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Smart Aquarium using IoT

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Abstract: ***In modern days, many people have fish as their pets at home. The fishes have been fed by the aquarist in the aquarium tanks which demands a proper setup for maintenance. The problems faced are changes in water quality, feeding the fish, maintaining the temperature, controlling the lights, and difficulty checking the conditions of an aquarium manually. Therefore, it's necessary to monitor the physical parameters closely and enhance the water condition. So, this project proposes a system that is equipped with sensors to be operated in real-time. It performs temperature monitoring, water pH level detection, turbidity detection, and fish feeding. An IoT-based system is implemented to monitor and deliver the status of the aquarium to the user's web application. Thus, intelligent aquarium management has been implemented with a temperature sensor, pH sensor, and turbidity sensor so that the fish is neither over nor underfed and thereby reducing the manual effort required in the maintenance of the aquarium.***

Keywords: IoT (Internet of Things)

I. INTRODUCTION

Pet ownership has been increasing at a steady pace in the last 20 years. After cats and dogs, the most popular pet is now the freshwater fish. The maintenance of fish aquariums is a very difficult task itself. Whenever you have to clean up your aquarium or you have to feed, you have to do a lot of things. You have to turn off your aquarium's powerhead/air pump and feed manually and turn on the air again after an hour. In the current system, all equipment such as light, heater, and filter are to be controlled manually using electrical switches. For this, the person needs to come near the aquarium and manually control the electrical switches to turn on /off the equipment. The fishes need to be fed twice a day even this requires the owner to walk up to the fish tank and feed the fish manually which makes the task of maintaining an aquarium much more difficult. At times when the owner is on vacation, he has no control over the aquarium and also can't feed the fish. The project with which we came up is a Smart Aquarium. The project will be more efficient than the systems available in the market nowadays. In addition to the efficiency, it will be of lower cost as well. The project's audience is the group of people interested in keeping fish at home or offices but doesn't have time to take care of, or they are worried to keep asking their neighbors to take care of the fishes in their absence. The project is an automated system to take care of fish. It will replace the manual maintenance of fish aquariums with its automated functions. The Smart aquarium system is a simple system that helps a user to monitor the different conditions of water like temperature, pH value, and turbidity of water. Also, it allows the user to perform actions like fish feeding and controlling temperature using a fan and bulb.

II. LITERATURE SURVEY

In this section, the relevant literature is reviewed. It describes various techniques used in the work.

A. Smart Aquarium Based Microcontroller by Budi Prijo Sembodo and Novendra Geofanda Pratama

The researchers Budi Prijo Sembodo et al.[1] have created a smart aquarium system that has an Arduino-based feeding system that controls the servo motor as an open and close system as the exit of fish feed into the aquarium.

The servo motor can automatically deliver fish feed that was controlled by Arduino and has a feed output of 12.5 grams that was adjusted to the state of the 7 decorative fishes and the daily feed demands of the ornamental fishes in the aquarium. With a 3-second delay, the servo motor can feed fish automatically according to the daily meal demands in the morning at 07.00 Western Indonesian Time and at night at 19.00 Western Indonesian Time.

If the light intensity is below 028.7 Lux, which was after half-past 6 p.m., this LDR (Light Dependent Resistor) type light sensor will send a signal to the relay, which was turned on the 220-volt lamp, and if the light intensity was above 203.4 Lux, which was after 6 a.m., the 220-volt lamp will be turned off.

The Arduino controls the water pump as an automated drainer and water filler based on the turbidity of the water in the aquarium by receiving a signal from the Arduino. The drain water pump can drain 30 liters of water in two minutes, while the filling water pump can drain 28 liters in four minutes.

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B. Smart system for maintaining aquascape environment using internet of things-based light and temperature controller by Daniel Patricko Hutabarat, Rudy Susanto, Bryan Prasetya, Barry Linando, Senanayake Mudiyanselage Namal Arosha

The main objective of the researcher's Daniel Patricko Hutabarat et al.[2] was to create a smart system based on an internet of things (IoT) application for a plant aquarium.

In this study, the parameters to be controlled by the system are light intensity and temperature. The hardware used to develop this system is the ESP32 as the microcontroller, BH1750FVI as the light sensor, high power led (HPL) light-emitting diodes (LED) lamp as the light source, DS18B20 as a temperature sensor, the heater, and the 220 VAC fan that is used to raise and lower the temperature.

This study also developed an application that is used by the user to provide input to the system. The developed application is then installed on the user's smartphone and used to connect the user to the system via the internet. The ease of adding and removing devices used on the system is a capability that is also being developed in this smart system.

The developed system can produce light intensity with an accuracy rate of 96% and always manage to keep the temperature within the predetermined range.

C. Smart Aquarium Design Using Raspberry Pi and Android Based by Khairunisa, Mardeni, Yuda Irawan

The researchers Khairunisa et al.[3] designed a smart aquarium device in order to feed fishes automatically, namely using Android-Based Raspberry Pi.

This aquarium performed a variety of tasks, including automatic fish feeding over the internet network and management of the aquarium's ornamental lights. It employed a servo motor to operate the fish feeding valve and a relay as an on/off aquarium ornamental light to move the fish feeding valve.

If the user forgets to feed the fish, fish feed devices can feed them on a regular basis. The fish feeding valve is rotated by the servo motor, and the feeding operation is completed automatically. The method was put to the test five times and each time it passed with flying colors.

The on/off process for ornamental lamps is used, with a success rate of 80% after four times of testing. The data is sent to the database later by Android, and the data is read by the Rasberry Pi.

D. IoT Based Automatic Aquarium Monitoring System for Freshwater Fish by Mohammad Fahmi Suhaimi, Nurul Huda Mat Tahir, Safuan Naim Mohamad, Suzanna Ridzuan Aw

The authors Mohammad Fahmi Suhaimi et al.[4] created a project that was based on a computer-controlled system that detects physical changes in the water and keeps it in optimal condition.

The aquarium will perform all the operations automatically including temperature control, pH control, turbidity control, feeding, and water level control.

The aquarium's status was continuously transferred to the database via the IoT monitoring system, which users may check over the internet.

The pH sensor module and the temperature module were then used to collect data for the freshwater fish monitoring system. To handle the data gathered from the sensor, the Arduino ESP8266 was employed as a controller. In the electrical box, the Arduino circuit and all sensor modules for this project are wired.

The IoT platform used for this project is thinger.io. Also, when sensors detected any problem, they sent a notification to the IoT platform, which was marked as an alert and monitored automatically.

E. Aquarium Monitoring System Based on Internet of Things by Wen-Tsai Sung, Shuo-Chen Tasi, and Sung-Jung Hsiao

The authors Wen-Tsai Sung et al.[5] created a remote monitoring system using IoT technology for the aquarium environment. The main control development platform for this system was a MediaTek LinkIt 7697, and remote monitoring components include temperature, illuminance, water level, and passive infrared sensor modules.

The system uses a wireless sensor network to communicate and calculate the obtained physical sensing signals (WSN). The program was compiled and sent to the LinkIt 7697's built-in Wi-Fi communication module using BlocklyDuino, a web-based visual programming editor for Arduino.

The results were shown on the Cloud Sandbox platform by the back-end computer. This platform allowed users to view the environmental data collected by each sensor in real-time. The system must keep the fish in the tank in a comfortable climate.

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III.METHODOLOGY

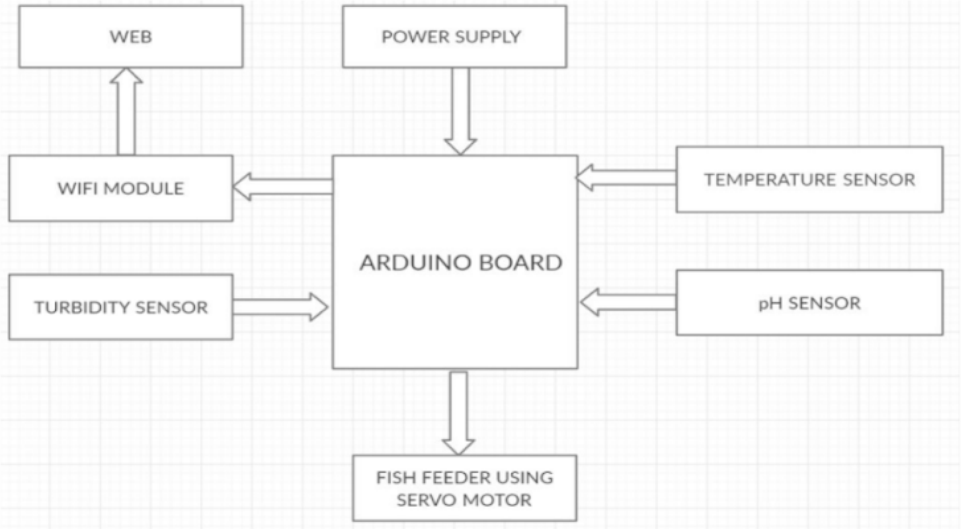


Fig. 1 Block diagram of Smart Aquarium

The above figure shows the block diagram of the smart aquarium. This consists of the following hardware and software

A. pH Sensor

A pH sensor is used to measure hydrogen ion concentration in a solution. Glass pH electrodes are widely used in pH sensors. The electrode is the main part of measuring the pH in a solution. It works on the principle of voltmeter and uses potential differences to check solution voltages and compare them with existing ones. The convenient range of pH of water for fish is from 6.5 to 9.0.

B. Temperature Sensor

Temperature sensor plays an important role in many applications in the case of fish aquarium it is necessary to check the temperature. Temperature sensors are usually thermocouple or RTD. We have used a thermistor-based temperature sensor that is capable of monitoring water temperature. It works on the inverse time characteristics phenomena. The resistance of the thermistor decreases when temperature increases and gives the signal of a rise in temperature.

C. LCD 20x4

This LCD consists of 20 characters wide 4 rows with white text and blue background. It is used to display the results in digital form. It is usually connected with Arduino and display output. Its Connection port is 0.1″ pitch, single row for easy breadboarding and wiring. Single LED backlight with a resistor included and also a grounded resistor as well. You can power it directly from 5V. You can adjust its brightness by using a variable resistor or PWM.

D. Servo Motor

Servo motor works on the basis of the applied signal to the control pin. It works on the principle of Pulse Width Modulation. The construction of a servo motor consists of a dc motor and variable resistors with a gear mechanism. Its movement can be 180 degrees or 360-degree based on the adjustment. For a high pulse, its response is high and its motion is to and fro.

E. ESP8266 Wi-Fi Module

The ESP8266 Wi-Fi Module is an independent SOC (system on chip) that can help any microcontroller to connect to the Internet. The ESP8266 is able to do either facilitate an application or offloading all Wi-Fi organizing capacities from one application processor to another application processor. Each ESP8266 module comes pre-modified with an AT direction set firmware, which means you can essentially attach this to your Arduino gadget and get about as much Wi-Fi capacity as a Wi-Fi Shield offers. The ESP8266 underpins APSD for VoIP applications and Bluetooth coexistence interface. It contains a self-adjusted RF, enabling it to work under every working condition, and requires no outer RF parts. ESP8266 helps in many projects to connect over Wi-Fi and Internet.

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F. Bulb

A bulb is used to increase the water temperature in an aquarium tank. They come in a variety of wattages, voltages, and sizes. Here we have used a bulb instead of a heater because heaters cannot be used for mini-fish-tanks due to their size. We have used the bulb such that if the temperature of the water drops the bulb will turn on and will try to balance the optimum temperature inside the tank.

G. Arduino IDE

Arduino IDE is open-source software that is mainly used for writing and compiling the code into the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing, and compiling the code in the environment. A range of Arduino modules is available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro, and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.

H. TinkerCad

TinkerCad is a free, online 3D modeling program that runs in a web browser, known for its simplicity and ease of use. Since it became available in 2011 it has become a popular platform for creating models for 3D printing as well as an entry-level introduction to constructive solid geometry in schools. TinkerCad uses a simplified constructive solid geometry method of constructing models. A design is made up of primitive shapes that are either "solid" or "hole". Combining solids and holes together, new shapes can be created, which in turn can be assigned the property of solid or hole. In addition to the standard library of primitive shapes, a user can create custom shape generators using a built-in JavaScript editor.

I. Working of Temperature Sensor

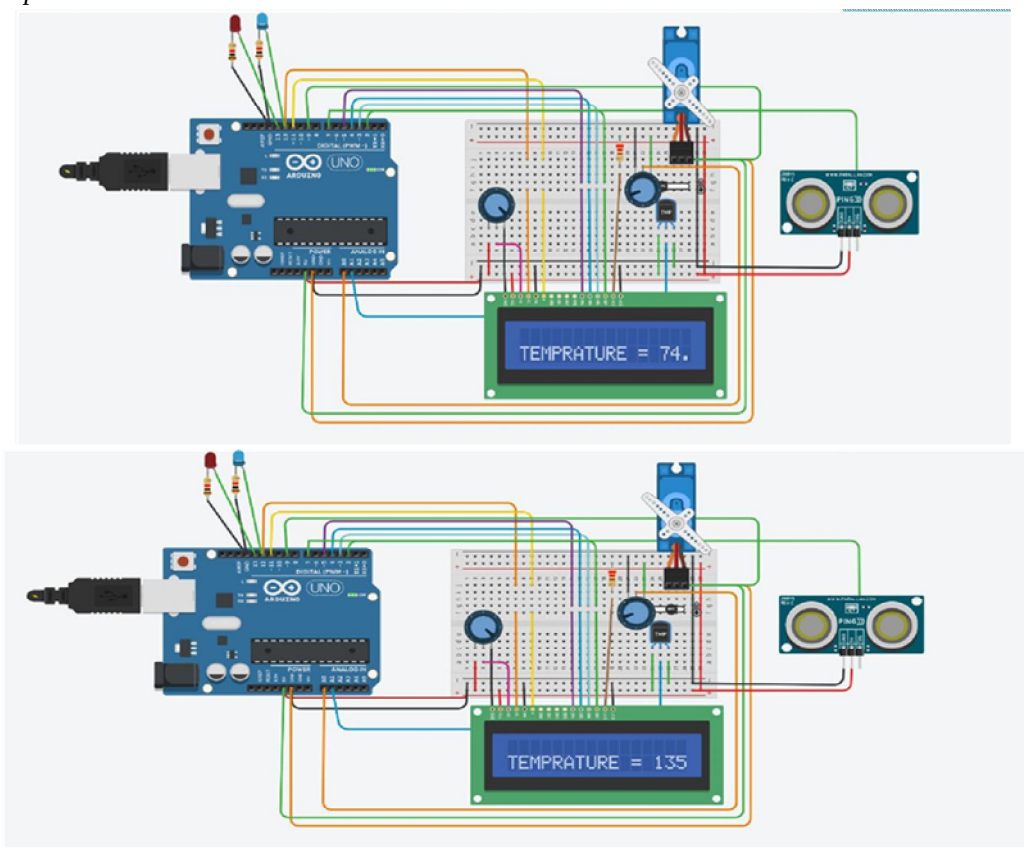


Fig. 2 Working of Temperature Sensor

In the above figures the Temperature Sensor is connected to the LCD Screen. The Sensor senses the temperature of the water and displays it on the Screen. As the Temperature of the water increases, the LCD Screen changes its display accordingly. The same way, when the temperature of the water decreases, the LCD Screen changes its display as well.

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J. Working of Ultrasonic Sensor

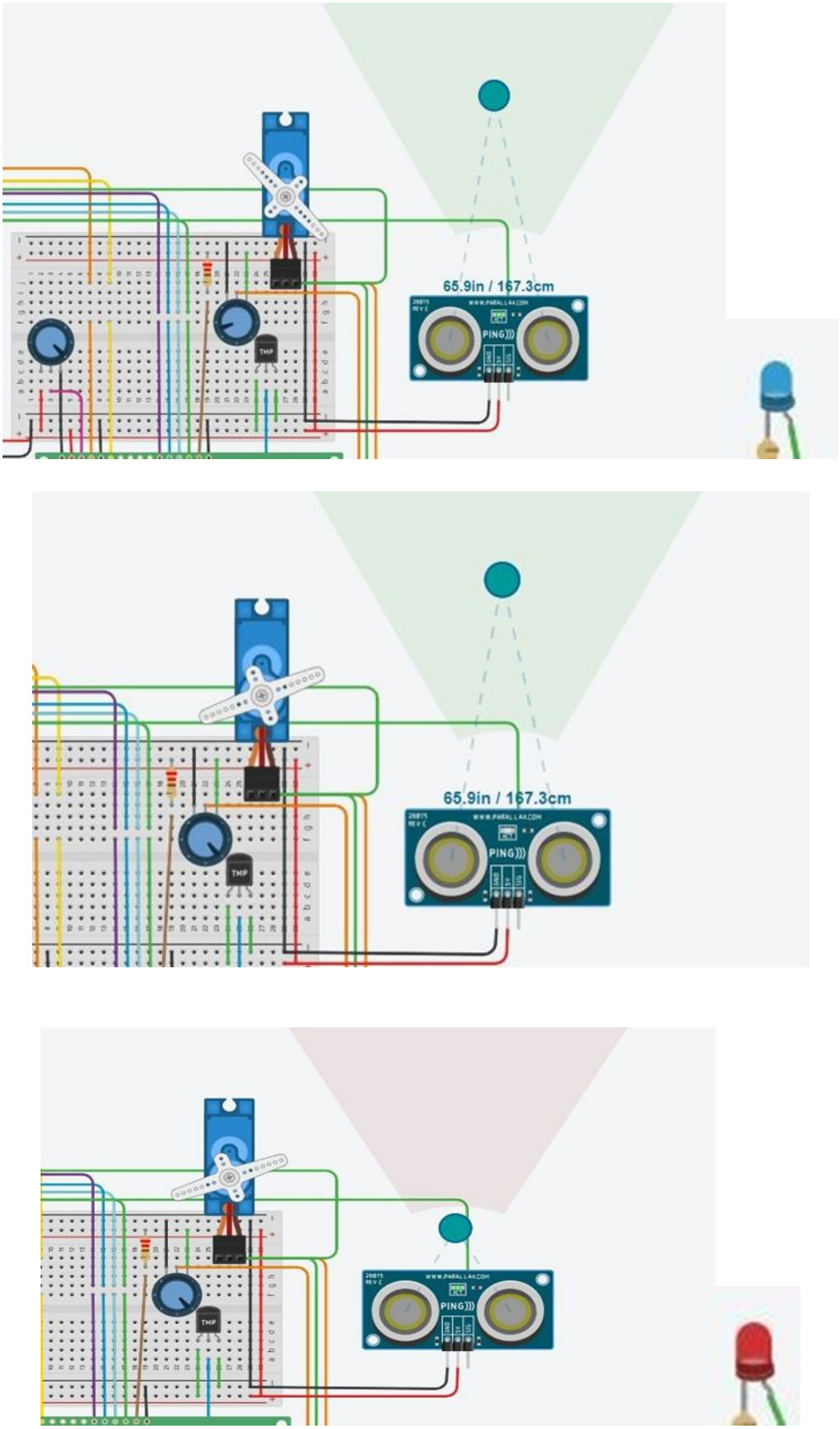


Fig. 3 Working of Ultrasonic Sensor

The Ultrasonic Distance Sensor is connected to the circuit. It is connected to the Servo Motor and another LED. When the Ultrasonic Distance Sensor is in range, it means that the tank has live fishes in it and the Blue LED glows. The Servo Motor of the circuit is used to feed the fishes in the tank. When the Ultrasonic Sensor is in range, the Servo Motor will also move accordingly.

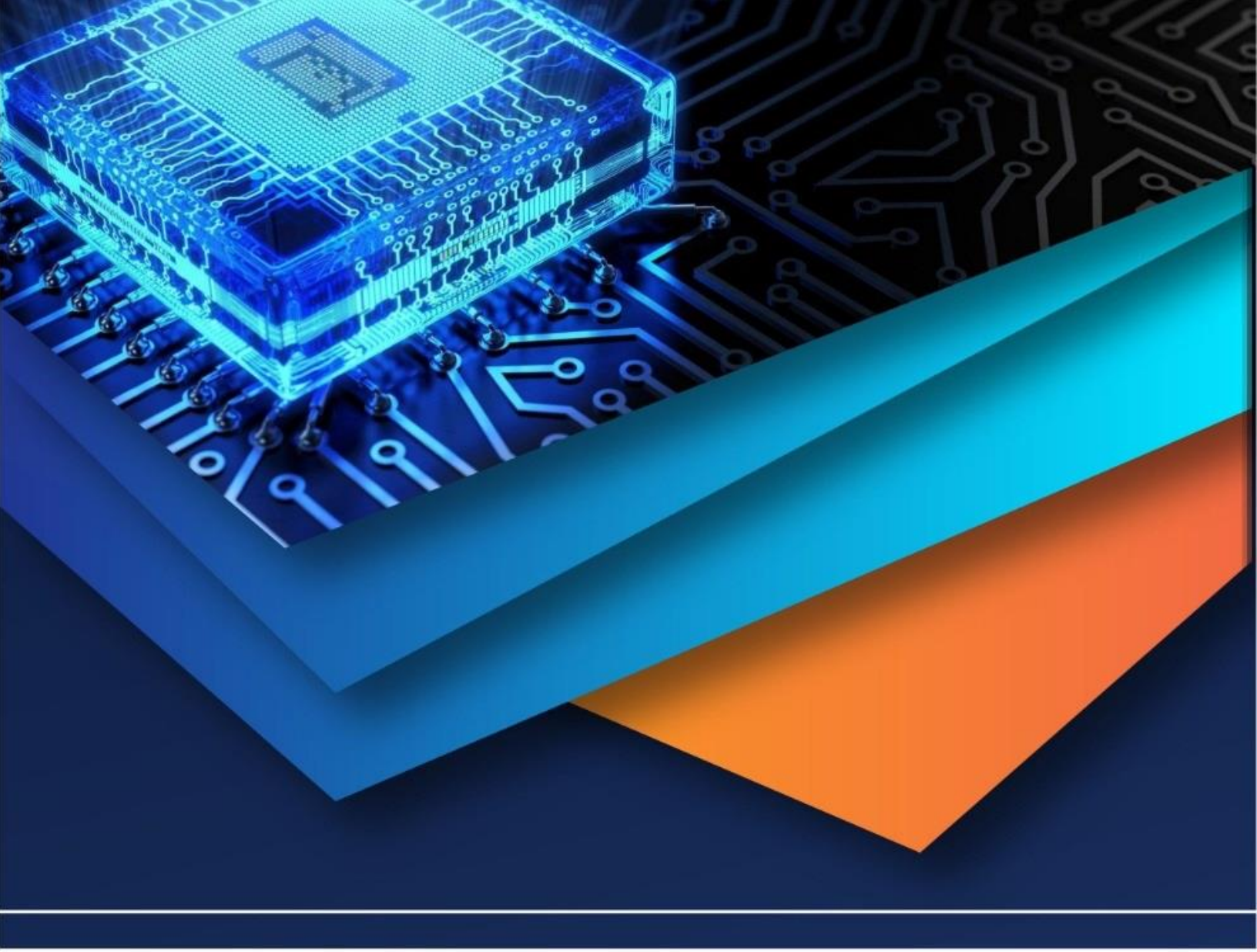
IV. CONCLUSION

The project was inspired by an idea, to create a system that could automatically take care of the fish and the ability to be able to control these devices remotely over the cloud. Now most of the operations happen by themselves, maintaining steady pH, water level, temperature. By using an IoT platform, it can monitor these variables, visualize the data and even control some features manually, over the internet which is successfully implemented in this project. Another important feature was the mechanical design and implementation of the fish feeding system, which is an original design. It is a rather simple design, but it efficiently does the job, there are other designs but they are complicated, so this project achieves simplicity, efficiency, time saving and cost saving. This project serves as a way to practically implement our skills to solve a very important management related problem and assist in achieving an ideal environment for fish in an aquarium.

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