Advanced Aquaponics Monitoring System Using Raspberry Pi3

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Abstract: This paper describes the concept of Aquaponics, including a brief history of its development and its place within the larger category of soil-less culture which is or else called Modern agriculture. Aquaponics system refers to the system that chains conventional aquaculture with hydroponics in a symbiotic environment. In normal Aquaculture, excretions from the animals being raised can accumulate in the water, increasing harmfulness. In an aquaponics system, water from an aquaculture system is nourished to hydroponic system where the by-products are broken down initially into nitrites and consequently into nitratesby nitrifying bacteria, which are consumed by the plants as nutrients, and the water is then recirculated back to the aquaculture system.The proposed Aquaponics system is based on food growth in Hydroponics and using Aquafarming techniques. The proposed system collects data acquired by the device and gives alert by sending message and activating the buzzer.

Keywords: Aquaponics, Hydroponics, Embedded, Agriculture

1. Introduction

The project contains the idea to develop the aquaponics system which concentrates on development of agriculture which also suitable for urban cities and non-arable areas where there is sufficient space. This system started with household development, as a small scale aquaponics system. The cultivated organic vegetables having rich nutrients and ammonia free which is sufficient for plants growth (Kloas et al., 2015).

In this proposal we mainly concentrate on pH sensor, Dissolved oxygen probe and Electricalconductivity sensor to maintain the healthy life for the organisms present in the system (i.e., fishes and plants). pH sensor is a determinant value depending on described scale value, similar to temperature. The pH level of water is measured with a log scale which is not a physical quantity. The scale ranges from the value 0-14, with a neutral value of 7. The lower range 0-7 is acidic and 8-14 is base. “pH” stands for “power of Hydrogen”; the value is determined by the effect of H+ ions and OH- ions (Nishimura et al., 2016);(Domingues et al., 2012). Figure 1 shows the pH scale value.

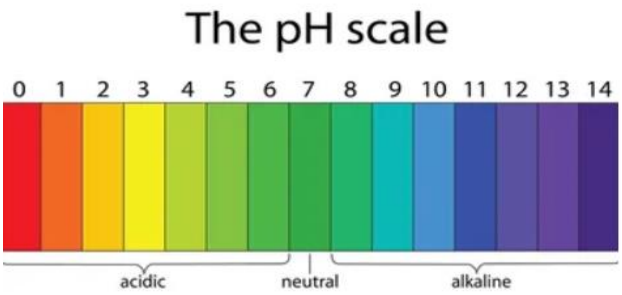

Figure 1. pH Scale

Managing the aquaponics system is quiet difficult because of three different organismsrequires different pH values. Plants, fishes and bacteria, each has different pH values, so it is difficult to maintain the system in an ideal range. Fish prefers base, whereas plants prefer acidic environment. This concludes most of the aquaponics system falls in a pH range of 6.5-7.5 which is common for plants and fishes.

The water is not just a mixture of nutrients, minerals and water. There are plenty of requirements needed for plants, fishes and bacteria in an Aquaponics system (Gutierrez-Wing & Malone, 2006); (Rakocy, 2012); (Aishwarya et al., 2018).

- The important nutrient is Dissolved Oxygen, required for Fish respiration
- Plants respiration,helps for nutrient uptake and strengthen the root system
- Bacteria exhales nitrification and respiration

This project is mainly implemented to produce healthy growth for fishes and plants which is consistently verified using LCD display and using alert message. This systems helps the aquaponics system to grow faster and healthier without any added chemicals and pesticides (Changmai et al., 2018);(Castillo-Castellanos et al., 2016);(Schmautz et al., 2016). Figure 2 shows the block diagram.

2. System Model

2.1 Block Diagram

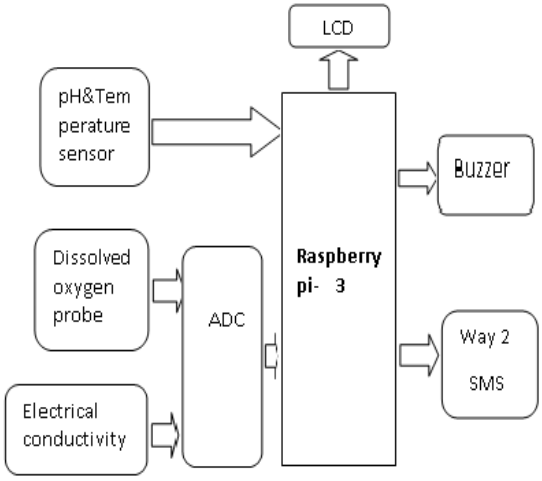

Figure 2. Block Diagram

2.2 Components of the System

- Sensors
- pH sensor
- Temperature sensor
- Dissolved Oxygen probe
- Electrical Conductivity
- Liquid Crystal Display
- Raspberry pi-3
- Analog to Digital converter
- Buzzer
- Wi-fi module

2.3. Flow of Working

a) Raspberry pi is used in this proposal since it contains inbuilt wide fidelity module used for alert messaging .
b) ADC is used in this project since it contains many sensors which converts to digital values.
c) Exceeding in pH effects certain factors hence the quantity of pH is measured. Safer range of pH for aquaponics system is 6.5 – 8.
d) Temperature sensor indicates the temperature in the aquarium and maintains the required Celsius for the growth of fishes and bacteria's.
e) Oxygen immersed in water effects the production of aquatic food. DO increases as the pressure increases, Bacteria need an adequate level of DO to maintain high level of productivity.
f) Electrical conductivity is used to determine ions present in the solution. Nutrient efficiencies effects the high and low EC values.
g) LCD displays the determined sensors value (Gonda & Cugnasca, 2006);(Nagayo et al., 2017).

3.Hardware Description

3.1 Raspberry pi-3

Raspberry pi3 are small board computers; it does not have inbuilt peripherals like keyboards, mouse and cases. Its major operating system is Raspbian which is RISC OS. Operating speed varies from 1.2 GHz and 64/32-bit quad-core ARM Cortex-A53.

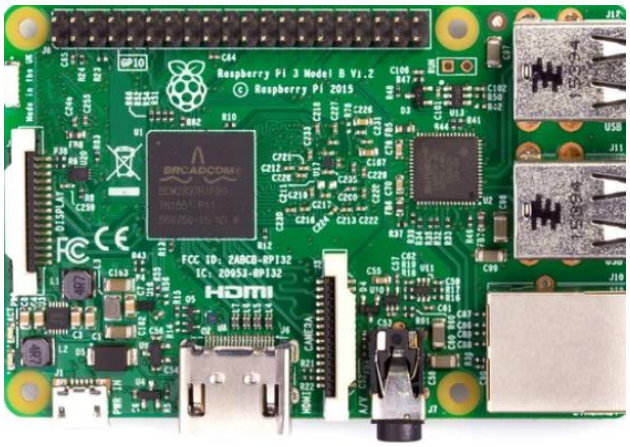

Figure 3. Raspberry Pi3 Model B Hardware

Figure 3 shows the raspberry pi 3 has special features on it by having inbuilt Bluetooth, wi-fi module and HDMI port (Liang et al., 2002); (Ulum et al., 2019).

3.2 pH Sensor and Temperature Sensor

Figure 4 shows thepH sensor and temperature sensor**.**pH sensor is used to measure hydrogen -ion acidity or alkalinity in the water solution. pHsensor has two electrodes which is a responding electrode and a unvarying reference electrode (Martinoia& Massobrio, 2000);(Vikram et al., 2017). pH sensor is calibrated using two buffers if not three buffers. It also has inbuilt water level sensor which indicates the increase and decrease of the solution. Sensor is dipped in the solution which is immersed to the water level.

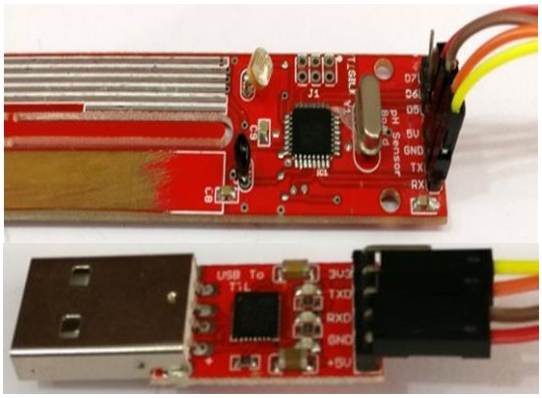

Figure 4. pH Sensor and Temperature Sensor

Temperature sensor is used to measure the Celsius present in the aquarium. Sensors are used than a thermistor to determine the prominent temperature

3.3Dissolved Oxygen Probe

Figure 5. Oxygen Probe

Figure 5 shows the oxygen probe. Dissolved Oxygen probe is used to measures the oxygen content present in the liquid. DO is the major contributed gas in the solution, when the DO drops below 3mg/l, it affects the survival

of fishes (Neto et al., 2014); (Martan, 2008);(JSM& Sridevi ,2014). When the DO drops above 5mg/l, it effects the growth of plants and Bacteria.

3.4 Electrical Conductivity

Figure 6 shows the probe to sense electrical conductivity.Electrical conductivity fluctuations and prolonged levels from the outside system's acceptable range will cause the plants growth with lack of nutrients(Nosir, 2011);(Ye& Li, 1998);(Walters& Currey, 2015). And even plants may grow very faster get matured with poor quality crop.

Figure 6. Probe to Sense Electrical Conductivity

4.Results

The hardware setup of the system is shown in the figure7. The sensors are connected to the microcomputer which senses the environment and transmits the sensed data to raspberry pi3 (Kushiro et al., 2003);(Ramlee et al., 2013).The appropriate results are got and the parameters are controlled with the help of motors to maintain the anticipated environment for the plants to grow (Espinosa Moya et al., 2016);(Lennard, 2012);(Cronin et al., 2016). The benefits of the work are:

- Effective and efficient food production system
- Reduction in usage of water level
- Two agriculture products fishes and vegetables are produced thus eco-system is balanced
- Plants growth will be significantly faster
- It is purely organic
- More crops are cultivated in less space
- Can be used in non-arable land such as deserts, islands, etc.

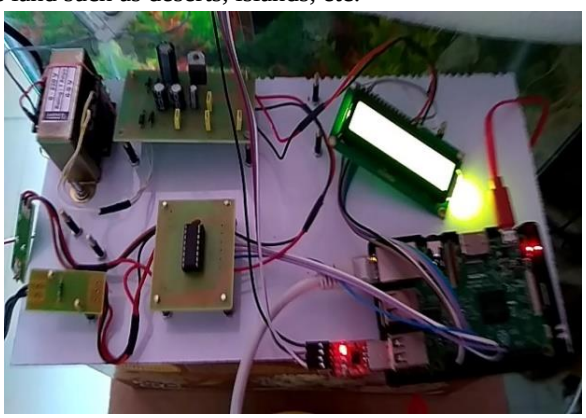

Figure 7. Hardware Setup

5. Conclusion

Aquaponics is the best system of agriculture for growing organic vegetables at crowded cities and non-arable lands. And this does not require much water and space. This system especially stands as an eco-friendly technology were it could be improvised at an individuals pattern of usage. The adequate amount of dissolved

oxygen and pH is continuously monitored and displayed. So there will be a Healthy growth in both fishes and plants. Future modification can also be included by the following technologies such as Image processing, Data logging and Data analytics. This system works without any chemical pesticides and fertilizers with regard to future expansion and development, the internet of things will be the better solution especially with regard to flexibility

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