Development of a Fully-Automated Portable Mint-Aquaponics for Urban Farming

Introduction

Aquaponics is an eco-friendly system to cultivate fish and crop without soil by utilizing aquaculture and hydroponics. In this process, Plants take benefits of nutrients from fish feces, while the fish uses clean water filtered by the plant roots. On the one hand, with the advances in technology and the improvement of people's living standards, they have no more extra time and labor for regular watering and fertilizing plants. On the other hand, it is not easy to maintain water quality parameters frequently. Therefore, it can be understood whole process is so complex and time-consuming. Considering on the above shortcomings, the fully-automated mini aquaponics system is proposed.

Firstly, in this study it is important to select suitable hydroponic plant species which have best water purification efficiency and growth efficiency. Next, develop a fully automated aquaponics system model.

In this study, it is developed a smart aquaponics system that can synergize fish farming and plant growing by continuously gathering data from various aquaponics sensors, monitoring the sensor information, and controlling the system accordingly. In addition, the proposed system can notify the user if any abnormality occurs in the system via smart display (Kyaw *et al,* 2017).

Selection of Plant Species

Plants which are planted in hydroponics systems are called as hydroponics plants. Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium (ex; gravel) to provide mechanical support (Nisha *et al.,* 2018). Among the Mint plant verities, Spearmint (*Mentha spicata*) is selected in this study. That is why, spearmint may be very useful as biological filters in aquaponics system to absorb and prevent the accumulation of nutrients produced by fish excreta (carlos *et al.,* 2018). And also, spearmint have been used as medicine due to their antiseptic properties. As an example, *Mentha spicata* is a natural repellent for *Anopheles stephensi* (Rafael *et al.,* 2018).

Selection of Fish Species

Several warm water and cold water fish species are adapted to recirculating aquaculture systems (P.S.Ranawade *et al.,* 2017)Therefore, guppy fish is selected for this project due to they are quiet tolerant of a verity of water conditions. It suggests that guppies have the capacity to survive and multiply in both fresh and polluted water (Shahjahan *et al.,* 2013)

Design of the system

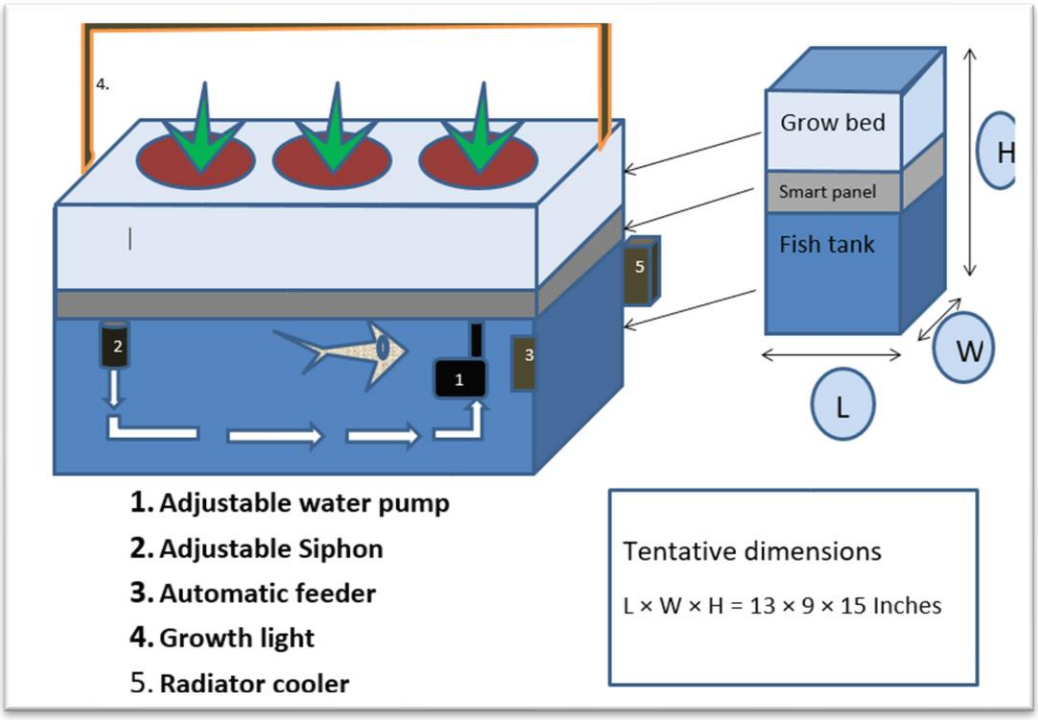

Figure 1. Overall system design

Figure 1. explains the overall system design. The fish tank, grow bed, adjustable submersible pump (1) work as an aquaponics system. Adjustable siphon (2) bring filtered water by roots from grow bed to fish tank. Automatic feeder (3) has been programmed to feed guppy fish twice a day. Growth light (4) provide a light spectrum similar to that of the sun for plants in the grow bed. Water temperature will be keep in constant level at 25 $C^{0©}$ with the aid of radiator cooler (5).

The hardware used is Arduino Uno as a microcontroller. It is used to store data from collection nodes (sensors), process data, maintain the changed water quality parameters by optimum values and then upload them to the mobile application.

Water level sensor for alarming at low level and high level of storage water In the system, pH sensor to detect the pH value of the fish tank, temperature sensor to detect the temperature of the fish tank and DO (Dissolved Oxygen) sensor to detect dissolved oxygen level in the system are used in this aquaponics system.

Extra water reservoir is there for water leveling in the smart panel (**figure 1.**). In here, pH sensor control module with BNC electrode probe support to maintain the pH level in optimum range for guppy fish (6.5-8.5). Aerators are programmed to switch-on when DO sensor makes to alarm the system. There is an alarm unit for this system. The alarm unit consists of a green LED light, a red LED light, and a buzzer. This unit displays green light when the system is healthy, but displays red light with buzzing sound to alert the user when the system is unhealthy. This section helps for users when they maintain the aquaponics system physically.

Analysis

The plants used in this project *Mentha spicata*, 33.4 g FW ± 20.8 g FW, 17.1 cm ± 1.2 cm, 4.7 true leaves ± 4.0 true leaves). Growth efficiency of plant species (using wet biomass) and water purification efficiency will be analyzed using one way ANOVA.