IoT based Smart Aquaculture

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Abstract

IoT and machine learning technology is growing very rapidly and its implementation has been conducted in several sectors. One of them is for aquaculture. For the traditional farmers, they face problems for monitoring water quality, food feeding and recycling of water. In this paper, we present the application of IoT and machine learning algorithms in aquaculture. The system performs water quality monitoring, automatic food feeding, and water recycling and fish disease detection. Water quality is a critical factor by culturing aquatic organisms. The quality of water is monitored continuously with the help of sensors to ensure growth and survival of aquatic life. The sensed data is transferred to the aqua farmer's mobile via IoT. Automatic food feeding system supplies a fixed amount of food at regular intervals of time. Water recycling system uses free energy water pump. Studies based on machine learning have been developed for the diagnosis of diseases in fish. As such, the proposed smart system has demonstrated to be a self-sustainable, cost-effective, eco-friendly urban farming that can attract commercial farmers and home gardeners.
Keyword- Machine Learning, Aquaculture, IoT, Fish Disease Detection, Water Recycling

I. INTRODUCTION

Aquaculture refers to the farming of aquatic organisms such as fish. It involves cultivating freshwater and saltwater populations under controlled conditions. Use of sensor technologies to monitor the environment where aquaculture operations take place is a recent trend. The sensors collect data about the aquaculture environment that are using by farm managers for decision making purposes.

The literature states a number of activities related to decision support systems in Aquaculture farm operations. A number of decision support systems have been developed for. Some of them use machine learning and IoT. For the sake of completeness we briefly discuss IoT based and machine learning based methods in the following section. Developed a framework where real-time water quality indicators, as well as operational information were displayed and their impacts on survival rate, biomass and production failure of aquaculture species were evaluated. Remote monitoring of the fish farming system by using the various sensors to reduce the risks. In this processes we use sensors like pH value, temperature and level sensors. The sensor nodes collect the water quality parameters and transmit them to the base station host computer by using these sensors all the work is automated and it will also be easy to monitor the fish farming remotely from other location. Research in aquaculture is an input to increase and stabilize production.

II. WATER QUALITY MONITORING SYSTEM

The automation of aquaculture systems will allow the industry to improve environmental control, reduce catastrophic losses, reduce production cost, and improve product quality. The most important parameters to be monitored and controlled in an aquaculture system include temperature, dissolved oxygen, pH, ammonia, nitrates, salinity, and alkalinity, since they directly affect animal health, feed utilization, growth rates and carrying capacities.

Water temperature affects the feeding pattern and growth of fish. Fish generally experience stress and disease breakout when temperature is chronically near their maximum tolerance or fluctuates suddenly. Warm water holds less dissolved oxygen than cool water. Oxygen consumption is directly linked to size of fish, feeding rate, activity level and pond temperature. The amount of dissolved oxygen in water increases as temperature reduces, and decreases when salinity recognized as a major cause of stress, poor appetite, slow growth, disease.

Temperature	*29-31^{o} celcius*
pH	*6.5-8.5*
Dissolved Oxygen	*>5ppm*
Salinity	*8-20psu*

Table 1: Tolerable conditions

According to the conventional methods of water quality monitoring, samples of water are taken and transported to a chemical laboratory to analyse the hazardous substances. On the other hand, the maintenance of the measurements and control process is manual influenced by the personal experience. This limitations can be overcome by introduced system.

Fishes	*Temperature*	*pH*	*Dissolved Oxygen*

Tilapia	*28 -30°C (82-86°F)*	*7.5-7.8*	*>5.0ppm*
Carp	*23 -30°C (73–86°F)*	*7.5-8*	*>5.0ppm*
Catfish	*24–30 °C (75-86°F)*	*6.5-9.0*	*>5.0ppm*
Barramundi	*26- 30 °C (78-86°F)*	*7.2-8*	*4-9ppm*
Eel	*23-28 °C(7382°F)*	*7-9*	*>5.0ppm*
Salmon	*25-28 °C(7782°F)*	*7-9*	*>8.5ppm*

Table 2: Tolerable Conditions of common fishes

Here in this paper the water quality parameters such as temperature, pH, salainity, dissolved(DO), turbidity are measured by using corresponding sensors from various fish tanks, since different fishes suits different water quality parameters and this data from the sensors are processed by the microcontroller and transmitted to the cloud server via wifi. Hence microcontroller within built wifi module is used. Then the data from the cloud is transmitted to the user mobile.

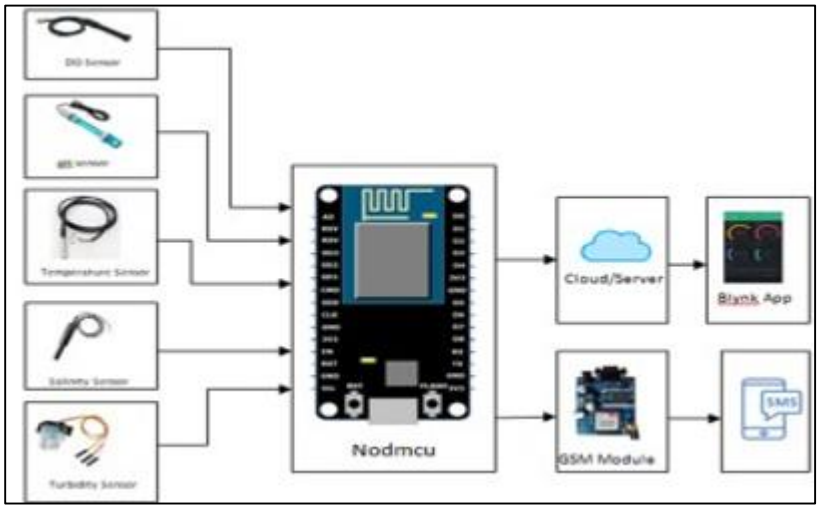

Fig. 1: Architecture of Monitoring System

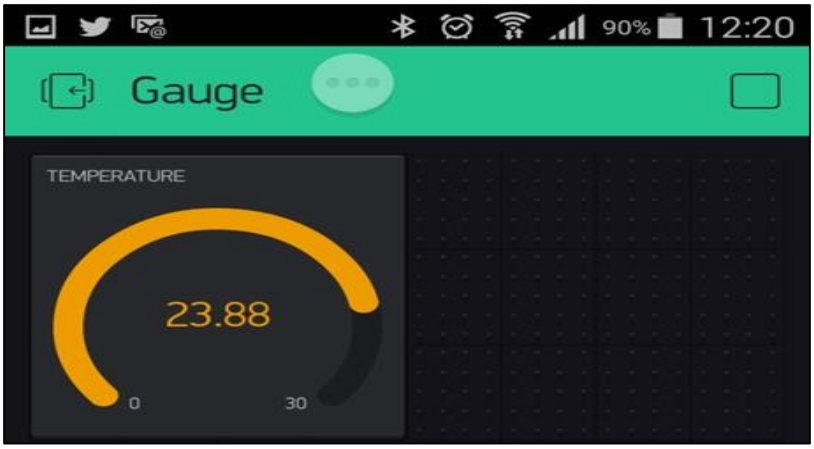

Fig. 2: Sensor temperature by blynk

III. FOOD FEEDING SYSTEM

Wastage and environmental pollution is caused by overfeeding fish and growth loss is caused by underfeeding fish. Armature farmers who combine fish farming with other businesses may not have the time required for regular feeding of fish. The discovery that manual feeding of fish was inadequate for effective fish rearing gave rise to the invention of fish feeding machines generally called fish feeders, which provide better measurement and dispensation of feeds. Fish feeders are very useful in ensuring a proper feeding plan in a fish farm. They aid reduction in cost, time and labour and can be designed with consideration of the size of the pond, fish size and fish species. Thus the paper introduces a system which supplies a fixed amount of food at fixed intervals of time with the aid of a timer and motor.

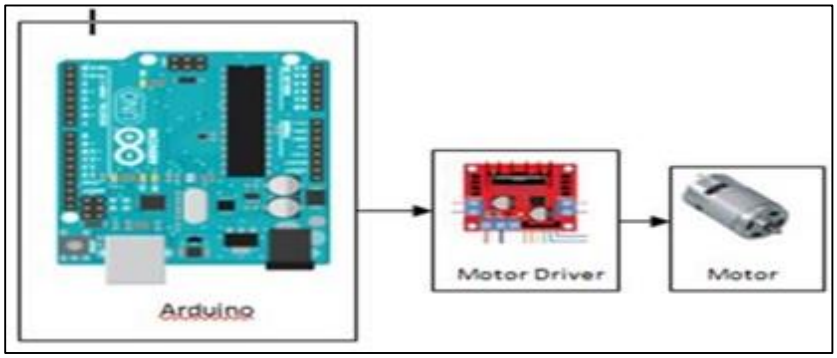

Fig. 3: Food feeding system architecture

IV. WATER RECIRCULATING SYSTEM

Recirculation in aquaculture is essentially a technology for farming fish or other aquatic organisms by reusing the water in the production. The technology is based on the use of mechanical and biological filters, and the method can in principle be used for any species grown in aquaculture such as fish, shrimps, clams, etc. Recirculation technology is however primarily used in fish farming, and this guide is aimed at people working in this field of aquaculture. Recirculation can be carried out at different intensities depending on how much water is recirculated or re-used.

Seen from an environmental point of view, the limited amount of water used in recirculation is of course beneficial as water has become a limited resource in many regions. Also, the limited use of water makes it much easier and cheaper to remove the nutrients excreted from the fish as the volume of discharged water is much lower than that discharged from a traditional fish farm. Recirculation aquaculture can therefore be considered a most environmentally friendly way of producing fish at a commercially viable level. The nutrients from the farmed fish can be used as fertilizer on agricultural farming land or as a basis for biogas production.

Here we use an energy free water recirculating system, which pumps water from the fish tank and it is allowed to pass it through grow bags for the filtration. As well as biochips are used for the nitrification. The water which is passed through the plants is fed back to the tank so that it reduces the excess nitrate content as well as the impurities present in the water. And since the water from the fish tank is rich in nitrate content it is good for plants and it will yield better.

V. DISEASE DETECTION

Disease issues are of great concern in aquaculture production. Production costs are increased through investment lost in dead cultured animals, cost of treatment, and decreased quality and quantity of yields. Likewise, health and environmental stability are threatened owing to public health hazards associated with disease occurrence and treatment involving synthetic drugs (especially antibiotics). And with these impacts and the fact that many diseases are still emerging; the aquaculture industry is finding it more challenging to guarantee its sustainable development. This study becomes necessary as there are various efforts to increase fish supply through aquaculture production to bridge the gap between the declining fish supply from capture fisheries and the increasing food fish demand. This study reviews the causes, significance, and control of fish diseases in aquaculture production to provide hands-on information on diseases and health management in aquaculture production, and create relevant awareness on cultured fisheries management and practices.

Development of an active disease in fish results from the effect of the association among the(pathologically linked) factors such as :

- Presence of environmental pathogens
- Low resistance of the fish
- Unfavorable water environment

In proposed system as shown in Figure ,Acquire the image or Input the Image those collected and then apply the morphological operations(convert the image into gray, removal of noise, segmentation) After that apply the feature extractor which is FAST which detect the interest point and interest point is ideally repeatable between different images, once the feature has been extracted from FAST it will be reduce by PCA which is used to reduce the dimensionality after selection of the features apply the classifier which is Neural Network and train it for detecting the fish disease as a result it gives better accuracy by matching the Training dataset with the testing dataset and get the accuracy. The proposed method automate the process and reduce the time of diagnose.

Steps in Proposed Methodology:

1) Image Acquision: - It is the process in which acquired or collect the image and converted to the desired output format according to the system.
2) Image Pre-Processing:- The pre-processing steps are performed on the acquired image. Increase the contrast of the image, convert the image into gray scale, removal of noise and segmentation.

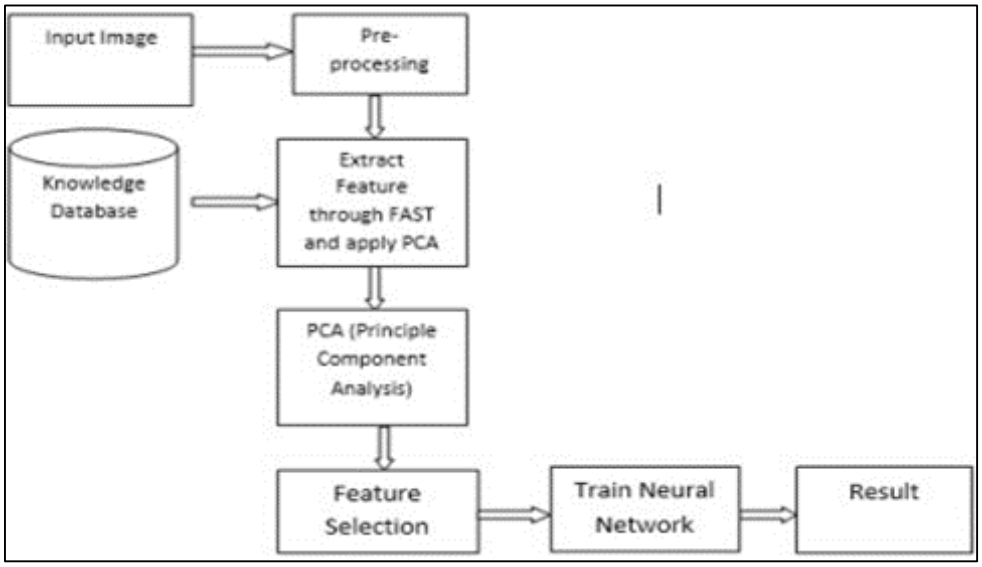

Fig. 4: Methodology

A. Feature Extraction and Recognition

In which to detect the symptom of the disease. Once the captured image is pre-processed. Extract the feature from the feature extraction algorithm which is FAST (Features from Accelerated segment Test) for recognition. To diagnose EUS, Infected images are loaded into the database and features are extracted after that will be treated by PCA (Principle Component Analysis) to reduce the dimensionality for the better accuracy.

B. Classification

After the feature selection classification will do by classifier which classifies the disease fish and non-disease fish. The dataset to be divided into training validation set and testing validation set which will be feed into the Neural Network. The Proposed Methodology to detect or diagnose whether the disease is present or absent in it. It is a Fast and accurate method for detecting and classification of the fish disease images and it is efficient and easy way to detect the EUS disease. After applying the PCA .The experiment results indicate that the proposed combination is fast and efficient in recognition and it gives better accuracy.

VI. CONCLUSION

We have identified a suitable model for the real time water quality monitoring. This system can be used to reduce the number of labour. It gives accurate measurement of water quality parameters. By changing the sensors and software programs, we can expand the system to monitor other water quality parameters. Food feeding is an important part in the growth and production of fishes in aquaculture and its management is major challenge in aquaculture field. Our system provides a good solution for this problem since it gives a fixed amount of food at regular intervals therefore the owner can reduce the labour cost and also need not to worry about feeding when away from the farm. It is a simple system which is easy to handle. A water recycling system which uses aquaponics for water purification is included. It is simple which works without a pump and motor. Hence it reduces the power requirement. Since the water taken from the fish tank is rich in nitrate content, which is good for the plants used in aquaponics and hence gives a good yield. It may not be possible to identify the fish diseases by the naked eyes which is another challenge faced in aquaculture. By using machine learning it is possible to identify the fish disease easily.

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