Real Time Multi Parameter Monitoring in Smart Aquaponic IoT

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Abstract - *Aquaponic system is modern way of farming in which multi domain farming is feasible. The fish farming requires typical water content analysis and time to time maintenance for better health of fishes. Along with feeding intervals water cleaning is important factor that affects fish health. The chicken farming in poultry is concerned with its own timely monitoring tasks in which feeding and waste cleaning is important factor. The soil-less plant growing has been new method of crop cultivation in which nutrient contents are directly feed to plants. The waste outcome from fish tank, and poultry farm can be given directly to the plants which is concentrated nutrient content. The aquaponic system proposed in this paper with the use of multi parameter monitoring sensors show easy cultivation method which helps to maintain and grow fish, chicken and plants altogether. The system shows efficient outcome in terms of cultivation method.*

Key Words: **Smart Aquaponic system, Soilless crop, Chicken Coop Automation, Fish Tank Automation, Web interface**

I .INTRODUCTION

Crops are planted utilizing chemical fertilizers and pesticides in agriculture due to rising population. Different diseases, such as cancer, have resulted as a result of this. As a result, countries such as the United States, the United Kingdom, and Japan have prohibited the use of such fertilizers and pesticides in favor of residue-free farming, dubbed "Organic Farming." As a result, organic farming is the way of the future in the agricultural area. The proposed effort helps to fix soil and natural food difficulties while also bringing the natural age back because everything used to be natural years ago. Aquaponics, a mix of aquaculture and hydroponics, is the suggested system. Aquaculture is concerned with the production of fish, while hydroponics is concerned with the cultivation of plants without the use of soil by supplying the necessary nutrients. In an aquaponic system, more fish feed could produce ammonia. Because bacteria eat down ammonia and convert it to nitrates, it is hazardous to fish growth. This will be used as a fertilizer on the plants. Hens will be utilized as a by‐product, and their wastes will be used to fertilize plants. As a result, the fish tank does not require any additional iron. Everything will be kept in order by this system. Sensors in the IoT domain can monitor temperature, humidity, pH factor, total dissolved solids, dissolved oxygen, and water level. Sunlight, artificial light, feeding controllers, and water pumps will all be turned on or off automatically. All parameters will be shown on an LCD, and a mobile app will be created for it. The Arduino microcontroller is used to build the entire system. As a result, it not only provides organic crops but also three sorts of yields: fish, vegetables, and hens, all while using minimal fertilizers and water (eggs).

II. LITERATURE SURVEY

[1] illustrates a modern aquaponic system in which RP acts as a back office for all data in an enterprise, as well as an integrated and always-up-to-date view of important business activities. ERP provides IoT on the cloud, however it is based on transaction data and lacks data analytics and adaptability. Identifying core causes and building the basis for future actions can provide insight into the IoT. ERP benefits from real-time agility, flexibility, and predictability thanks to cloud-based IoT. [1] Traditional farming is depending on soil quality, climate conditions, chemical fertilisers, pesticides, and water, among other things. Aquaponics is used to address traditional farming issues. The combination of aquaculture with hydroponics is known as aquaponics. Hydroponics is concerned with providing nutrients for the development of soilless plants, whereas aquaculture is concerned with the raising of fish. Aquaponics will be employed to provide the country with natural food. Humans will benefit from an aquaponics system that provides both fish and plants. In an Aquaponics system, water is reused, taking up less space and providing natural food to the user. Using IoT technology and sensors such as pH, temperature, humidity, dissolved solvents, and water level sensors, aquaponics may be managed and regulated automatically. For monitoring, Node MCU and Arduino UNO are utilized. This technology can be utilized to construct a system that is both indoor and outdoor. In this arrangement, the sump tank, fish tank, and grow bed are all layered on top of one other. The sun mica sheet with holes for grow box fitting is placed over the last grow bed. Plant seeds are grown into seedlings in a sponge with water. Fish food will be provided to the tank's inhabitants in order to aid their development. Pipes were used to help. The fish will excrete some extract, which will settle in the tank. This wastewater will flow into the sump tank, where it will be cycled by a motor to the plants on the grow bed. The sump tank's clay

plates will aid in the storage of some water [2]. Contributions to aquaculture and hydroponics research are increasing, attracting the attention of academics and practitioners. The project's ultimate purpose is to gain competence in biological and electrical engineering so that aquaponic growth can be used as a long-term food source. The author combines aquaponics experts' technical knowledge of automation, IoT, and smart systems with automation experts' understanding of the biological processes that occur in aquaponic systems. Creating a link between scaled-up aquaponics systems and commercial viability will help the field advance faster [3].

Because agricultural output is dwindling as a result of shrinking land, land and water-saving technologies, together with a wide variety of vegetables, are essential for maximising yield. Aquaponics is a type of sustainable agriculture that blends aquaculture and hydroponics in one environment. This water planting material provides nutrients to plants while also filtering the water. To retrieve data, sensors were installed in the aquaponics system. Data can be transferred to the Ubuntu IoT Cloud server over a real-time internet network. The ultrasonic sensor had a measurement success rate of 99.94%, the pH sensor had a measurement success rate of 92.35%, and the temperature sensor had a measurement success rate of 97.91%, according to the data. Plant and fish growth on the smart aquaponic system runs from 25 to 30 degrees Celsius, with pond water pH between 7 and 7.5 and fish feeding three times a day [4] This also encourages new farmers as well as ordinary people to engage in healthy organic food production. Farmers will be able to monitor their aquaponic farming from anywhere using the Aquaponics model. This will also enhance their revenue and cause a shift in their way of life. Aquaponic farming is simple to do. The value is detected by the microcontroller and displayed on a 16x2 LCD. This will boost efficiency, development, productivity, and profitability by combining aquaculture with hydroponics farming. The same technique can be used by farmers in rural areas to receive information on fish and plants via SMS [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 high sun-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 aquaponic system is developed in the proposed work. The hardware development is done with the use of Atmega328P microcontroller based monitoring and control system. The fish tank is interfaced with oxygen dissolving bubble making pump which keeps dissolving oxygen in the water. The typical system constructed with fish tank, chicken farm and soilless plant growing system constructed is shown in figure 1.

Figure 1: Proposed aquaponic system

The wastage from hen's compartment, located at fish tank overhead, falls in the tank water which dissolves all the nutrient content from chicken wastage. The wastage from fishes also gets dissolved in the water. The dissolved water thus contains concentrated nutrients required for plant growth. The plants located on overhead of chicken farm thus are feed with water from fish tank using pump. Depending on the required delivery rate the pump capacity can be changed with respect to application.

The undissolved contents from the water reside at the bottom. For the removal of undissolved wastages which reside at the bottom of tank can be taken out using bottom outlet controlled with manual tap. The tap can also be automated for interval based wastage collection based on timed analysis for specific period.

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.

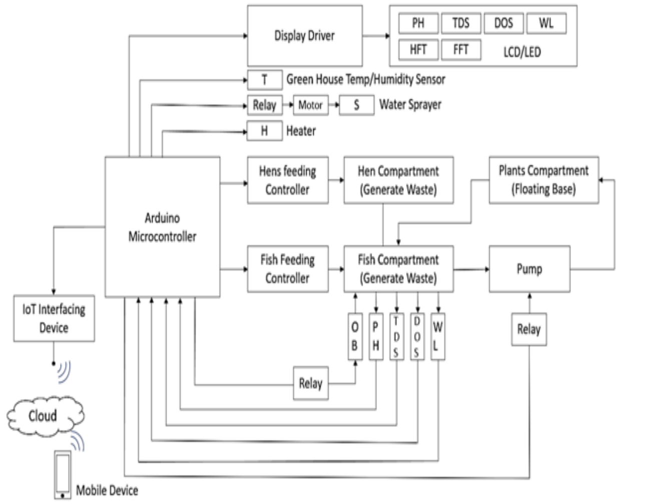


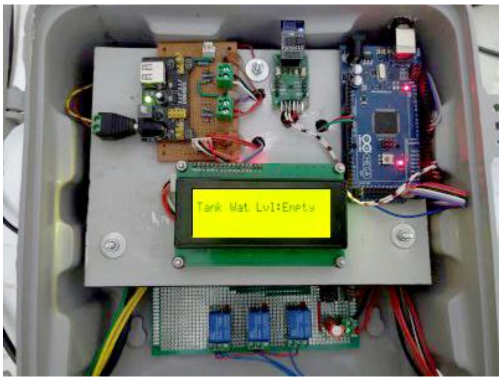
Figure 2: Proposed Electronic System Architecture

IV .Results and Analysis

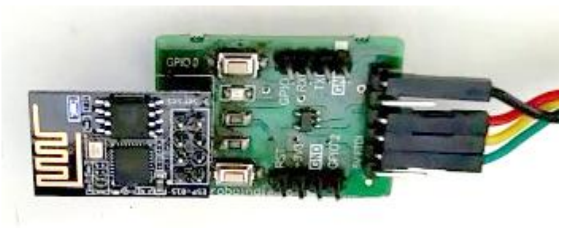
The dissolved oxygen measurement is conventional titration method which is time consuming. The expected range of dissolved oxygen in water is 15-20 mg per liter. The minimum required oxygen for survival of fish in water is 1-6 mg per liter [9]. The dissolved oxygen level can be maintained with timely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

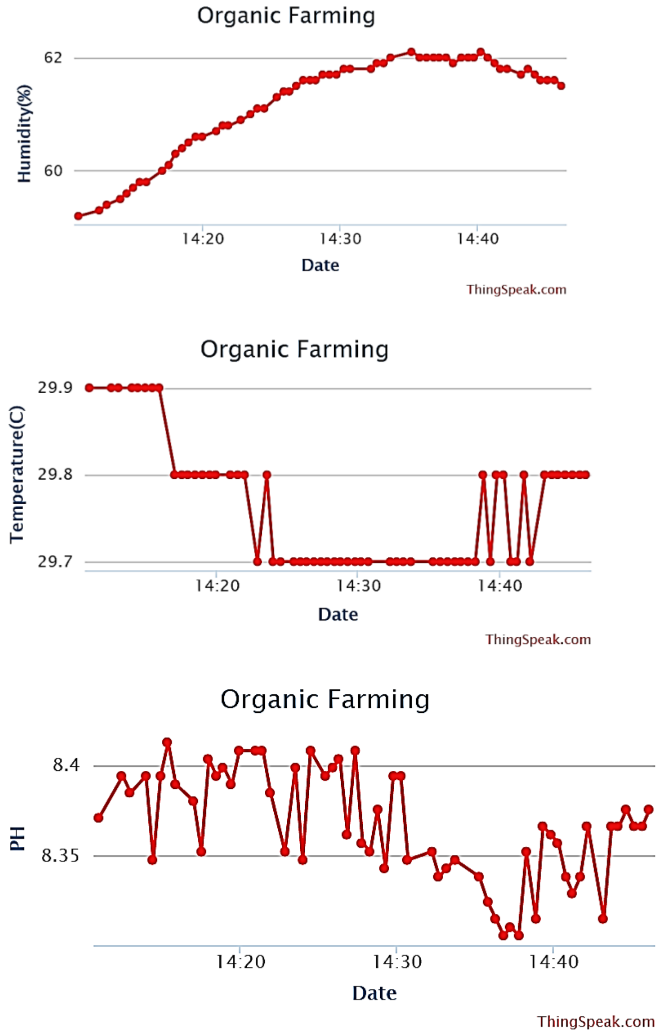


Figure 5: ThigSpeak Server Data Graph Plots

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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