appropriate for solar power generation.

In [11], the challenges, traps, and promise of a daylight-based regulated water pump are examined. During testing, 17 out of 90 inverters were found to be off the mark. As a result, proven and true and advantageous inverters become problematic. In order to control high power in an aquaponic system, a direct structure of inverter is required. During the inverter experiment, it is assumed that the inverter would not be successful and strong. As a result, it is wiser to employ a pump that is voltage-evaluated to the pump itself. [12].

III. PROPOSED WORK

The proposed effort develops the aquaponic system. An Atmega328P microcontroller-based monitoring and control system is used in hardware development. The oxygen-dissolving bubble-making pump that is connected to the fish tank continuously dissolves oxygen in the water. Figure 1 depicts the usual system built with a soilless plant growing system, a chicken farm, and a fish tank.

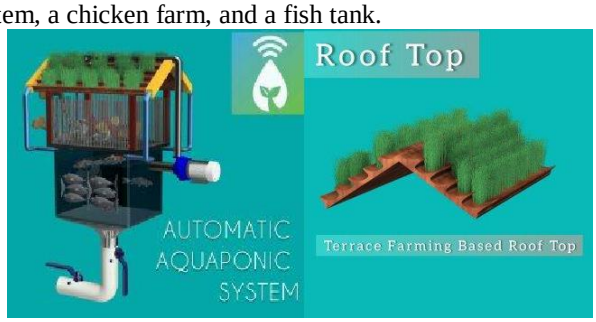


Figure 1: Proposed aquaponic system

The waste from the henhouse, which is above the fish tank, flows into the water, dissolving all of the nutrients from the chicken waste. Fish waste is likewise dissolved in the water. Therefore, concentrated nutrients needed for plant growth are present in the dissolved water. As a result, the plants above the chicken farm are fed with water via a pump from the fish tank. The application-specific pump capacity can be adjusted based on the necessary delivery rate.

The water's undissolved components are found at the bottom. The bottom exit of the tank can be used to remove any undissolved waste that is present by utilizing a manual tap to manage it. Additionally, the tap can be programmed to automatically collect waste at intervals depending on timed analysis for a predetermined duration.

While controlling the water content it is important to keep sufficient level of water in the tank. The water level controller can be used with the fresh water feed connected to it. The temperature of water remain under control due less exposure of water tank direct to sun light. The temperature and humidity level in chicken cabinet is required to be monitored continuously to keep healthy air inside the cabinet. DHT22 humidity and temperature sensor are used to monitor the level of temperature and humidity. The hens food feeding is also atomized for periodic feeding. The temperature and humidity in hens compartment is kept at normal level by periodic fan based ventilation. The fan is turned ON and OFF timely to keep these parameters under control.

The system interfacing architecture diagram is shown figure 2.

The water feeding to plants is done with sprayer controlled with pump pressure. This keeps good air moisture content around the plants. The interfaced system is implemented with use of Atmega328P controller and interfacing with sensors and display system. The relay card is used to control Fans and pumps which may be operated on DC or AC supply. The prototype system consist of DC operated FANS and PUMPS. The prototype system is shown in figure 4.

The collected data is recorded on ThingSpeak [14] web interface via WiFi 8266 [15] module interface. The recorded dataset screen shot is shown in figure 5. The data is easily accessible on mobile through ThingSpeak interface.

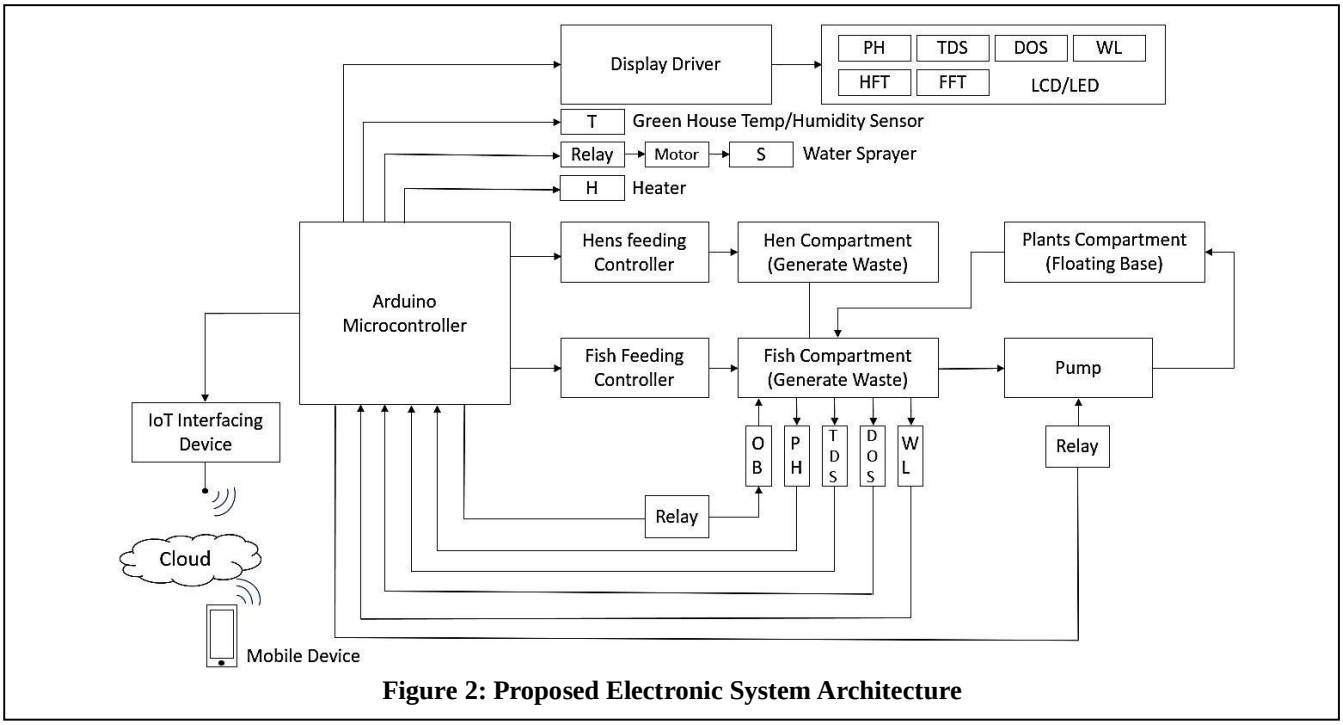


Figure 2: Proposed Electronic System Architecture

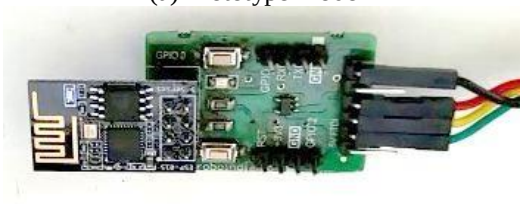
IV. Results and Analysis

The dissolved oxygen measurement is conventional titration method which is time consuming. The expected range of dissolved oxygen in water is 15-20 mg per liter. The minimum required oxygen for survival of fish in water is 1-6 mg per liter [9]. The dissolved oxygen level can be maintained with timely turning on the oxygen blower. This can keep up the dissolved oxygen level at sufficient level

Another important water quality measuring is done with the use of TDS sensor. The water quality due to fish waste keep degrading and at the same time the wastage falling from hens compartment into the fish tank also degrades the water quality. The suitable level of water quality [13] is thus monitored and fresh water feed along with removal of poor quality water is automated. The poor quality water which especially contains plant essential nutrient is feed to plant and remaining water is drained through drain valve. The typical fish tank with monitoring interface is shown in figure 3.

Figure 3: Automated Chicken Coop and Fish Tank Monitoring System

(a) Prototype Model



(b) ESP8266 WiFi Module

Figure 4: Aquaponic System Electronic Prototype Model

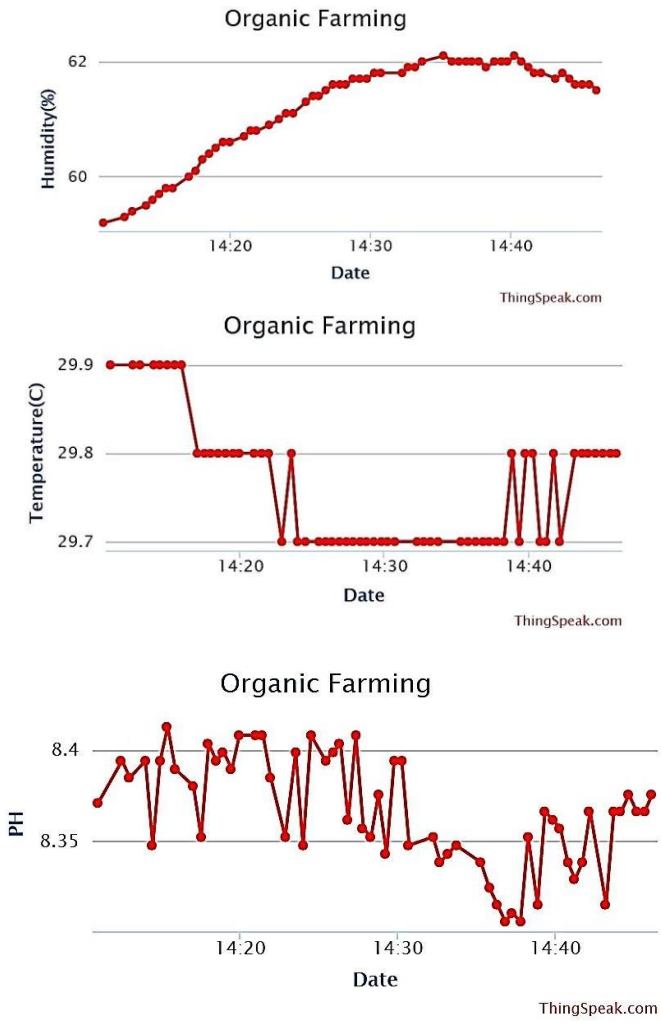


Figure 5: ThigSpeak Server Data Graph Plots

V. CONCLUSION

This paper shows a contributing work with IoT interfaced Aquaponic system with in depth parameter monitoring and control system. The proposed system provides satisfactory accessibility via mobile interface. The system is useful for advanced farming system in agricultural leading country like India.

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