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STUDY AND DESIGN OF INTELLIGENT AUTOMATED AQUAPONICS SYSTEM

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***Abstract*— In the current scenario to achieve the target, an effort was made to develop Intelligent to automate the Aquaponics System technology for farmers' benefit and overcome crucial concerns such as food security and water scarcity. Aquaponics is a mixture of aquaculture that grows fish and other aquatic animals, and hydroponics that develops soilless plants Aquaponics utilizes these two in a symbiotic mix, where plants are fed the spill or waste of the aquatic animal. The vegetables in exchange clean the water which goes back to the fish. Microbes perform a vital role in plant nutrition, including the fish and their waste. These beneficial bacteria accumulate in the areas between plant's roots and turn the fish waste and solids into substances that can be used by plants for development. Aquaponics was considered a viable process of development. This provides a range of beneficial environmental features along with soil protection, effective use of water and nutrients, sustainable fertilization, and produces the highest yield on.**

This paper discusses the comprehensive design a nd functionality of the system, a listing of the ne cessary component, costs involved in developing, maintaining and running the system, benefits a nd drawbacks.
It has also developed an automated prototype to test the reliability of the device. An autonomous control system is required to tackle this issue. It also makes good use of the implementation of an independent control system for the continuous automatic supervision and monitoring of a complex system. Throughout this paper established gaps that could fill in the gap between both the development and study of practical Drip irrigation systems. Research indicates that Organic farming is capable of being an indispensable component for the growth of interconnected crop production processes. Water shortage regions should benefit primarily from the use of this technology in a commercial setting.

This paper explores the Organic farming Prehistory in detail, characterizes its fundamental precepts and importance, and compares the different intelligent aquaponics models.

***Keywords*— Aquaponics, organic fertilization, Physical conditions, Intelligent, Automatic prototype etc.**

1. INTRODUCTION

Not long afterward we either produced our own food or recognized the farmer who had grown it. Small local farms, however, have been practically wiped out in recent decades by an industrial and corporate dominated food system that has poisoned our natural resources, drained our farmland, sprayed toxic pesticides and genetically engineered our food in an attempt to "feed the masses." There is an immense amount of packaging, manufacturing and electricity and carbon emissions to the sale of food to customers. Conventional food delivery systems emit 5 to 17 times as much CO2 as local and national food production. If that wasn't enough, industrial agriculture is the world's largest water user. Aquaponics is a renewable food source in organic farming aquaponics refers to any system that combines traditional aquaculture with

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hydroponics in a synergistic setting. Aquaponics farming is an enormously popular way to develop organic food, plants, spices and fruit without the need for any agrochemicals, with the additional benefit of fresh seafood as a healthy and sustainable primary energy source. This is a ground-breaking mechanism for plant growth, under which fish farming contaminated water is diverted to crop beds in a safe, closed environment [1]. Fishes and crops depend on the equilibrium of the soluble vitamins and minerals and the consistency of the water as they produce using each other's metabolic products. Due to the mutually supportive absorption and discharge of vitamins and minerals from fish to crops, frequent surveillance of the organic farming water system is essential [2]. This needs a genuine commitment to our precious time and careful treatment. Some of the limitations encountered in the drip irrigation system is the effort to maintain an optimum performance level and the time needed to monitor and physically adjust the specifications to the correct extent. An autonomous control system is needed to resolve these penalties. The history of Aquaponics begins with the 'stationary islands' created in shallow lakes in Central America (Aztec Chinampas 1150-1350 BC).

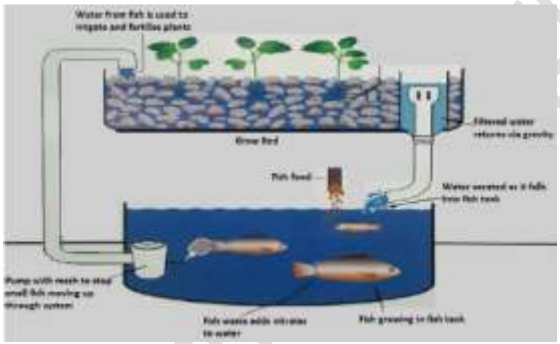

Fig.1: Traditional Aquaponics System

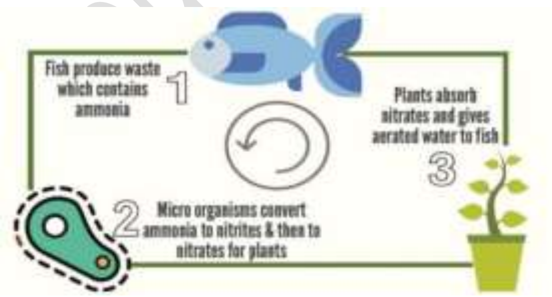

Fig.2: Chain of basics idea of Aquaponics System

The survey, led by Love et al. [3], shows that aquaponics has become increasingly concerned since 2010, which confirms its rising effect on society as an creative approach to food security.

2. NEED OF AQUAPONICS SYSTEM

An aquaporin farm creates and generate

1. Significantly reduced water use than land-based agriculture.
2. There are no toxic chemicals and fertilizers. It's a perfect eco-system.
3. Compost for soil replenishment.
4. Fodder for animals and livestock.
5. Sustainable farm raised fish.
6. Green company that contributes to the well-being of people and the world.
7. Local jobs, education, volunteer and therapeutic opportunities.

3. TYPES OF AQUAPONICS SYSTEM

All basically, there are three major shapes in aquaponic device architecture.

1) Media-filled bed
2) Deep water culture (or raft)
3) Nutrient film technique.

3.1. MEDIA-FILLED BED may be regarded to be the most traditional and straightforward aquaponics design. It's typically the theme embraced by most aquaponics growers in the courtyard. In this process, the plants are grown directly in a medium-filled bed. The development media used may be expanded to include clay or rubble. Water rich in nutrients (ammonia-containing discharge and nitrates) is drained from a fish pond to a water source.to a medium-filled rising bed.

Fig. 3: Media-filled bed

The configuration of the media-filled bed aquaponics may be further divided into two systems – the continuous flow system and the flood and discharge system (also referred to as

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the ebb and flow system) centered on the re-circulation of the water.

3.2. DEEP WATER CULTIVATION OR RAFTING is predominantly used for commercial gain, as it is comparatively cheap to grow and a broad range of leafy vegetables and herbs can be developed. Holes are ruptured by floating boards or flexible rafts for pots. The plants are then developed in these pots, and the roots are submerged in the soil.

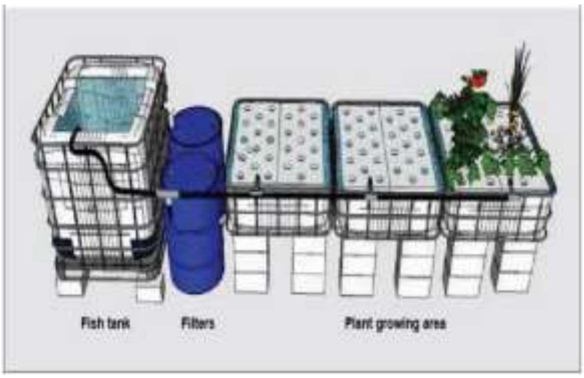

Fig. 4: Deep water culture

The raft may literally be floated directly on top of the fish tank. The most common approach, however, is to catch fish in a specific reservoir, to drain nutrient-rich water through a filter and into large tunnels where rafts loaded with plants are floating on the surface of the water to digest gluten. Unfiltered water contains fish solids that can bind to the roots of the plants, impacting their abilia.

3.3 NUTRIENT FILM TECHNIQUE (ALSO KNOWN AS NFT AQUAPONICS) is the least frequently used feature of the aquaponics system. This is commonly used for hydroponics, however, Nutrient-rich fish tank water is pumped down narrow sealed canals.

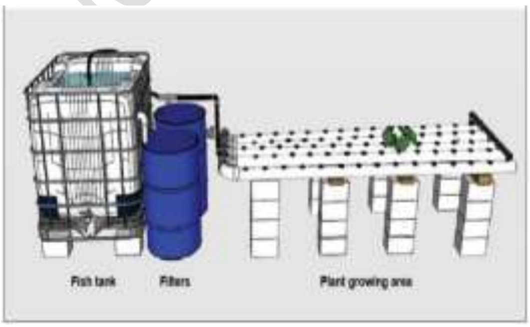

Fig. 5: Nutrient film technique

In several NFT aquaponics systems, holes are bored along the length of medium-sized PVC pipes. Optionally, second-hand gutters can be used. The volume of water that flows through the base of the channels is so minimal that it just forms a very thin film.

4. ADVANTAGES AND DISADVANTAGES & FACTORS OF SYSTEM

ADVANTAGES

- Aquaponics uses 90 percent less water than soil-based agriculture, and even less water than hydroponics or recirculating aquaculture
- Aquaponics farming does not require pesticides or herbicides, it does not use any harmful chemicals because it may destroy fish.
- Aquaponics reduces a lot of hectic gardening chores. Growers will relax and enjoy the activities of fish feeding and plant harvesting.
- User can launch the aquaponics systems anywhere. Aquaponics can be achieved in an open space using grow lights, in a greenhouse, rooftop, backyard or even a home.
- Aquaponic systems can be designed to any size. An aquaponic system can be as small as an aquarium, and can be a large commercial greenhouse farm
- Grower obtains simultaneous fish and plant harvest from the same water supply.
- Aquaponic farms have bacteria which make these farms immune and self-healing.
- Aquaponics offers a denser plantation area compared with soil-based agriculture, resulting in higher yield.

DISADVANTAGES

- Aquaponics growers need to have in-system awareness of fish, bacteria, plants and many other small components.
- Not-everyone can develop aquaponic farms. Expensive design.
- A One disadvantage of using an aquaponics system is that the electrical

outputs are high as water pumps run 24 hours a day.

- Not all crops can be grown in aquaponics.

4.1. WHAT MEASURES THE AMOUNT OF NUTRIENTS ESSENTIAL TO PLANTS?

Several factors, as described below, were responsible for the availability of nutrients to plants. These factors should be strictly and timely controlled in order to ensure optimum plant production. Density of fish population

- Size of fish
- Temperature of water
- Amount of uneaten fish feed in water
- Availability of beneficial bacteria
- Amount of plants in the system
- Media present in system
- Water flow rate

4.2. WHAT ARE MAJOR PARTS OF AN AQUAPONIC SYSTEM?

Aquaponics consists of two major segments, the aquaculture component for breeding aquatic animals and the hydroponic part for crop growth.

- Live components
- Fish (or other aquatic creatures)
- Plants
- Pathogens
- Hydroponic subsystem
- Bio filter

5. DESCRIPTION OF HARDWARE

Aquaponics uses the best of all the growing techniques, namely Hydroponics, Aquaculture, and traditional agriculture; utilizing the waste of one element to benefit another mimicking a natural ecosystem In Aquaponics, fish waste, along with the large amount of water in which it lives, doesn't have to be disposed of regularly, as is the case in the Aquaculture environment. Costly plant food does not need to be added as it would with a hydroponic system. Also, there is no need to flush out the grow beds periodically to replace it with water that is fresh and clean. Aquaponics thus is a method of growing fish, development and other types of plants in a sustainable closed-loop method.

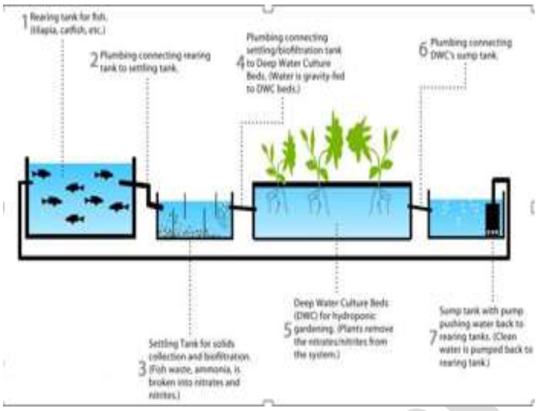

Fig.6: General setup of an aquaponics system

5.1. THE AQUAPONICS SYSTEM CYCLE:

- First the fish in the aquaponics tank are fed with fish food supplied by the grower.
- Fish secrete waste and ammonia that can be detrimental to the fish in sufficient quantities.
- The fish breathe in oxygen but exhale carbon. The water is contaminated with fish waste and carbon. The fish tank water is cycled into the plant grow bed media.
- The grow bed media is a perfect environment to billions of bacterial microbes that convert the ammonia initially to Nitrite, and then to Nitrate.
- The plant roots absorb the nutrient-rich Nitrate and the carbon helping to clean the water while elevating the health of the plant.
- The purified water is poured back into the fish tank while oxygenating it at the same time.

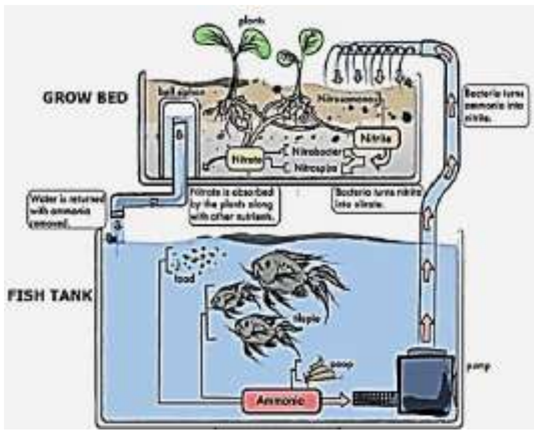

Fig. 7: Cycle of Aquaponics System

6. LAYOUTS OF PROPOSED MODEL

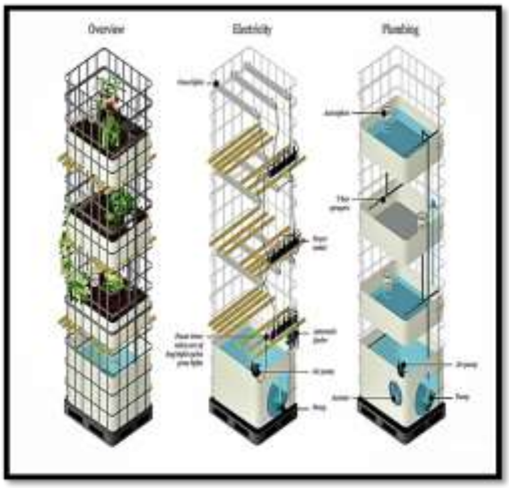

Fig. 8: Design & Construction layouts of the proposed System.

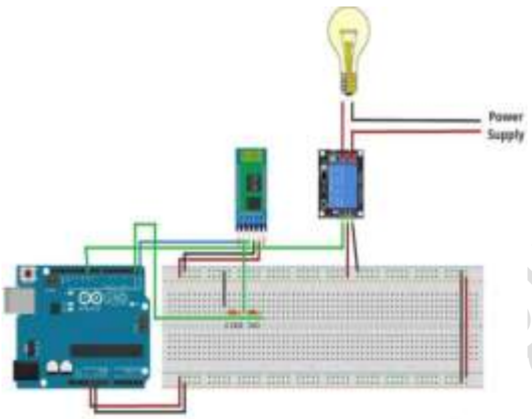

Fig.9: Hard ware circuit connection diagram of the proposed System.

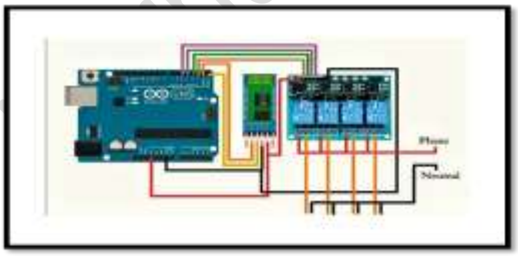

Fig.10: Control circuit diagram of proposed System.

Fig. 11: Hardware implementations of the proposed System

Table I. Cost of operation and maintenance:

Subject	Remarks	Estimated costs
Fish fingerlings	Once every new batch of fish is to be reared.5 to 8 months.	500/-
Plant seeds	Once for every new harvest for 2 to 4 months for leafy vegetables.	300/-
Fish feed	As per the daily requirement. 10 kg will last for a batch of ten fish over the full growing period.	500/- for 10 kgs
Water quality check	Once every week such as pH and turbidity.	Negligible
Electricity	According to the amount of time grow light is used and wattage of water pump	1000/- per month
Miscellaneous maintenances and depreciation.	Unforeseen repair and aging of components	5% per annum

7. COMPONENT REQUREMENT FOR AUTOMATIC AND CONTROLLED SYSTEM

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The components of the aquaporin system that differ in size or design, but each system includes a fish tank, a growing bed or bed, plumbing, plants and fish. To demonstrate this, a concept model has been prepared that is operated and automated by a Bluetooth powered switch.

Table II. Cost of construction

Component	Quantity	Price per item
Grow beds	3	990/-
Fish tanks	2	990/-
Sump tank	1	990/-
P.V.C pipes (different diameter)	10 meters	500/-
Elbows, tees, & valves	10,10,&3	450/-
Aerator pump	1	549/-
Water pump	1	2199/-
Grow lights	9	750/-
Bio filter media	3 kgs	500/-
Mechanical filter	1	300/-
Arduino Uno board	1	450/-
HC-06 Bluetooth module	1	300/-
Wires	10 meters	100/-
8 port relay switch	1	600/-
Miscellaneous (nails, bolts, etc.)	As per req.	300/-

7.1. SPECIFICATIONS OF COMPONENTS OF PROPOSED MODEL:

Foot space acquired by the System: 48 sq. feet (8"x6")
Height of the system: 10 feet
Number of grow beds: 3
Number of fish tanks: 2
Amount of grow space: 144 sq. feet (triple the foot space acquired)
Grow bed: 60x40x32.5cms **Fish tank:** 60x40x32.5cms
P.V.C. PIPES & FITTINGS Diameter/s: 1'' and 1.5''
Stand: 8x6x10 feet (5 racks)
Water Pump: .5 HP
Grow lights: 4.9 watts (x9)
Control Switches: Arduino based Bluetooth switch

Table III. Cost Incurred on Prototype

COMPONENTS	QUANTITY/ PRICE PER ITEM		
1. GROW BED	1	125/-	
2. FISH TANK	1	125/-	
3. SUMP TANK	1	125/-	
4. PVC PIPES (VARIOUS DIAMETER)	1Meter	50/-	
5. ELBOW AND FITTINGS	8	100/-	
6. 0.15HP WATER PUMP	1	180/-	2265/-
7. BIO MEDIA/MECHANICAL FILTER	1	100/-	
8. ARDUINO UNO BOARD	EACH		
9. BLUETOOTH MODULE (HC 06	1	450/-	
10. 4 PORT RELAYS	1	300/-	
11. GROW LIGHT (LED)	1	500/-	
12. WIRE	2	150/-	
	3Meter	60/-	

8. CURRENT APPLICATIONS OF AQUAPONICS

8.1. DOMESTIC/SMALL-SCALE AQUAPONICS: Aquaporin modules with a fish tank capacity of about 1,000 liters and a increasing area of about 3m2 are considered small-scale and are suitable for domestic family household development.

8.2. SEMI-COMMERCIAL AND COMMERCIAL AQUAPONICS – Due to the increased initial installation-up cost and limited overall experience with this size, there are few commercial and/or semi-commercial aquaponic systems available.

8.3. EDUCATION- Narrow-scale aquaponic systems are being promoted in numerous educational institutions, along with primary and secondary schools, colleges and universities, unique and adult education institutes and society-based associations.

8.4. HUMANITARIAN RELIEF AND FOOD SECURITY INTERVENTIONS- With the emergence of extremely effective aquaponic structures, there has been a concern in exploring how the mechanism behaves in underdeveloped countries. Sources of aquaponic projects can be found in Barbados, Brazil, Botswana, Ethiopia, Ghana, Honduras, Haiti, India, Jamaica, Malaysia, Mexico, Nigeria, Panama, the Philippines, Thailand and Zimbabwe. At first glance, there seems to be a significant amount of aquaponic operation in the humanitarian domain.

9. CONCLUSION

By integrating aquaculture and hydroponic systems, aquaponics are built by means the nutritionally-rich contaminated water from the food production process is being used in the hydroponic system. This system contains Arduino board and Bluetooth module for making aquaponics system intelligent and automated. This aquaponics method also contains numerous untapped potentials, and this way of farming could really serve the community in a big way. It can be a remedy to major problems such as water shortages, food security, and its purity. It uses less energy and produces higher yields, both in terms of quality and quantity. It has no negative effects on the environment and, if used on a wider scale, it may help to solve the problems of water contamination and soil depletion due to the widespread use of chemical fertilizers and pesticides. In this age, in which land is a rare asset, it could be a valuable step towards being higher. In aquaponics, the aquaculture wastewater is treated and recycled back into the environment. Aquaponics provides an ability to reconsider traditional fish farming, to get more capital into the field.

10. FUTURE SCOPE

Easiness in construction and operation with virtually zero energy and minimum maintenance costs makes these structures an fascinating solution anywhere land availability, floods, efficiency but also the ecological footprint are a major problem. In conjunction, the use of water trees and bushes as a tool will undoubtedly improve employment prospects in all of the directly impacted areas around the world. More work is required to resolve the nutrient interactions of different growing environments and to streamline the system design and nutritional needs of vegetables within these bodies of water containing minimal dissolved nutrients. The opportunity of this intuitive interface is really strong and can offer both peasant farmers and large aquaculture manufacturer's sensitive benefits. Moreover, the scope of these systems is not completely known and interdisciplinary interconnections and the analysis will undoubtedly address many of the challenges still unexplained.

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