iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VII **Month of publication:** July 2018

DOI: http://doi.org/10.22214/ijraset.2018.7057

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VII, July 2018- Available at www.ijraset.com

Smart Aquaponic System with IOT

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Abstract: In this paper, A Smart Aquaponics system model is represented which is a collaboration of Hydroponics, Aquaculture, Vertical farming. The main idea behind the model is the mutual benefit for the survival and healthy growth of plants and fishes with the help of bacteria and save water by reuse of water, with increase in yield by cost effective means. This is achieved by the use of a control system using an microcontroller (Arduino uno), various Sensors (Ammonia, Co_2, P^H, Water Level Sensor, Temperature), LCD Display and a Zigbee module. The sensors collect the various parameters and those data are compared for their optimum range when they fall short or exceed the optimum range the microcontroller performs the control action bringing the parameter in the range and also this data is sent to the central monitoring station using Zigbee where it is recorded for analysis. The main aim of the paper is to increase the food production with minimal water usage and with reduced cost.

Keywords: Aquaponics, Hydroponics, Aquaculture, Arduino uno Sensors, LCD Display, Submersible Pump, Things Speak.

I. INTRODUCTION

Water covers 71% of the Earth's surface. It is vital for all known forms of life. On Earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of ice and liquid water suspended in air), and precipitation. Only 2.5% of this water is fresh water, and 98.8% of that water is in ice (excepting ice in clouds) and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products. A greater quantity of water is found in the earth's interior. The water available for domestic and agricultural use is less when compared to total available water. And the distribution of this available water is very vivid, so usage of this water must be very efficient. The model described in the paper i.e., is the Smart Aquaponic system is an example for efficient commercial use of water.

This model simply implements an embedded system in Aquaponics to regulate the parameters in water so that it can be used for nourishing the plants and the fishes growing in them. The idea to save water it's by reuse in the process of aquafarming and hydroponics and vice-versa. This is based on the concept called Partial Exchange. The other important part is the bacteria which converts the fish waste into manure for plants. The entire system is monitored as variation in the levels of from optimum range will lead to the death of plants and fishes. The model includes Arduino uno board, pump, Sensors for ammonia, P^H, Co_2, water level, Zigbee for transmitting data over internet. The thingspeak website for reading the data transmitted by microcontroller.

II. LITERATURE SURVEY

Cho Zin Myint*, Lenin Gopal*, and Yan Lin Aung et.al., proposed "Reconfigurable Water Quality Monitoring using IoT" Since the effective and efficient system of water quality monitoring (WQM) are critical implementation for the issue of polluted water globally, with increasing in the development of Wireless Sensor Network (WSN) technology in the Internet of Things (IoT) environment, real time water quality monitoring is remotely monitored by means of real-time data acquisition, transmission and processing. This paper presents a reconfigurable smart sensor interface device for water quality monitoring system in an IoT environment. The smart WQM system consists of Field Programmable Gate Array (FPGA) design board, sensors, Zigbee based wireless communication module and personal computer (PC). The FPGA board is the core component of the proposed system and it is programmed in very high speed integrated circuit hardware description language (VHDL) and C programming language using Quartus II software and Qsys tool. The proposed WQM system collects the five parameters of water data such as water pH, water level, turbidity, carbon dioxide (CO2) on the surface of water and water temperature in parallel and in real time basis with high speed from multiple different sensor nodes.

Nazleeni Samiha Haron, Mohd Khuzaimi B Muhammad, Izzatdin Abdul Aziz, Mazlina Mehat et.al, proposed "A System Architecture for Water Quality Monitoring System Using Wired Sensors," developed a water quality monitoring system for eliminating cost consuming jobs of manual monitoring. In this system the measured data of water quality monitoring sensors are collected by the data kit which gives data to the data processing unit through GSM modem. In data processing unit the data from different sensors are differentiated and it is continuously compared with the ideal parameters of the sensor value. If the water isn't meeting its quality parameter value the alert signal is there which is connected to the buzzer. This system is not reliable for long distance also it will apply to only single unit of water source.

III. PROPOSED DESIGN 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 leads out 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 uno then 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 .

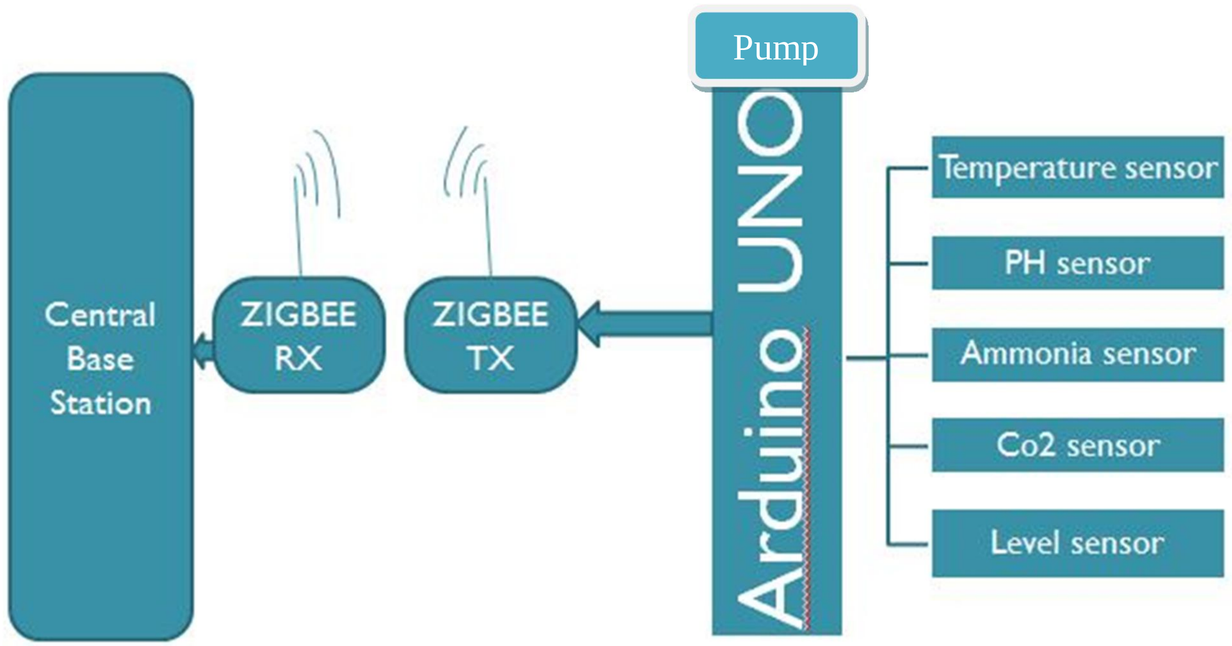

Fig 1 Proposed method

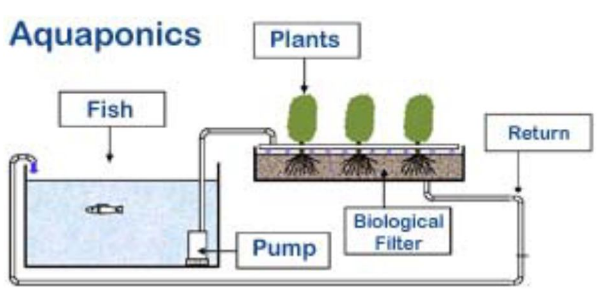

Fig 2 Proposed model

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

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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 sensed typical values are given below. The values of different quantities w.r.t the prototype used is given below. The main parameter is ammonia and values for differs for different kinds of fishes and the optimum value for ammonia is set according to the variety of fishes grown in the aquaculture.

Readings on the Grafana				
Water Parameters	**Min.**	**Max.**	**Average**	**Current**
Temperature	31° C	57° C	41° C	43° C
Water Level	356 mm	1.575 m	555 mm	1.575 m
pH	14	14	14	14
CO_2	699 ppm	1076 ppm	766 ppm	718 ppm
Turbidity	4	4	4	4

Table 1 Example of samples from sensors.

IV. HARDWARE IMPLEMENTATION

A. Power Supply

This model requires both Ac and Dc power supply the DC is for the Arduino and the AC supply is for the submersible pump. The DC requirement is 12V and AC is 230V. The Model uses a step-down transformer, Bridge rectifier circuit and filter to convert AC to DC so that require Power is obtained.

B. Arduino uno

The Arduino is widely used controller board with ATMEL328P microcontroller onboard with 14-pins and among it 6-pins are analog and also supports UART and operates at 5V supply with many more features.

C. 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)

D. P^H Sensor

It works on 5v , with an range of measurement 0-14, with 0.1 accuracy and 1 minute response time with operating temperature as 0-60 degree Celsius

E. Water level sensor

Float 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.

F. Zigbee

ZigBee is based on the IEEE's 802.15.4 personal-area network standard. All you need to know is that ZigBee is a specification that's been around for more than a decade, and it's widely considered an alternative to Wi-Fi and Bluetooth for some applications including low-powered devices that don't require a lot of bandwidth - like your smart home sensors. ZigBee is for sensor-monitoring and control of various applications/devices from multiple companies, because it lets ZigBee-enabled devices work and operate together while also giving you the ability to control them. Hence it is ideal for smart homes.

G. Submersible Pump

Submersible Pump is a highly efficient tool for various machines that require a pump to function. This pump has an 15W motor that can lift water up to 1.40m and is made of rust proof durable ceramic shaft. The motor submerges completely into the water as it is water resistant. The product comes with an Output Pipe with dimensions 1/2 and 3/4 inches that has an output of 780 liters per hour. The pump weighs 300 gms and is highly portable. pump is easy to install ^{H}and handle which comes in a compact size that consumes low electricity.

H. 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.

I. Thingspeak Website

This is a open source platform which has fixed protocols to receive data over internet ant display them in the form of a graph with a given scale. This project utilizes thingspeak to display the five parameters and one important feature of thingspeak is the time stamp for every sample.

V. EXPERIMENTAL SETUP AND RESULTS

Fig 3 experimental setup prototype

Fig 4 PH and temperature sensor data received at Thingspeak station.

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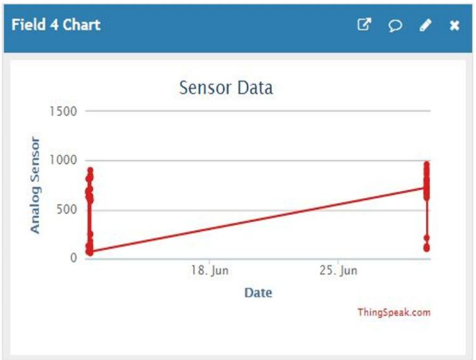

Fig 5 Ammonia and Co_2 sensor data received at Thingspeak station.

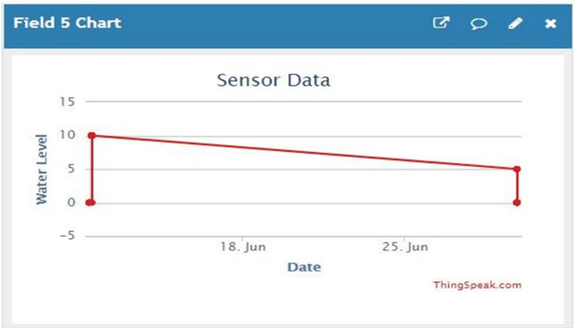

Fig 6 water level data received at Thingspeak station.

VI. RESULTS

It is evident that with the use of this system the water requirement has been reduced considerably and the yield has not deteriorated. And this remote sensing module with the help of additional battery can be used to check the water quality of water resources and can be used for the process of surveillance in industrial sites and regulate water pollution. This system with the help of thingspeak also maintains a database of samples which can be studied to improve the yield.

VII. CONCLUSION

It is observed that the model presented saves the water up to 57% when compared to traditional aquaculture and enhances the economic stability of the farmers by providing yield of both fishes and plants and also reducing the resources spent for water. It can also be seen that if this model implemented using community farming method the work force required for maintenance can be reduced by monitoring through central monitoring base. Overall the model represent an efficient embedded system to minimize water wastage and increase yield.

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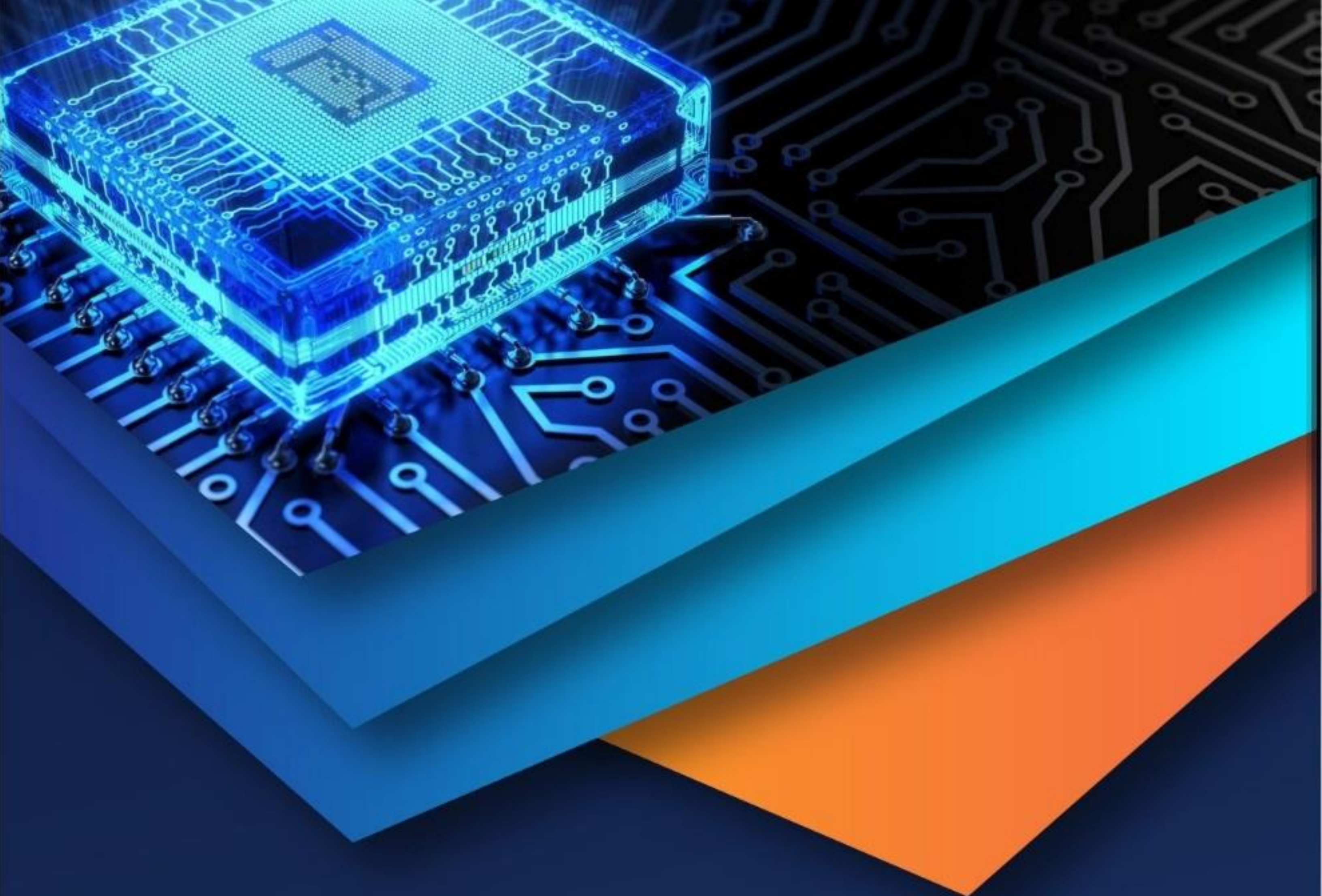

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