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Smart Aquaponics System Using IoT

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1. ABSTRACT:

To fulfill the demand of food products and aquatic products, Aquaponics is introduced as a farming culture. It is the combination of hydroponics and aqua culture. Hydroponics Is the process where plants are grown without using soil and aquaculture is the process of growing fish in tanks. Aquaculture waste produced by fish is used by plants as nutrients and this water is purified by plants. This water is again pumped back to the fish tank. During this process there will be changes in parameters like temperature, pH, salinity which are harmful for both plants and fish. these parameters should be regularly monitored. Manually doing this takes a lot of human effort and time. so, an IOT system can be used to simplify this process.

Keywords:

Aquaculture, Hydroponics, Aquaponics, Nutrients, Temperature, Ph, Salinity, Plants, Fish, Human Effort and Time, IOT System.

2. INTRODUCTION:

According to UN department of economic and social affairs world population is projected to reach 9.8 billion in 2050 and UNESCO stated food lack of food is one of the four major challenges faced by world in its public survey report. Both fish and plant products are on demand now and it will continue in future. To fulfill the demand Aquaponics is new style farming comes to play in which fish and plants are grown together to reduce the use of water, land, pesticides and chemicals.

In aquaponics, water is always circulating in the fish tank. This water contains different toxins and nutrients from the fish and acts as a fertilizer for plants, they get purified by plants absorbing all toxins (toxics are ammonia rich water with fish waste and extra food). So, there is a need for continuous monitoring of parameters like temperature, pH, salinity. Though it is a easy process with equipment, it is difficult to keep testing the water frequently.

To simplify this process there is a need some system that makes the process for farmers. This can be done an IoT system. This system monitors the parameters (like temperature, pH,

salinity) on which growth and survival of the aquatic life depends and water level of tank in real time. These measurements are sent to Arduino and based on the optimum condition set, it makes the decisions and alerts farmers through application or message or alarm. and real time monitoring of parameters can be stored in cloud and viewed on mobile application or web page. Or an LCD or LED screen can be connected to the Arduino for monitoring those parameters.

Later parts of the section contains 3. Literature Review and Survey, 3.1 Summary of literature survey table followed by 4. Proposed system, 4.1 simple flow, 4.2 block diagram, 4.3 sensors followed by 5. Experimental results and 6. Conclusion. References are attached at the end.

3. LITERATURE REVIEW AND SURVEY:

There are many IoT systems proposed previously to simplify and reduce effort in agriculture and aquaculture. Most of them brought changes in farming culture though they have some limitations. Every system used different approaches to communicate the results of the system. Some of them used [1] Intelligent Voice Control System (IVCS) to communicate the results of the system with farmers. Where farmers are supposed to be at the output device at particular times. That waste their time to and that might not be preferable in some situations.

Micro controller units and Architectures are changed between models. Some times costly units are used irrespective of requirement. Raspberry [2][4] pi is used to receive data between from Arduino and send it to cloud. That can be replaced by some low cost units like Wi-Fi modules which can do the same work as Raspberry pi in these systems. Many of them is used higher MC's like Arduino mega [3] that is beyond the requirement and costlier. That can be replaced by some lower controllers like Arduino Nano and Arduino UNO.

Common problem identified in all of them is the whole system is automated. [5] There is no flexibility between switching the sensors and actuators. Which leads to unnecessary wastage of power and whole system should run even though one or two sensors are needed. This can be overcome by adding switches to all the sensors and actuators [1][2][3][4][5]. As this is beginning of the aquaponics there are no many technologies that can be implemented in this. As the requirements come up there may be need of new technologies in this.

3.1 Summary of Literature Survey:

Ref.no	Title	Publication	Limitations	Comparison
1.	To Improve the Production of Agricultural using IoT-based Aquaponics System.	May 26, 2020 published by International Journal of Applied Science and Engineering	Live monitoring is reached to user by intelligent voice control system.	Live monitoring is reached to user by Web application.
2.	Smart Aquaponics: Challenges and Opportunities	April 1, 2021 by Annals of R.S.C.B	Raspberry pi is used to send data from Arduino to database or app.	Raspberry pi is replaced by Wi-Fi module.
3.	Automated aquaponics: A survey	June 2, 2021 by IJSET	Arduino mega is used.	Arduino mega is replaced by Arduino Nano/UNO.
4.	The Aquaponic Ecosystem Using IoT and IA Solutions	2021 by IJWLTT	Raspberry pi is used to send data from Arduino to database or app and no manual switches are added.	It is replaced by Wi-Fi module and switches are placed.
5.	An intelligent management system for aquaponics	September 24, 2020 published by De Gruyter	As it is completely automated system we cannot switch required sensors or actuators.	Switches are provided to switch between sensors.

4. PROPOSED SYSTEM:

A cost effective smart aquaponics system is proposed to reduce human effort and time and simplify the process of aquaculture.

In this paper, the proposed system is used to measure all the parameters by the sensors that are placed in the fish tank. We used only temperature, pH, conductivity and float sensors. More detailed explanation of sensors is given in later part of paper. A pump is

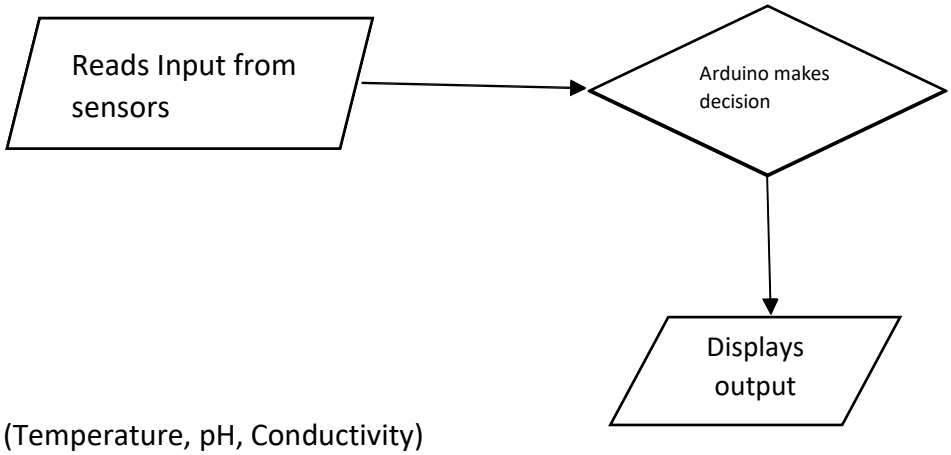
connected to fish tank to pump water into the tank. Other side of the pump is connected to relay.

The other sides of the sensors and relay are connected to micro controller unit viz Arduino Nano or Arduino UNO is used in this system. This Arduino outputs are connected to LCD/LED and a Wi-Fi module where Wi-Fi module transfers the information to cloud and which can be viewed through a mobile app or website.

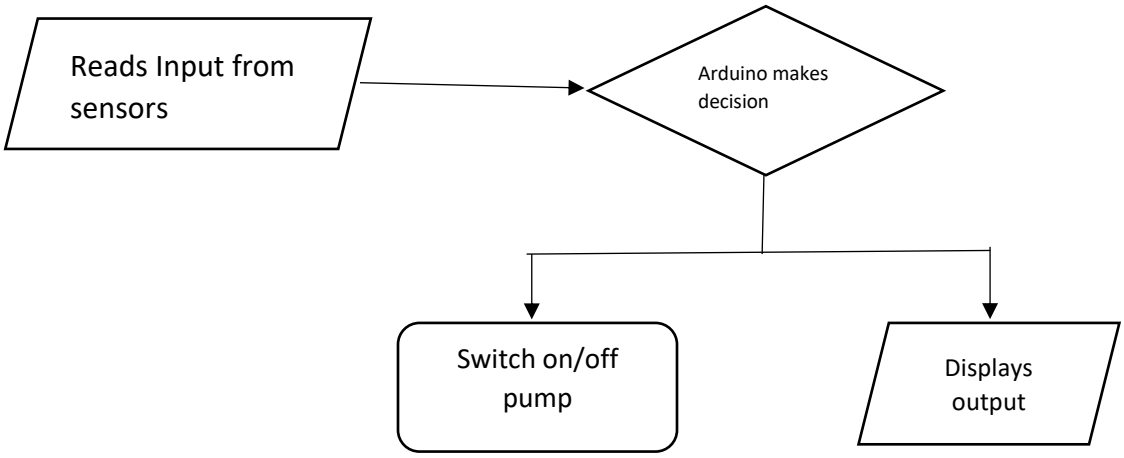
The first three sensors measures the parameters temperature, pH and salinity in water. These parameters are sent to Arduino to make decisions if required and send that to user. The other sensor is float sensor which measures the water level in tank. It keeps sending the measurements to Arduino and Arduino makes decision if it is below or above the optimum level then the it switch on off the switch.

Language C/C++ is used to program Arduino and to interface with sensors.

4.1 Conceptual Flow Diagram:

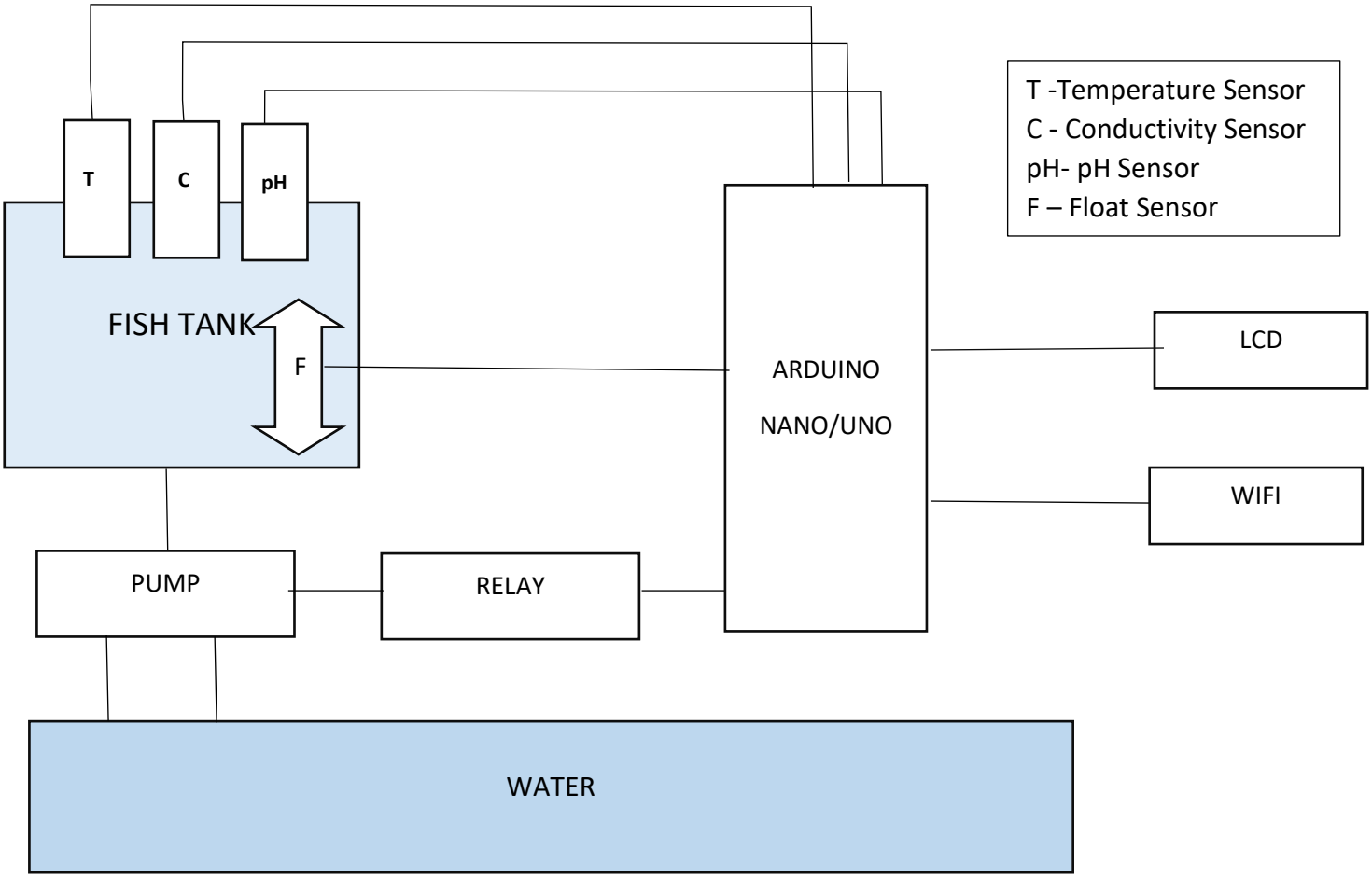


(Temperature, pH, Conductivity)



(Float sensor)

4.2 Block diagram:



4.3 Sensors:

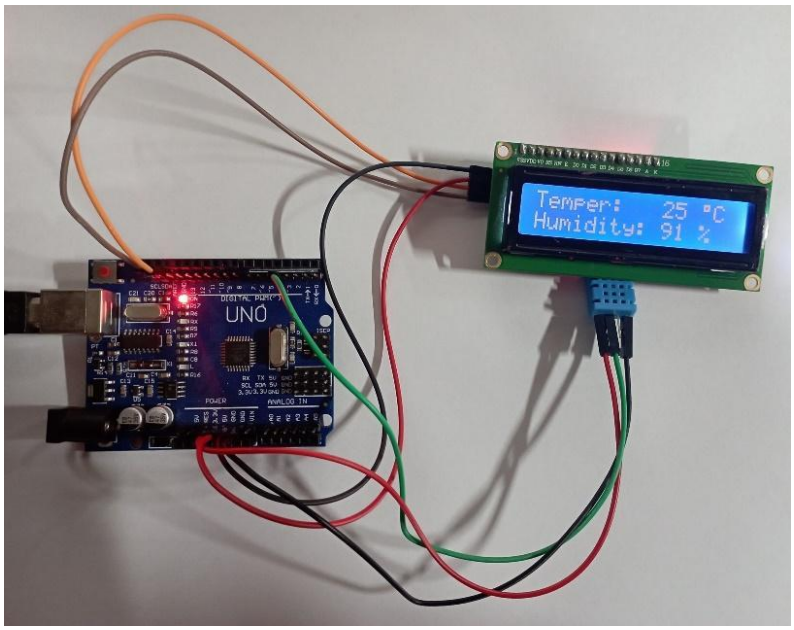
- Temperature Sensor: Temperature is a major part which affects other parameters of water quality such as pH, salinity etc, instead of using portable thermometer DS18B20 sensor is made use of and is waterproof and replaceable.

- pH Sensor: In Traditional methods water is tested at labs. Testing pH level of water frequently would be difficult and hence pH sensor is used to measure the pH level.

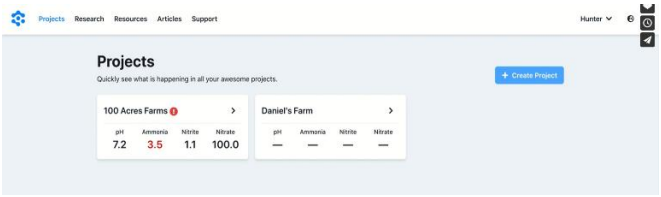
- Conductivity Sensor: In contrast to the traditional method where the salinity levels are tested at labs, here Conductivity sensor is used to measure salinity of water.

- Float Sensor: A float sensor is used to determine the water level in the fish tank.

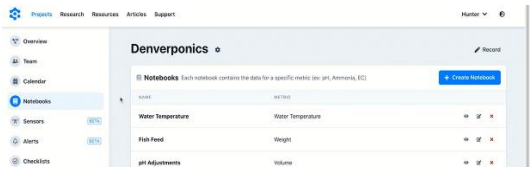
5. Experimental Results:



(Fig 5.1. Arduino with LCD)



(Fig 5.2. Parameters on Website)



(Fig 5.3. Analysis of parameters on Website)

With this system the required parameters are measured and outputs the results through LCD display and through the mobile application. The pump is automated depending on the water level in the tank.

The sensors used here are working properly and results are displayed on LCD screen as in fig 5.1. and the measured parameters measured and analysis of them are displayed on website as in 5.2 and 5.3

6. Conclusion:

New technologies should be implemented in agriculture and aquaculture to improve the yield, reduce effort, save time and fulfil the demand. Therefore a smart aquaponics system using IoT is proposed. Using sensors this system measures the parameters required and water level in the tank and display them on LCD screen and website. Based on the optimum water levels Arduino is making decisions from float sensors input and pump is automated accordingly.

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