Grenze International Journal of Engineering and Technology, June Issue

Unlocking Insights: Object Detection in Aquarium Datasets

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***Abstract*— It will keep a check on temperature, pH levels, illumination, feeding schedules, and many other things. Using sensors and an Internet connection, it will automatically adjust settings in order to maintain perfect aquarium conditions for the fish and plants. As a result, maintaining an aquarium is made easier and friendlier toward the environment. Relying on the Internet of Things technology, the system aims to enable better management and monitoring of various factors in the aquarium environment, including temperature, pH levels, lightening, and feeding schedules. With the help of sensor networks and cloud connections, real-time data gathering and analysis enable accurate changes and automatic reactions to maintain optimum conditions for living aquatic organisms. The use of this kind of technology has the potential to increase productivity, decrease the need for manual intervention, and promote environmentally friendly aquarium management methods. Real-time data analysis makes use of sensors and cloud connectivity to provide automatic modifications to guarantee ideal conditions for aquatic life, hence offering efficiency and sustainability in aquarium care.**

***Index Terms*— aquarium, design, internet of things, automated, detection, dataset.**

I. INTRODUCTION

Pet ownership has steadily increased during the past 20 years. Nowadays, dogs and cats are the most popular pets, followed by freshwater fish. Keeping a fish tank maintained may be an extremely challenging undertaking in and of itself. There are several things you have to do when feeding or cleaning your aquarium. The power head and air pump on your aquarium must be turned off. You must then hand-feed the tank and restart the air pump an hour later. Under the current setup, all equipment, and electrical switches must be used to manually turn on and off appliances like lights, heaters, and filters. This requires a person to reach the tank and turn the switches physically. Individuals of different ages enjoy keeping fish as a pastime or for décor in their homes, workplaces, etc. Fish farming, both decorative and commercial, has grown in popularity. For this reason, automating a pond or aquarium is crucial. Because it is hard to inspect an aquarium's conditions manually. We are introducing an Internet of Things (IoT) system that uses electronics to oversee and manage the entire aquarium while providing the user's smartphone with real-time status data. The project aims to create an automated fish care system. It will keep an eye on the physical alterations in the water and implement the necessary adjustments to keep it in optimal condition.
Every operation in the aquarium, such as feeding and watering, replenishment, monitoring illumination, temperature and pH regulation, and more, is done automatically.

Grenze ID: 01.GIJET.11.2.269_20

Because the aquarium management process is automated, less manual labor will be needed to maintain tanks.
The challenge of keeping an aquarium is increased by the requirement that the fish be fed twice a day, a task that necessitates the owner coming up to the fish tank in person. Sometimes, when on vacation, The owner is unable to maintain control over the tank and feed the fish. It was us who devised the concept of the Smart Aquarium. Compared to existing market solutions, the project will be more effective. Not only will it be more effective, but it will also cost less. The manual fish will be replaced by its automated characteristics aquarium function. car[1,2].

II. Related Works

A. Literature review

According to J. Eksteen, L. Coetzee, et al [3,4], the advent of the notion of the Internet of Things resulted in a profound change. In recent years, the Internet of Objects (IoT) has advanced beyond computers to people to objects, opening up a vast array of applications and services. Many industries are embracing IoT concepts for their purposes and providing advice on how to put them into practice. Every technological industry will see globalization as IoT continues to progress. IoT has a bright future ahead of it as it continues to flourish in many different technical domains. The development of TCP/IP, or Transmission Control Protocol/Internet Protocol, allows users and servers to communicate with one another and may be compared in this way. It's similar to visualizing your geyser activating on cue from your clock alarm so you can have warm water before you wake up. All appliances get a signal to turn off automatically to save energy when you leave the house. The only way to make these possibilities come true is by using IoT.
According to Tao, Fei & Zuo, Ying & Xu, Li & Zhang, Lin., et al [5], Beihang University described cloud computing as a system in which a cloud may function eliminating the need for a server by acting as a data tracking and managing device in the Internet of Things-based networks. Cloud Manufacturing (CMfg) is a perceptive, customer-focused area that is well-recognized and receives a lot of attention. Manufacturers must carefully choose the finest and most easily available Cloud manufacturing resources to guarantee the best possible adoption of CMfg. Research is being done on the use of IoT in CMfg to solve the problem of precisely locating and acquiring manufacturing assets.
N. K. Suryadevara, S. C. Mukhopadhyay, S. D. T. Kelly, and others, [6,7]. The picture suggests that there is still room for improvement in the IoT space. When it comes to the adoption and use of IoT, this complicates the decision-making process for organizations. The three primary categories of Internet of Things applications are collaboration and information sharing, big data and monitoring, control, and business analysis. Utilizing metrics such as net present value (NPV) and real options, IoT may be used to evaluate future and current investment possibilities. Five problems were identified in an American research that looked at the implementation of IoT applications in various contexts.
Yubang Shen, Kangning Yue, et al., [8,9] Because it enables real-time worldwide engagement, In the study of aquaculture systems, Internet of Things technology has been viewed as crucially disruptive. Combining sensors and security cameras with IoT is necessary to improve environmental condition monitoring in various aquaculture regions. Most IoT-related research has utilized one or more of the subsequent methodologies: 1) Water quality is monitored through sensors; 2) feeding is managed remotely; and 3) fish health is tracked via remote video surveillance.
It has been observed by Francis E. Idachaba, Joseph O. Olowoleni, Augustus E. Ibhaze, Oluyinka O. Oni, et al. [10] that aquaculturists monitor the pond's conditions and respond appropriately. They monitor the temperature, feed the fish three to five times a day, and manage the water, which is refilled into the tanks after being emptied by the state of the water.
Tseng, Hung-Chun, & Yi-Bing, Lin, et al. [11,12] A clever electronic management system for freshwater aquaculture ponds has been introduced. The system monitors the hydrobiological factors necessary for fish development. However, there is no mention of how to find and empty saline water. The automatic Aquarium salinity removal and detection system is the main focus of their research.

B. Objective

To provide an intelligent aquarium monitoring and breeding system in terms of solution to aquarium hobbyists, while incorporating all sensors measurable to keep a grasp on basic water variables such as pH, dissolved oxygen, and temperature for maintaining a steady and ideal environment for aquatic life, its system also serves with an automatic scheduled feeding system that allows setting time schedules in line with the dietary requirements of various species. In addition, this technology simulated natural cycles of day and night through

light intensity control and enabled remote monitoring and control through a web interface or a mobile app.The safety features augment the security of the aquatic environment by triggering alerts for possible issues such as equipment malfunction or water leaks. Thus, this smart aquarium system puts more emphasis on the well-being of the habitat's residents, energy conservation, scalability, and user-friendliness to streamline aquarium administration tasks.

To train generic object detection methods that are capable of accurately recognizing and categorizing different species of fish, plants, and other amenities found in aquarium ecosystems. Apply object detection algorithms for real-time supervision and tracking of environmental variables including water temperature, pH levels, and water quality indicators. Test and observe the behavior of fish over time to explore their social connection, habitat preferences, and behavioral patterns in aquarium settings.

C. Methodology

A well-organized approach is required to design a functional aquarium object detection system. Identify the target items first (fish species, decorations, etc.) and collect a mixed dataset representative of diverse ambient conditions. Have it annotated using masks or bounding boxes in order to train your object detection model. You can select from the likes of YOLO or Faster R-CNN. The data must be preprocessed-cleaned, normalized across pixel values-trained and modified with the aquarium dataset. This involved applying the implemented object detection model to give inference on new aquarium datasets in practical situations after it had been trained and evaluated. For such automation monitoring and analysis, it required either a proprietary application to be developed or integration into the existing aquarium management software.

Evaluate the model's performance using metrics such as recall and accuracy, and make adjustments and optimizations where necessary. Incorporate the trained model into the aquarium monitoring system and deploy it for inference in real-time with appropriate solutions. Continue to practice refinements through frequent updates and retraining with new adaptations. Establish a monitoring and maintenance phase that ensures the object detection system's effectiveness and reliability over time.

This project's main objective is to use actuators and sensors to construct an aquarium that can be viewed online. Fish feed containers are arranged using a visible servo motor and load cell that are controlled by a portable application. An electrical appliance called a power supply provides enough electricity to run workstations, servers, and other electronic loads. A source's electric flow has to be transformed into the right voltage, frequency, and current to drive the load's fundamental function of the power supply.

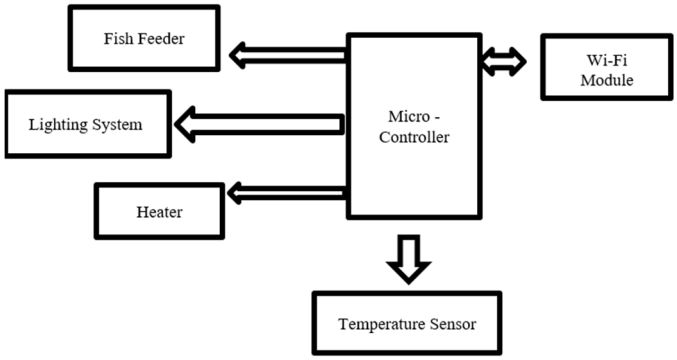

Figure 1. Flow Diagram

D. Data Collection

As of my last knowledge update in January 2022, there isn't a specific and universally recognized "Aquarium Dataset" that I'm aware of. However, datasets related to aquariums could refer to collections of data gathered from various aspects of aquariums, such as water quality measurements, temperature records, species information, feeding schedules, and other relevant data. Datasets are frequently used in research, teaching, and analysis to help people understand and manage aquatic ecosystems, notably those found in aquariums. These datasets might be used in studies into marine biology, ecology, or the development of aquarium management practices.If there have been any advancements or new datasets published after my last update, I recommend consulting current sources, academic journals, or online repositories for the most up-to-date information on an "Aquarium Dataset." You can come across datasets about specific aquariums, marine environments, or aquatic research programs.

This dataset is an object detection dataset. It has 7 classes listed down below

- Fish
- Stingray
- Jellyfish
- penguin
- shark
- puffin
- starfish

E. Result Analysis

The effectiveness of the models for object identification in recognizing and monitoring various objects in aquarium datasets was encouraging. The precision, recall, and F1-score have shown high competence in accurately identifying fish species, plants, and other items of interest. Models showed great efficiency in the identification of species, identifying various distinct fish species according to their different visual characteristics. This capacity is going to influence monitoring biodiversity and conservation plans in aquarium environments. Object detection made monitoring temperature and pH water parameters and quality indicators relatively straightforward. Models, with the ability to discern changes or deviations in focal variables, enable rapid responses to optimize conditions for aquaria. With the added object recognition prowess, the models demonstrated the track ability to document movement and behavior of the aquatic species over time. This granted researchers insight into social interactions, fish behavior patterns, and preferences for varied environments in aquaria settings.

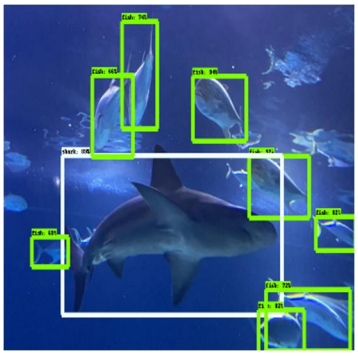

Figure 2. Note how the caption is left aligned

III. CONCLUSIONS

Using advanced object detection algorithms, data from aquarium environments have been further explored concerning aquatic ecosystems. We see that newer techniques are able to keep track of and identify different kinds of fish, plants, and other objects in the aquarium. It has improved our ability to keep the aquatic organisms healthy. Looking ahead, more exciting uses should emerge for aquarists and researchers. Some of the Findings of this research provide a hope for object detection, bringing a significant change in how aquarium monitoring and management are done. With the help of object detection, monitoring awareness becomes less of a human burden, as all fish and their habitats can be detected and identified in short periods, enabling an effective decision.

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