SMART AQUAPONICS USING IoT

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ABSTRACT:

Aquaponics is the conventional aquaculture with the combination of hydroponics in a symbiotic environment. It is a low cost design system.In aquaponics the plant such as cabbage, cauliflower can be grown by the excreta from the fish .One of the shortcomings that encounters in aquaponics system is the excretion in maintaining optimal level. In order to overcome these ,an autonomous control and monitoring of the fish tank is required. The system consist of pic microcontroller, wifi module, sensor module and LCD as local display and several central monitoring components. It processes these data and compares with the optimum range for these parameter. Cloud based IoT processed data providing the analysis which is the foundation for predictive analystics and informed decision-making. Hence, an integrated system of agriculture and aquaculture system was introduced to control and monitor to reduse the water and reduce or even avoid the use of chemical fertilizers.It fortifies its increasing impact for society as an innovative response for the security

KEYWORDS: Aquaculture, Pic microcontroller, IoT, Integrated system.

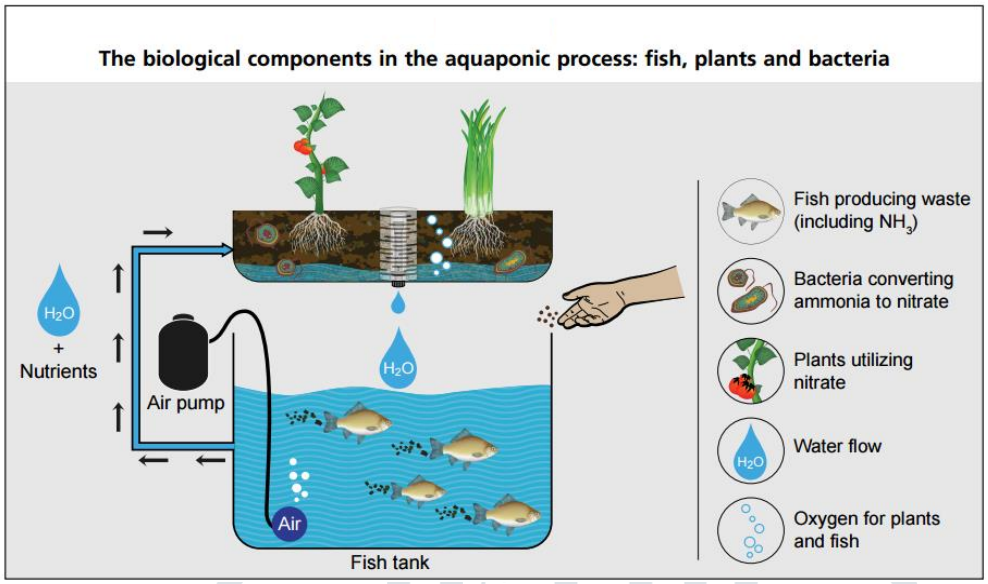
I. INTRODUCTION

Aquaponics is the integration of recirculating aquaculture and hydroponics in one production system. In an aquaponic unit, water from the fish tank cycles through filters, plant grow beds and then back to the fish. In the aquaponics system, bacteria are responsible for converting ammonia to viable nitrate for biofilm plants on all hard surfaces throughout the system basins, tubes and all system vehicles that are in constant contact with water. The submerged roots of the collected plant contain a large area where many bacteria can accumulate. Plants benefit from water soluble ammonia loaded with fish waste by converting it to nitrate, which is needed by the plant by 90%. Fish are derived from the elements produced by the plant in water, after being filtered and returned to the fish in a continuous cycle of the same water. The electric pump pumps nutrient rich water from the fish tank through the solvent filter to remove and filter particles that the plants cannot absorb. The water then provides nutrients to the plant and purifies before returning to the aquarium. Filtered water from the aquatic aquaculture system is filtered into fish tanks for recycling. Aquaponics can be more productive and economically feasible in certain situations, especially where land and water are limited. However, aquaponics is complicated and requires substantial start-up costs. The increased production must compensate for the higher investment costs needed to integrate the two systems. In aquaponics, before committing to a large or expensive system, a full business plan considering economic, environmental, social and logistical aspects should be conducted. Aquaponic system is greatly useful in maintaining environment sustainability. This system can reduce water consumption compared to traditional farming. Water is lost due to evaporation and transpiration of plant in this system. Thus, water in the fish tank is only replaced with fresh water at 5% to 10% of recirculation water volume daily which is about 80 to 90 percent less water used in traditional farming

II. AQUAPONICS:

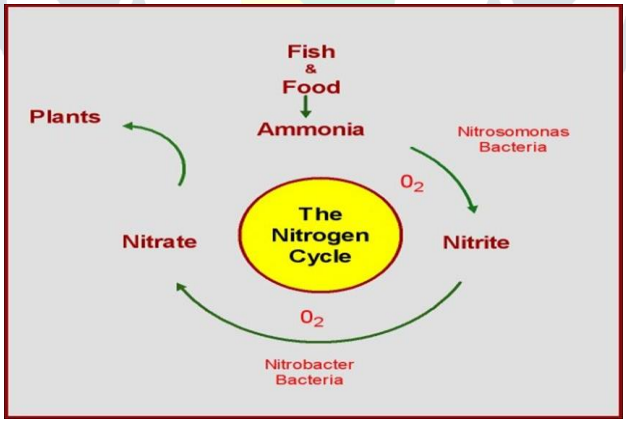
Aquaponics is a combination of aquaculture and hydroponic (soil-less plant culture) plant growth techniques. It doesn't require soil or any chemicals to produce a large amount of fish and vegetables in a small space. In aquaponics, the nutrient-rich water that results from raising fish provides a source of nutrients (Urea) for the nitrogen-consuming bacteria, which helps to clean the water where the fish live in by breaking down these compounds into nitrates, which then feed the plants and keeps them healthy. Water consumption is lower and plant density is usually at least twice that of soil based methods. As such the combination of aquaculture and hydroponics help to sustain an environment in which they both can thrive.

Aquaculture + Hydroponics → Aquaponics



III. THE NITROGEN CYCLE:

The most important biological process in aquaponics is the nitrification process, which is an essential component of the overall nitrogen cycle seen in nature. Nitrogen (N) is a chemical element and an essential building block for all life forms. Nitrogen is the most important inorganic nutrient for all plants. Nitrogen fixation is facilitated by bacteria that chemically alter the N2 by adding other elements such as hydrogen or oxygen, thereby creating new chemical compounds such as ammonia (NH3) and nitrate (NO3-) that plants can easily use. The ammonia is metabolized by a specific group of bacteria, which is very important for aquaponics, called nitrifying bacteria. These bacteria first convert the ammonia into nitrite compounds (NO2 -) and then finally into nitrate compounds (NO3-). Plants are able to use both ammonia and nitrates to perform their growth processes, but nitrates are more easily assimilated by their roots.



IV.COMPONENTS

(a) pH sensor:

pH measurements are predominantly conducted with pH-sensitive glass electrodes, which have, in general, proven satisfactory in measurements of pH. However, the behaviour of pH-sensitive glass electrodes often falls short of what precision is required.Even with the most careful treatment, the potential of cells containing glass electrodes often drifts slowly with time after such cells were placed in a new solution. Drift of cell potentials is an especially severe problem in investigations dependent on precise observation of small pH differences. Measurements involving cells with liquid junctions are subject to further uncertainties due to the dependence of liquid junction potentials upon medium concentration and composition and due to pressure changes in the system.

Ideally, the change in liquid junction potential (residual liquid junction potential) between test solution and standardizing buffer should be small or at least highly reproducible. In practice, systematic errors between many measurements suggest that the reproducibility of the residual liquid junction potential is often poor and that residual liquid junction potentials are dependent on the construction and/or history of the liquid junctions used in various investigations. Since pH fluctuations in marine waters are very small, an absolute accuracy of less than 0.1 pH units and a resolution of at least 0.01 pH units is required. For an assessment of the CO2/CO3 systems even a higher accuracy is necessary.

(b) CO_2 Sensor:

Analog CO2 sensor SKU: SEN0219 is used to measure the concentration of CO2. The concentration of CO2 is measured in parts per million (ppm). One ppm is equivalent to 1 milligram of something per litre of water (mg/l) or1 milligram of something per kilogram soil (mg/kg). The characteristics of SEN0219 are waterproof and anti-corrosion, high sensitivity, low power consumption, stability, temperature compensation, linear output, high life cycle, anti-water vapour interference and no poisoning. The operating voltage is 4.5-5.5V DC and average current is <60 mA at 5V, the peak current: 150mA at 5V respectively. The effective measuring range of CO2 sensor is 0-5000 ppm. The accuracy of the CO2 sensor is ± (50 ppm + 3% reading).

(c) Water level sensor:

Sensor is an electrical ON/OFF Switch, which operates automatically when liquid level goes up or down with respect to specified level. The Signal thus available from the Float Sensor can be utilized for control of a Motor Pump or an allied electrical element like Solenoid, Lamps, and Relays etc. Float Sensors contain hermetical sealed Reed Switch in the stem and a permanent Magnet in the Float. As the Float rises or falls with the level of liquid the Reed Switch is activated by Magnet in the Float.

(d) MQ-137 Ammonia sensor:

The Size of sensor is 32mm x 22mm x 30mm – with main chip LM393, and can be used to detect NH3 gas, working voltage DC 5V. the dissolved ammonia vapours are sensed by the gas sensor, with the help of proportionality the dissolved ammonia in water can be obtained.

(e) PIC (16F877):

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

(f) Submersible water pump:

Most commonly ,an submersible water pump is used as the heart of an aquaponics units submersible pump of its capacity would consume 25-50 W/h. A helpful approximation to calculate energy efficiency for submersible pumps is that a pump can move40 litres of water per hour for every watt per hour consumed, although some models claim twice this efficiency.
When designing the plumbing for the pump , it is important to realize that pumping per is reduced at every pipe
Fitting; upto 5% of the total flow rate can be lossed at each pipe connection when water is forced through.Thus , use the minimal number of connections between the pump and the fish tanks. It is also important to note that the smaller the diameter of the pipes,the larger the water flow loss.A 30mm pipe has twice the flow of a 20mm pipe even if served from pumps with same

capacity.In addition, a larger pipe does not require any maintanence remove the buildup of solids accumulating inside. In practical terms, this results in significant savings on electricity and operating cost.

(g) LED

LEDs are used in many places. They are the colored indicator lights on many electronic devices, they can be used to make bright advertising signs, brake lights on some newer cars, in TVs, and more recently, light bulbs for the home. White LEDs bright enough to illuminate rooms are usually more expensive than regular lightbulbs but they last longer and burn less electricity.

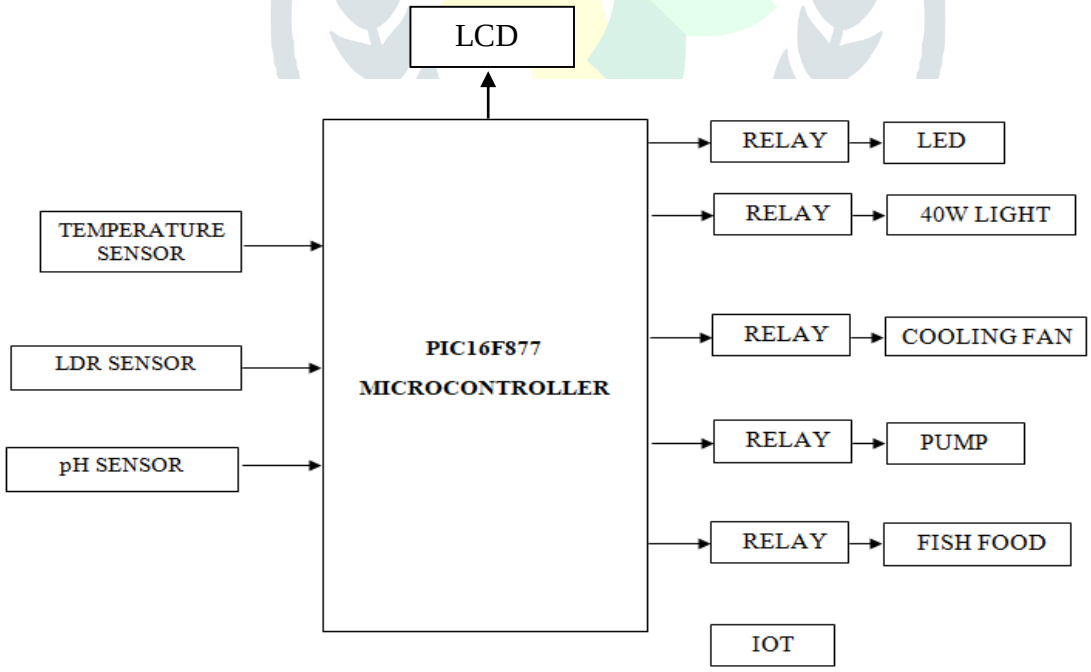
LEDs, which make their own light, should not be confused with LCDs, which block light. Some displays, however, mix the two technologies, using LEDs to backlight the LCD.

Today, some LEDs are surface-mount devices (SMD), so they can be very small.

V. METHODOLOGY

This system consists of arduino uno, Zigbee module, sensor module, LCD as a local display, Central monitoring station, 2-stage rack, pump, hydroponic plants, fishes and bacteria. Arduino uno control module is composed of 14 digital pins leadsout I/O ports. Our proposed project first uses five sensors to detect the parameters of water. On sensing the sensor passes this data to the arduino Uno. The arduino unothen processes this data and compares with the optimum range for these parameters if the values of quantities are in the optimum range. Than the control module passes this data to central station using zigbee and also displays the values in the lcd display, takes no control action. If the quantities value are below or above the optimum range is close the arduino Uno sends a control signals to turn the pump on and the pump remain in this state until all the parameters reaches back to optimum level. The basic concept is fishes produce and release ammoniotic waste in the water this pollutes water and then kills fishes. So this leads to periodic change of water with freshwater must be done this consumes too much electric power and and requires large volume of water periodically so certain hydroponic plants which needs nitrogen based manure in large quantities are grown along with aquaculture so that water is transferred to hydroponic system certain bacteria's are used in hydroponic system that converts the ammonia into nitrates and nitrites these are absorbed by the plants directly filtering water than this water can be re-transferred back to the aquaculture tank, this reduces amount of water required, saves cost of manures for plants produce economic benefits from plants grown, the exchange of water is based on the values of different quantities

VI. PROPOSED SYSTEM



This system consists of PIC 16F877 microcontroller, temperature sensor LM35, pH sensor, LDR and relays that acts as a switch in controlling the operations. The temperature sensor keeps sensing the water temperature and the pH sensor is used to detect the pH of the water to maintain a sustainable environment for fish and plants to live in. When the temperature sensor detects the value of the range above 35 o C, the microcontroller will control the temperature by turning on the cooling fan through the relay. On the other hand, if the sensor detects the value below 35 o C, the microcontroller will switch on the heat source (here 40W bulb). With the help of an inbuilt timer in PIC, the water in the tank will be changed automatically for a certain interval of time(say every week or twice a week). The LDR senses value below 50, the LED will be switched on. LDR is used for the decorative outcome of

this proposed system. These processes are all controlled and delivered according to the delay time using PIC microcontroller. IoT helps to collect and monitor the information about conditions such as the temperature of the water, moisture, the pH level of the water, light source detecting LDR. The values and the ranges of these sensors will be continuously monitored using IoT. If there is any change in the range of the parameters then the microcontroller takes over the control to set back the optimum range by performing the needful control operations.

VII.CONCLUSION

The electronic approach in the traditional aquaponic system that helps in evicting the existing problems faced in aquaponic farming. It encourages people to produce two streams of income, fish and vegetable rather than just one with advanced IoT monitoring system. For this project, the setup of the fish tank in the aquaponics system is done primarily. By the application of Internet of Things in the system, it has been possible to view the readings from anywhere in the world and also it provides the graphical and analytical view of the parameters in this system. The internet of things is the modern growth among technological fair. Its part in the project is the development of relative and routine information is all available through cloud storage as data content, it further makes it easy to utilize and get to know the future improvement in the technological domain. IoT can also play a major role in the natural composition by this Aquaponics culture for the reputed genre of future resources.

VIII. REFERENCES

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