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The Anatomization of an IoT Based Aquaponic Farm Model towards the Agronomic Resilience in the Indian Subcontinental Region

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Abstract

The paper describes most advanced ways of farming in agronomy. The key motive of this paper is to discuss the creation and monitoring of an IoT based aquaponic model on Indian crops such as paddy and its analysis. Aquaponics integrates both aquaculture as well as hydroponics, the planting of plants in groundwater within a circulation system. The result is beneficial products such as fish and crops as well as reducing nutrient pollution in aquatic habitats This paper includes automating the PH concentration and maintaining likewise for crops management for hence better results such as more yield and more income.The primary mechanism is to control the flow of water between the fish pond and the plant beds. The water usage will be 90% lower than the conventional way of farming. More growth will be seen because plants will face ample amounts of nutrients every time.

Keywords

Agriculture, Aquaponic, IoT.

INTRODUCTION

Aquaponics is a symbiotic combination of two food production fields: (1) aquaculture, the practice of aquaculture; (2) hydroponics, the planting of plants without soil. Aquaponics integrates both within a circulation system. The regular circulating aquaculture system filters and removes organic matter ("debris") that accumulates in the water, keeping the water clean for fish. However, the aquaponic system filters out nutrient-rich contaminants using a vegetable container. The result is beneficial products such as fish and vegetables as well as reducing nutrient pollution in aquatic habitats.[1] This paper includes automating the PH concentration and maintaining likewise for crops management for hence better results such as more yield and more income.[2] The paper also include the analysis of the data extracted from experiments in Indian crops such as Athyrium filix-femina , Raphanus sativus and Oryza sativa.

SYSTEM DESIGN

The step consists of many components required for a proper farming of fishes and the crops. The fishes excreta fertilize the water which is then pumped to the plant nourishment.

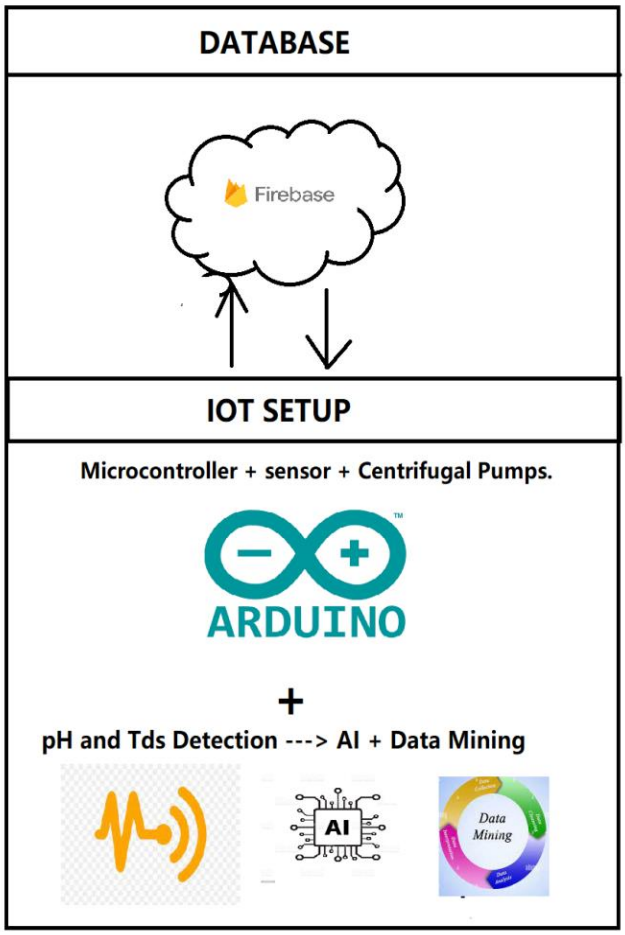


Figure 1. Architecture of the proposed IoT system

IoT Setup

The IoT setup is very essential for this project as the main objective of the paper is to demonstrate this. It contains arduino uno and esp8266 for interfacing.The arduino is used for all data extraction and the esp8266 is used for communication with the internet. The IoT setup consists of various sensors such as - Tds, pH, temperature and humidity as well as water flow sensors. The arduino extracts the data and activates all the pumps accordingly.

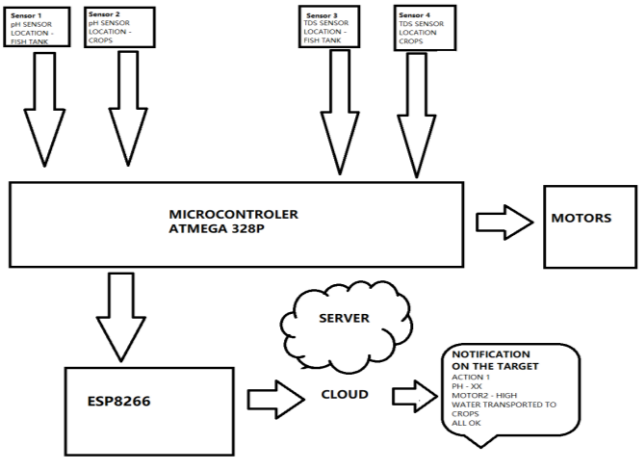


Figure 2. Working of the sensors with IoT.

Real-time database.

The firebase realtime database is used inorder to store and forward the data in target devices through web view and notifications.

The formats are in graphs and GUI for more interactions with the user.

Mechanism of the Bio filter.

In aquaponics, if the extra space in your growth media is not enough for the germs to accumulate, we need to add more space.The biofilter is a really important part of our system. It ensures that plants have enough nutrients to grow healthy while purifying the water for the fish to survive.

The entire aquaponics system is a biological filter. The Vertical, and aquaponics farms to grow our plants we cannot rely on the natural process of bio filtration due to lack of sufficient space but the media-based aquaponics system usually does not require a separate biological filter because it is a reservoir, growing media (expanded clay, rock formations, or lava rock), tank walls, and other surface areas provide ample space for germs to accumulate.

The biofilter is an exceptional extension of your aquaponics system. It's far and away a critical part of our aquaponics device as it guarantees that your plants get the nitrates to grow at the same time as purifying fish water.Germs get attached to the surface of the biofilter. Biofiltration in aquaponics occurs in three main steps. This process is a widespread set of aquaponics. The system or steps might also range relying on your biofilter design.

1. An air pump pumps water from a fish tank to a biological filter.
2. Within the biofilter, water flows through the nitrification procedure. There were useful microorganisms that helped to transform ammonia and nitrites into nitrates.
3. Nutritious water flows from the organic filter to the flowers, in which the plant roots absorb the nutrients while purifying the water earlier than returning to the fish tank.

Top biofiltration is critical for the chemical stability for your aquaponics device. That's why it's vital to apprehend the function of the herbal clear out in aquaponics so you realize if your system needs a natural filter out.[4]

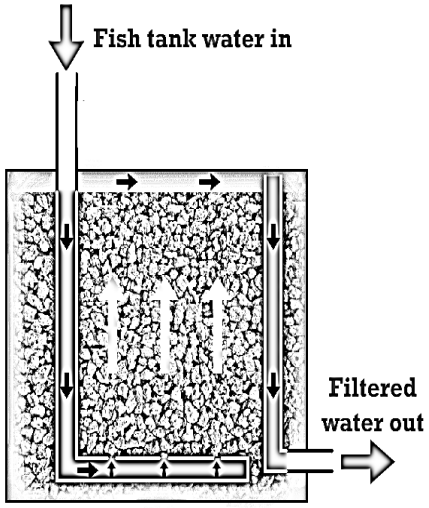


Figure 3. the diagram of the bio filter.

Ph and Tds mechanism.

The ph and tds are kept in two sites in the module one in the planting area and other in the fish pond the both data are taken simultaneously in order to attain a differential data. When the pH of the fish pond is higher the water is sent to the planting area and when the pH of the planting area is neutral it is sent back to the fish pond. Same mechanism goes with TDS.TDS formulas for interfacing with arduino. Total Dissolved Solid = Correlational Factor * Electrical Conductivity .[5]

Water Recirculating System.

There are many designs of aquaponics systems made , however one system is famous for its simplicity. Which is known as CHOP representing the steady peak One Pump program. This system consists of a hydroponic plant mattress, a fish aquaculture tank and a sump tank. The submersible water pump is set up within the sump tank to continue turning in water to the fish tank constantly even as the water is fed to the growing bed via a drain pipe. The accumulated water in the hydroponic beds is then discharged again into the sump tank with a bell siphon. The bell siphon is a popular tool used for flood structures and drains. With CHOP, the water stage within the fish tank is maintained and as a consequence considered to be the most green system to apply and gets rid of stress on fish due to water fluctuations.

additionally, it makes use of the handiest one pump to deliver constant water flow for this reason saving power compared to maximum pump structures.[11,12]

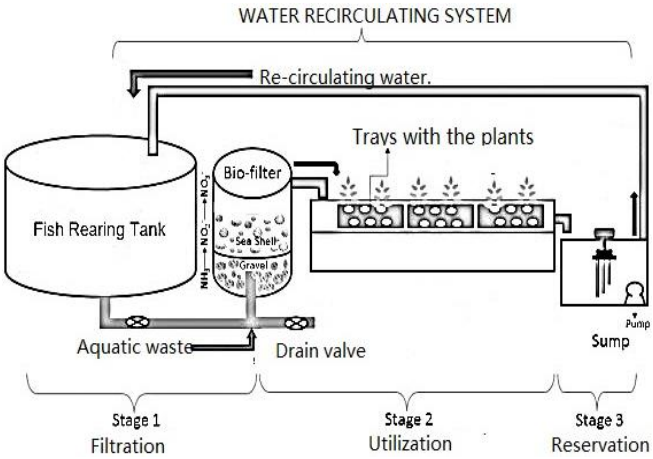


Figure 4. The Water Recirculating System.

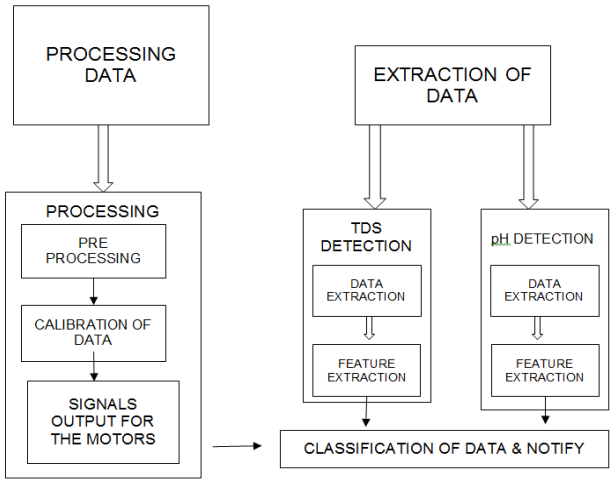


Figure 5. Proposed framework.

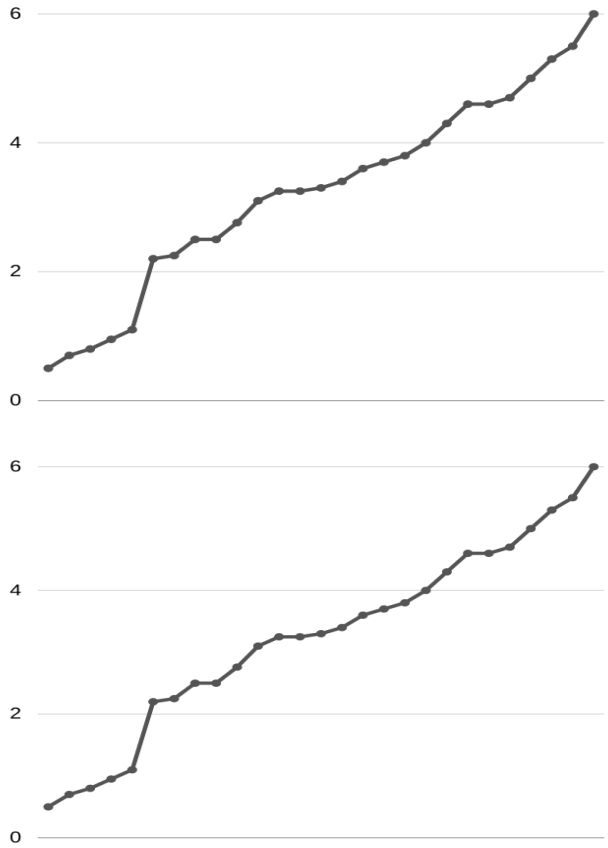
EXPERIMENTAL DATA AND ANALYSIS OF RESULTS.

Impact of Aquaponics in Various Indian Crops

Aquaponics was seen quite successful in Indian crops as the growth of the fishes as well as for the Indian crops was quite well observed.

Figure 6. The automated aquaponic farm model Athyrium filix-femina

The growth of Athyrium filix-femina was recorded and presented below in cms of the plant's size with a time period of 2 weeks.



Graph 1. The growth of the crops in the automated aquaponic farm.

Figure 7. The automated aquaponic farm model Raphanus sativus.

Impact of Paddy in Aquaponics.

The Paddy requires 68° to 82° F, pH Requirement = 6 to 7, Nutrient Requirement: Medium to High[9,10] and which can be attained by aquaponics and we can get a good yield.

But due to the high infrastructure cost of paddy in aquaponics it is not tried on a large scale.The experimentation of paddy was done on a small scale with automations but we did not receive good yield.

Figure 8. aquaponics farm model of paddy.

Crops in Aquaponics

Aquaponics holds a record of various crops that can be grown in it which include cucumbers, shallots, tomatoes, lettuce, capsicum, red salad onions, snow peas, carrot,cabbage,strawberry.

Table 1. The crops in aquaponics.[3]

CROPS	NUTRITION REQUIREMENT	pH	TEMP (F)	REMARKS
Lettuce (Lactuca sativa)	LOW	6.0-6.2	60°-70°	EASY
Mint (Mentha)	LOW	6.5-7.0	65 ° to 70°	MODERATE
Tomato (Solanum lycopersicum)	HIGH	5.5 to 6.5	65°F to 85°	MODERATE
Chili (Capsicum frutescens)	MEDIUM TO HIGH	5.5 to 6.5	60° to 75°	HARD
Cabbage (Brassica oleracea var.capitata)	HIGH	6.2 to 6.6	45° to 75°	EASY

Fishes to be used in Aquaponics

The fishes that are very hard and which secrete more excreta can be used in aquaponics.

Table 2. Fish that breathe air and which are tested during the experimentation [8]

I. Anabas	This Anabas fish is also called mountaineering Perch, it eats meat and will grow up to fifteen to 30 CM in duration in the wild. The planting season is 6 months to one year. It has the capability to survive without water for 6 to eight hours.
II.Pangasius	Pangasius is also referred to as Shark catfish, It grows to size (20 to 30 CM or extra) in clear water. The planting duration stages from 6 months to one yr.
III.Gourami	This fish is likewise referred to as hiking Gouramis, it's miles smooth and pleasant. it will develop to a size (20 to 30 CM or greater) in tall water. It can be harvested in 12 to 24 months.

Figure 9. The fishes that were used in the experiment for aquaponics.(Anabas testudineus)

Comparison between Round and Square NFT Channels.

The square channels are more considered as they offer a higher surface area to volume ratio and thus better air movement and gas exchange along the length of the channel and they also offer greater stability than the round channels but they are very hard to construct and very expensive in the market. The round channels are very easy to find anywhere but the stability and mobility is a big disadvantage for them.[6]

Analysis of the Data in IoT.

The working of the IoT is quite complex as due to the variation of data in various parameters. The actual results of the proposed frameworks have been listed below.

PH1 FISH TANK	PH2 CROP AREA	RESULT
HIGH	HIGH	WATER WILL BE SENT TO OTHER TANK FOR LATER USE
HIGH	LOW	WATER WILL BE SENT TO CROPS AND THE CROPS WATER WILL BE SENT TO FISH TANK
LOW	HIGH	WATER WILL STAY AS IT IS AND ALL THING IS PERFECT
LOW	LOW	WATER STORED IN THE TANK WILL BE SECREATED TO THE CROP AREA

Table 3. The actions taken by the computer (microcontroller) in specific parameters listed above.

The Tds sensor was connected with the microcontroller and the data that were observed is listed below. The microcontroller recorded everything and presented the data in the serial monitor so that the data could be analyzed properly.

Figure 10. The TDS reading on the serial monitor.

The pH sensor was connected with the microcontroller and the data that were observed is listed below. The microcontroller recorded everything and presented the data in the serial plotter .

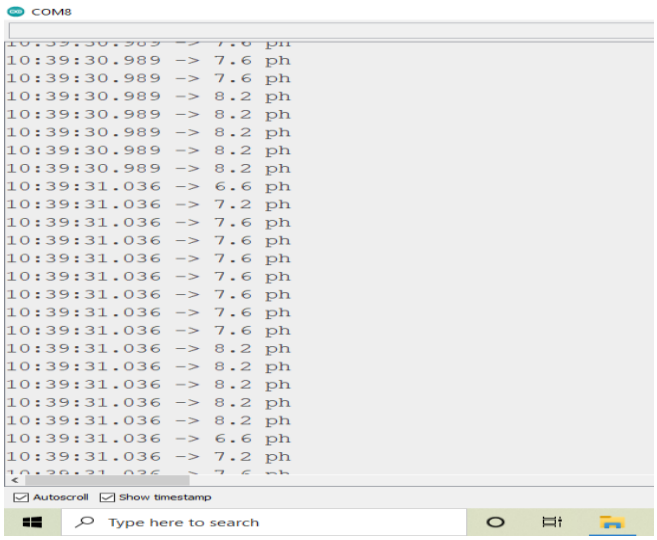
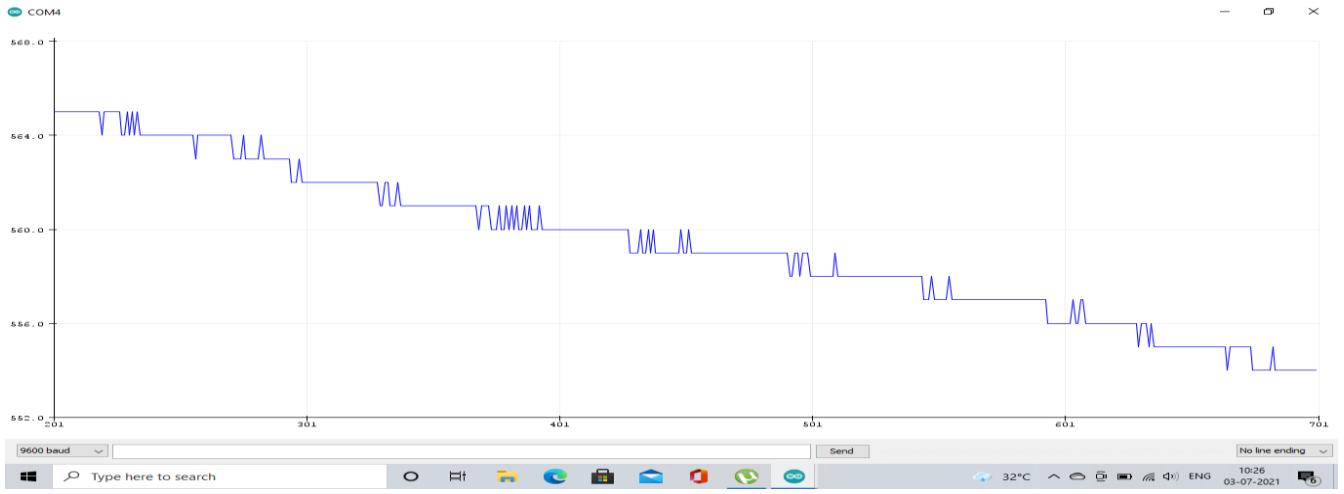


Figure 11. The pH reading on the serial monitor.



Graph 2. The pH reading on the serial plotter.

The notification of the working of the system is sent by two mediums - email and message and both illustrations are provided below.

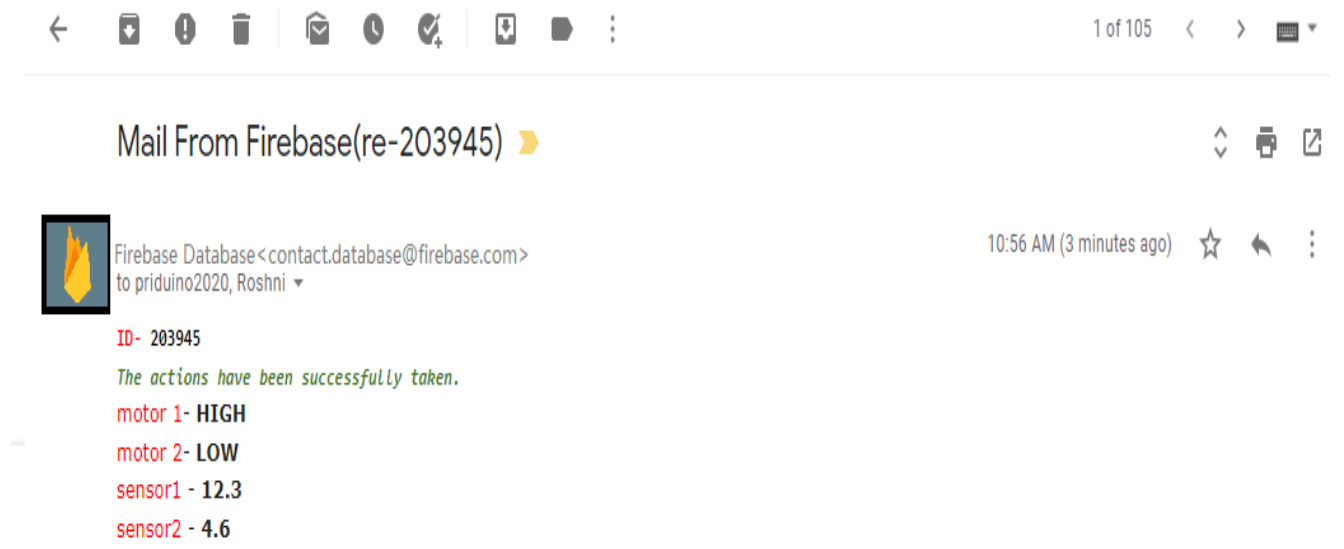


Figure 12. The notification email from the firebase of actions.

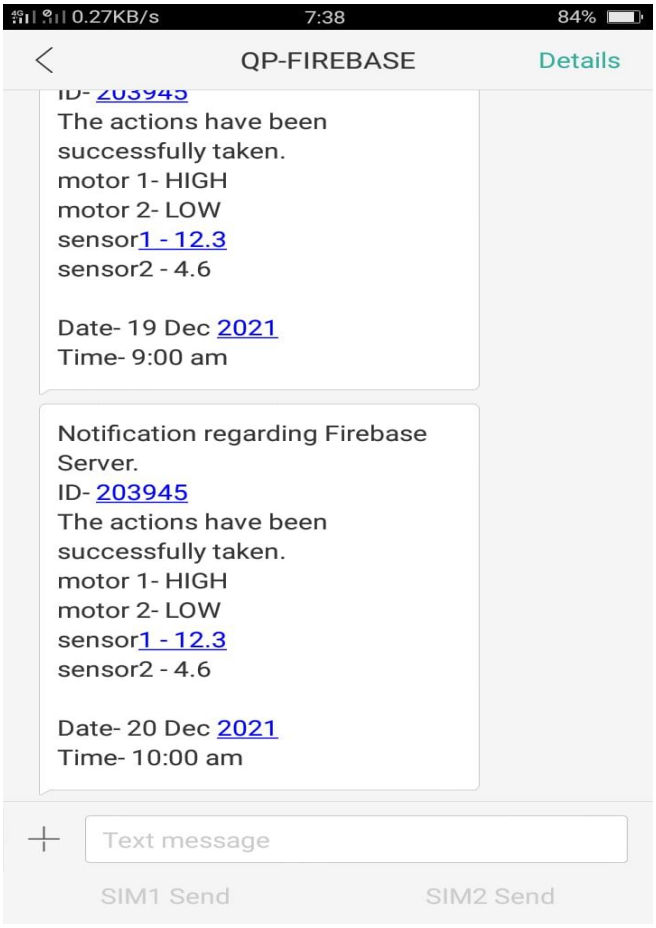


Figure 12. The notification message from the firebase.

CONCLUSION

In this study, the automation of aquaponic farms was conducted. Farmers will see an increase in profits as crop yields increase, as well as a doubled income from fish. Fertilizer costs will be reduced, which will benefit farmers. The amount of water used will be 90% less than in traditional farming.[7]

No chemicals will be employed, and only fish excreta will be used, resulting in a fully organic yield.Plants will grow faster since they will be exposed to abundant amounts of nutrients at all times.

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