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# Secured Framework for Fish Farming using Internet of Things and Blockchain

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**Abstract**

**This paper proposes a blockchain based secured framework for legacy fish farming to ensure data integrity. Traceability of various operations involved in fish farming is accomplished with blockchain. This proposed framework strengthens the remote monitoring of the fish farming based on the Internet of Things (IOT). The presented framework is implemented with different sensors to decrease the faults in the legacy fish farming. The sensors measures the important factors of the water like temperature, pH value and water level. The sensor data is analyzed through the "Think speak" cloud. The analyzed results is then sent to Fish Farmer as notifications on smart phone and it is programmed using python. The purpose of this proposed work is to provide traceability of fish farming accordingly sparing time, cash and intensity of the rancher and it provides warning messages when it needed a user intervention. Various processes of the fish farming are performed automatically with smart contracts to decrease the faults occur during the operations.**

**Keywords:** Internet of Things, Monitoring, Fish Farming, Temperature, pH Value , Water Level

## 1. INTRODUCTION

The Internet of Things (IoT) is the network of devices or things that can automatically connect to the Internet and talk to each other without any external intervention. This technology uses numerous sensors to collect data from the surroundings. The output devices for the Internet of things is called actuators.

The IoT has many challenges or issues due to its limited power and storage. Security, reliability, privacy and performance are considered to be the major challenges of IoT. The IoT technology has evolved from the convergence of wireless technologies, micro electromechanical systems, micro-services and the internet. This transition has torn down the walls between operational technology and information technology, permitting unstructured machine-generated data to be analyzed for insights that will drive enhancements. Fish farming is precisely farming of aquatic in surrounded places of the river, sea and small ponds through simulated atmosphere.

It has been estimated that world fish supply in 2020 reached 30 million tons due to growing aquaculture farms. If well conserved, fish farm would be successful with high yield and help reduce world food security problems. Intelligent fish farming is a progressive and optimum way of farming fish through use of recent technologies such as Internet of Things, Cloud and big data analysis.

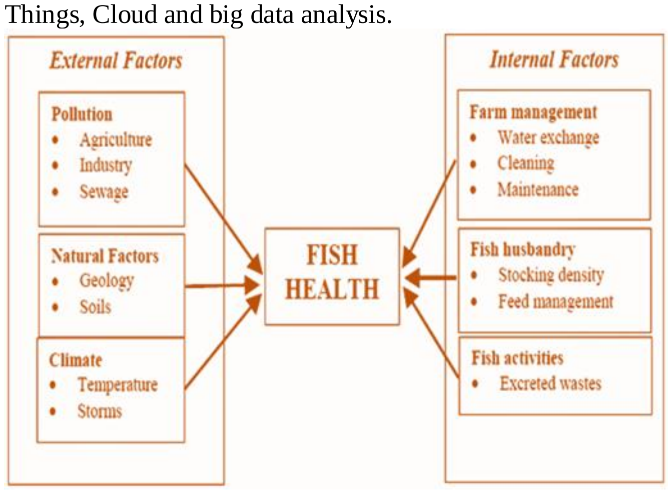


**Figure 1:** Factors influencing for Fish Health

Fish are sensitive to change in their conditions as they are cold blooded organisms. Minor variations in factors could also severely influence the growth of fish. The health of the Fish depends on External and Internal Factors as shown in the figure 1. External Factors namely Pollution, Natural Factors and Climate plays a major role in fish farming. Internal Factors such us Farm Management, Fish husbandry and Fist Activities are also important for fish farming. Both these external and internal factors are the responsible for the growth of the fish. For example water temperature in fish tank, pH value, dissolved oxygen value, etc. The health factors which are all influencing the growth of the fish will be monitored with the help of pH. temperature, turbidity, water level sensors.

These sensors are connected to raspberry pi and with the help of wifi and internet the collected sensor data is stored in cloud. The stored cloud data is then analyzed with the respective ranges for each factor and it can be visualized in the farmer mobile menu driven application. After seeing the values , the farmer can take a call and respond accordingly. This secured framework will help the fish farmers in controlling and monitoring the parameters remotely using blockchain. The challenges that are faced in aquaculture are as follows:

1. Quality of Water in Fish Tank
2. Water health
3. Fish Feed Control

**1.1 Quality of Water in Fish Tank:** For the growth of Fish, the quality of water is very important. If the quality of water is to be taken care at frequent intervals. Otherwise, the fish can be prone to severe diseases or even can be dead.

**1.2 Fish Feed Control:** Fish feeding is one of the vital task in fish farming since it is labour oriented and rigorous process. The other key parameters which influence the feeding rate are time, what type of season, temperature of water, dissolved oxygen levels, and variables of quality related to water. This makes the process time consuming and inefficient.

**1.3 Health Parameters for Fish Farming and its Ranges**

1. **Temperature :** The body temperature of fish is 0.5 to 1°C above or below
2. **pH Value:** For fish, the optimal pH range is within 6.5 - 8.5
3. **Turbidity:** It is optical property of water. The range of turbidity obtained in the present study was 20 to 72 NTU
4. **Dissolved oxygen:** oxygen is the most important for the survival of organism under aquaculture. Dissolved Oxygen ranges from 7.3 to 7.9 mg/l.
5. **Carbon dioxide in Water:** The value of $CO_2$ is ranged between Nil to 4 mg/l
6. **Alkalinity of Water:** Concentration of alkalinity will be taken care by proper liming. This value ranges from 50 to 300 mg/l
7. **Chloride:** The chloride value ranges from 15 to 40 mg/l.
8. **Hardness of water:** Hardness of water depends on the dissolved solids and pH. The value of hardness ranges from 30 to 180 mg/ltr
9. **Phosphate:** Phosphate value ranges from 0.2 to 0.3 mg/l.
10. **Nitrate:** Nitrate is not toxic to aquatic animals even in large concentrations. Its value ranges from 0.1 to 4.5 mg/liter

**1.4 Edge Computing for Internet of Things**

Edge computing is an significant revolution that is required to make IoT based systems more competent and accessible, which must be used in all walks of life, especially in some areas where cloud computing is unproductive. Compared to cloud computing, edge computing provides the following benefits.

1. Real-time data analysis and good support with big data analytics for cloud.
2. Low cost.
3. Higher application runtime efficiency.

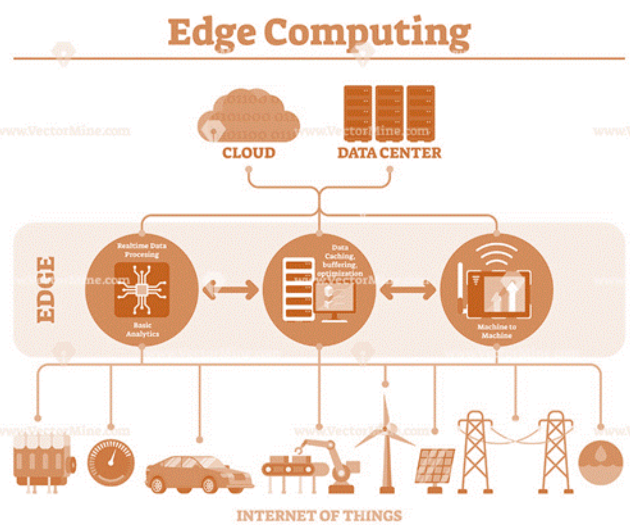


**Figure 2:** Use Cases of Edge Computing

## 2. PROBLEM STATEMENT

The main objective of this proposed research is implement an Internet of Things based secured Framework for remote monitoring of fish farming by using Edge Computing and blockchain. In this proposed secured framework the various sensors are used to reduce the various risks faced during fish farming. This proposed framework use sensors like pH value, temperature and water level sensors. By using all these sensors all the fish farming manual labour works are automated and it will also be easy to monitor the fish farming remotely from remote location. . Hence, this proposed research paper deals with construction and implementation of an Internet of Things based intelligent framework for Fish Farming using Edge computing and blockchain.

## 2.1 PROPOSED METHODOLOGY

The growth of the field of Internet of Things is very fast as the number of smart devices attached to the internet is increasing day by day. This field opens enormous opportunities for the birth of numerous distributed wireless applications. The internet of things is fit for applications that require high mobility, geographical distribution, and quick response. Therefore, real-world applications like smart grid, smart city, and traffic management can be implemented with the help of IoT. Figure 8 depicts the IoT Based secured Framework for Fish Farming using Edge Computing and blockchain. Each node of the model contains Raspberry Pi, camera, pH value, temperature and water level sensors.

## 3. PROPOSED FRAMEWORK

Figure 10 depicts the menu driven interface used by the fish farmer for remote monitoring of fish farming with the Internet of Things Based secured Framework. Since we are using the ionic tool for creation of the applications we can use the application on various platforms such as android, ios and windows.


**Figure 3:** IoT Based Intelligent Framework for Fish Farming

This application provides a menu a driven interface as it provides us a menu to view all the parameters of water in fish tank i.e. temperature of water, water level, pH value. The fish farmer can be able to see the data from the respective sensors connected to the raspberry pi coming through the cloud.

## 4. BLOCKCHAIN

Multichain is an open source used for developing this blockchain system. It helps us to create different nodes for devices which will get communicated through blockchain network as mentioned in Figure 4.

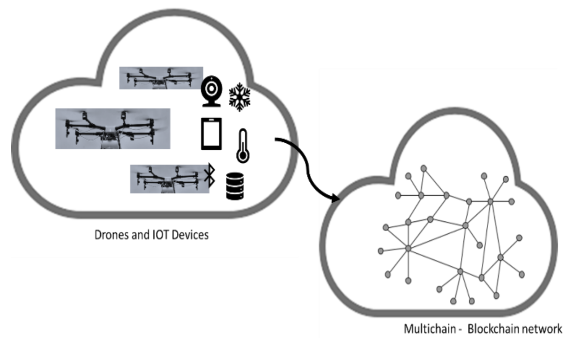


**Figure 11:** Blockchain Communication

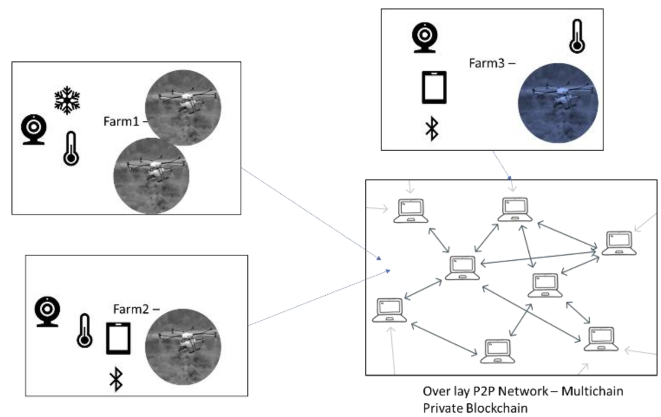


**Figure 4:** Blockchain based Connected Fish Farming plant

Each fish plant has its set of IOT devices, drones as mentioned in Figure 5 and which will communicate with its local immutable register deployed in the fish farm. It processes all incoming and outgoing transactions and utilize a shared key for location communication with IOT devices and local storage (i.e. one of the multichain node). This will be repeated for other farms and ensure all the devices are securely authenticated. Overlay is P2P (Peer to Peer) network which keeps the same copy of the ledger across different nodes with in the blockchain network. By default Multichain uses consensus protocol and it doesn't need a mining as it's a private blockchain network specific to that farm. The below example shows how we create blockchain and start interact with IOT devices and drones.

***Step 1:*** *Create Blockchain in Multichain*
*We will create a new blockchain named fish_farm1 On the plant1 server,*
*multichain-util create fish_farm1*
*To view the blockchain's settings of fish_farm1*
*cat ~/.multichain/fish_farm1/params.dat*
*Connecting to Blockchain network*
*multichaind fish_farm1@[192.168.1.100]:[5432]*

*The blockchain was successfully initialized, but we do not have permission to connect. we should also be shown a message containing an address in this node's wallet*
*multichain-cli fish_farm1*
*grant 192.168.1.120 connect*
*we can repeat the same process for other server that we planned to setup in the blockchain.*
***Step2:** Create Stream to use for data storage and retrieval.*
*create stream fish_farm1_stream*
*publish fish_farm1_stream key1 2253253616d2064617461*
*The txid of the stream item is returned.*
*subscribe fish_farm1_stream*
*liststreamitems fish_farm1_stream*
*We want the second server to be allowed to publish to the stream on the first server:*
*grant 192.168.1.121. send*
*grant 192.168.1.121 fish_farm1_stream. write*
***Step 3:** Create Assets*
*We can create new asset and send it between nodes, asset on this node with 1000 units, each of which can be subdivided into 100 parts, sending it to itself. Also, we created a drone unique identifier (DUID) and kept in the fish_farm1_asset1.*
*issue 192.168.1.121 fish_farm1_asset1 10000 0.01*
*sendwithdata 192.168.1.121. "{\"agro_farm1_asset1 \":125}"*
*{\"for\":\"fish_farm1_stream1 \",\"key\":\"transfer\",\"drone1_duid\":\"953051\"}"*
*To start block validation between the nodes. In the case of a permissioned MultiChain blockchain, consensus is based on block signatures and a customizable round-robin consensus scheme for IOT kind of transactions.*
*grant 192.168.1.121. mine – Here no real mining takes place as its private blockchain*
*Multichain Explorer is a tool for browsing the Transactions in multichain network It looks something like below*

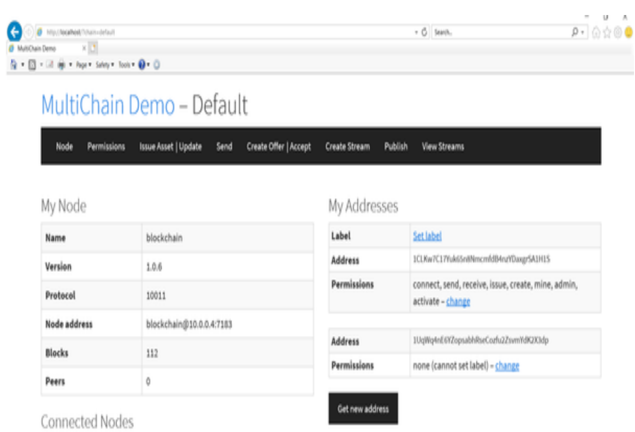


**Figure 5.** MultiChain-in-blockchain

### Cloud Environment

We will use Amazon IOT Hub or Azure IOT Hub to collect the data from IOT Edge. The edge will have necessary device id and event id to communicate with respective IOT Hub or Event hub to push the transactions. we use MQQT based communication between IOT Edge to cloud hub.

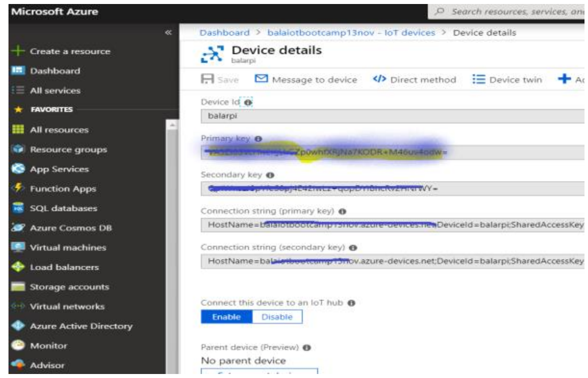


**Figure 6.** Microsoft Azure Device details

**Data Lake Store:**
Based on above cloud store, the data from IOT Hub will be pushed to Azure Data Lake store services and it will be kept as JSON format for better processing in NOSQL database like Cosmos DB.

**Visualization:** The data available in the NOSQL store will be accessible via visualization tools like Power BI or Tableau which help us to explore the insight from agro plants either real-time or near-real time based on the data refresh frequency. The necessary machine learning model can be plugged along with visualization tools to predict the yield growth.

**Mobile Apps:** the real-time information will be fetched directly from the drone's computer via REST API and also the blockchain (Multichain) API's to get the device specific information.

## 5. DEPLOYMENT CONSIDERATIONS AND ISSUES

### A. Deployment considerations:

The whole objective of the above approach should help the fish farmer and their network to automate the fish plant monitoring and predict the yield much ahead to time. Also, the regulatory KPI should help them to compare with other plants and comply as per local environmental guidelines.

a. Farmer's network for Trading of fish products: the same platform can be reused for trading agents, farmers and buyers to buy or sell their products through this. The new blockchain technology needs to be added with Ethereum or Bitcoin kind of model to support financial transactions.
b. Device Manufacturer in Blockchain network: To allow the device manufacturers of IOT or Drone devices will help them to deploy the necessary firmware and allow them quickly to fix the issues that is reported via Blockchain network.

c. Drone type: Based on the fish farming plant (e.g. Farm or Livestock or Fish farm) the drone with specific camera or sprayer to be installed.
d. IOT Edge compute: the data collection from drones or different sensors needs specific edge compute to support imagery processing (e.g. NVIDIA Hardware). The specific microcontroller or microcomputer will also be used in edge layer based on the data or protocol format.
e. Deep learning: Based on the image format and level of noise in the data, right algorithm to be chosen to detect or classify the images collected from drones. Deep learning can be defined as neural networks with many parameters and layers in one of four fundamental network architectures:
    - Unsupervised Pre-trained Networks
    - Convolutional Neural Networks
    - Recurrent Neural Networks
    - Recursive Neural Networks

**B. Known issues:**

- Drone deployment:
  Still some of the countries are not allowing drones to be deployed. Also the type of drone requires few clearances from the local environmental body.
- Network connectivity in the plant: there are high chances of low network bandwidth might fail to communicate with internet or local gateway computer due to the distance which drone planned to travel.
- Edge storage: The local storage is mandatory at the time when the drone failed to communicate with gateway server or cloud server. This will limit the image collection from the field as the edge storage might not able to store for large set of images.
- Data Synchronization: The data will be kept in the edge server requires frequent synchronization with cloud storage to make sure that image set are available with proper sequence, otherwise the prediction of health hazard or productivity might not be accurate.
- Blockchain Network:
  The type of blockchain (either cryptocurrency or transaction specific) will be decided at the time of IOT implementation. Now a days IOTA is also considered for such use cases.

## 6. CONCLUSION

In this paper, an Internet of Things (IoT) based secured framework for remote monitoring of fish farming using block chain is presented.

The proposed framework composed of various sensors that measure temperature of water in fish tank , pH value and water level and the data from these sensors can be accessed by an application through firebase. Based on the data received from cloud the fish farmer responds and do necessary actions in pace. This proposed research aims maintain healthy conditions in fish farm to increase the fish production. The research clearly studied the significant factors that influences the vital signs of fish such as turbidity, pH, temperature, and dissolved oxygen. The optimal ranges of the fish farming environment factors were also stated.

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