

# Embedded System-Based Automation for Feed Efficiency and Aquatic Health Monitoring

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**Abstract:** Arduino is an open-source microcontroller platform used for building electronic projects. It is easy to program and can control sensors, motors, and other devices. In this project, Arduino acts as the central controller, reading data from water quality sensors and operating the feeding and pumping mechanisms automatically. Feed Efficient Fish Health Monitoring System is developed to promote sustainable and efficient aquaculture practices. The system automates the fish feeding process while continuously monitoring essential water quality parameters to ensure a healthy aquatic environment. By dispensing the right amount of feed at the right time, it reduces wastage, lowers operational costs, and supports faster fish growth. Real-time monitoring enables early detection of unfavorable water conditions, allowing timely corrective actions to prevent fish stress or mortality. This integrated approach improves productivity, enhances fish health, and provides a reliable, low-maintenance solution for modern fish farming.

## I. INTRODUCTION

Fish farming is the management of fish in a controlled environment for food and commercial production. In Indonesia, the sector is growing rapidly, especially in areas such as Pasaman Regency, thanks to government support and community participation. Through the selection of superior fish seeds, water quality management, and proper feeding, fish farming contributes to local economic growth, job creation, and sustainable food security (Mashur et al., 2020). Uncontrolled feeding can be a challenge in fish farming. Besides increasing production costs, it can also lead to a decline in water quality, which affects fish health. Farmers often face time constraints and must handle

multiple tasks simultaneously, increasing the risk of feeding errors. As a result, fish quality decreases, affecting harvest outcomes and reducing overall profit potential (Fernanda, 2022). IoT-based automated feeding systems can be a solution to ensure fish receive feed on time and in the correct amounts. This technology allows for efficient regulation of feeding schedules and quantities, even remotely, thereby maintaining water quality and supporting optimal fish growth (Abu-Khadrah et al., 2022). This research focuses on the design of an automatic fish feeding and monitoring system based on the Internet of Things (IoT). The objective is to improve the organization and efficiency of fish feeding by utilizing IoT technology with NodeMCU ESP8266 as a microcontroller. This device enables data collection and transmission via a Wi-Fi network, automatically providing real-time information on feeding schedules, feed levels, water temperature, time, and date, while allowing for remote monitoring and control. Aquaculture is a rapidly growing industry that plays a vital role in meeting global food demands. One of the most critical aspects of fish farming is feeding management, which directly affects fish growth, health, and overall productivity. Traditional manual feeding methods are often inefficient, leading to problems such as overfeeding, underfeeding, and feed wastage. These issues not only increase operational costs but also contribute to water pollution and disrupt the aquatic ecosystem. With technological advancements, the integration of automation and IoT in aquaculture presents an innovative solution to enhance feeding efficiency. An automatic fish feeder equipped with IoT-based monitoring can optimize feeding schedules, minimize waste, and provide real-time monitoring through a mobile or web application. The Arduino ESP8266 microcontroller is a cost-effective and reliable platform

that enables remote control and automation of feeding operations, making fish farming more sustainable and productive. Monitoring is the process of observing and controlling a system to ensure that every component functions properly. In automated systems, such as automatic fish feeders, monitoring is used to oversee feeding schedules, feed portion sizes, and the surrounding environmental conditions (Safitri et al., 2022). Aquaculture plays a crucial role in global food production by providing a sustainable source of protein. One of the key challenges in fish farming is managing feeding schedules efficiently. Traditional manual feeding methods often result in overfeeding, underfeeding, and feed wastage, which can negatively impact fish health, increase operational costs, and degrade water quality. Ensuring an optimal feeding process is essential for maximizing fish growth, maintaining water conditions, and improving overall productivity. With technological advancements, automation and IoT offer innovative solutions to improve feeding efficiency in aquaculture. An automatic fish feeder integrated with IoT-based monitoring allows precise control over feeding times and portion sizes, reducing waste and ensuring a balanced diet for the fish. The Arduino ESP8266 microcontroller is a cost-effective and reliable platform for automating the fish feeding process while enabling remote monitoring via a mobile or web application. This technology provides real-time data on feeding activities and water conditions, helping fish farmers optimize their operations efficiently. The Internet of Things (IoT) is a network that enables devices to connect with humans or other devices via the internet to share data and information. In this process, ensuring data security during transmission is crucial (Rofii et al., 2021). The technology embedded in these devices allows IoT to adapt to both internal conditions and the surrounding environment, supporting decision-making processes. IoT connects devices to the internet, allowing them to communicate with each other and share data related to usage and environmental conditions (Febrianti et al., 2021).

## II LITERATURE SURVEY

### A. Related Work

An IoT-based aquaculture monitoring and control. The IoT method in [10] used technologies in water quality management systems. Raspberry Pi-3 is used instead of Arduino because of its advancement and module

connected with turbidity, pH, temperature, and water level sensors. Time series charts display the system quality metrics using the Wi-Fi module. Aqua monitoring system using AWS [11] is another technology available for data storing and analysis. The ESP32 microcontroller and DHT11 were used to monitor the temperature, water level sensor, and fish feeder for the fish farm. Data can be accessed anywhere using the Amazon web services dashboard MQTT protocol chosen for transmitting the data to the AWS cloud from the microcontroller. Another work found in [12] wireless sensor network model for shrimp culture monitoring using open source IoT. Arduino microcontroller used with pH, dissolved oxygen, and temperature sensors. An open source IoT is created using ThingSpeak channels. The system is not included a Phone app and web interface, which is inefficient for displaying the data.

### B. Problem Statement

It can be observed in the literature review that aquaculture is one of the most growing industries in developing countries. The practice of rearing marine fisheries in an artificial environment such as ponds and tanks is known as aquaculture. While production of these fisheries in artificially designed environments, many factors come into consideration. Financial development and food production are critical in this activity and facing enormous global challenges. The most significant are viral, bacterial, and fungal diseases. All of them were discovered as a result of water quality. Water quality changes can stress the fisheries and threaten their survival. To determine water quality parameters, most aquacultures rely on manual methods. Manual testing takes time and produces inaccurate results because of the parameters and, on the other hand, insufficient facilities close to their aquaculture. Parameters of water measurement change regularly and are inconsistent.

## III PROPOSED MODEL AND DESIGN

### A. System Design

This System design consists of two categories. The first is the hardware setup, and the second is software implementation. First, assembling and calibrating sensors and connection with microcontroller Arduino UNO R3. The second part is programing the Arduino and establishing a connection with Wi-Fi for sending data to the server.

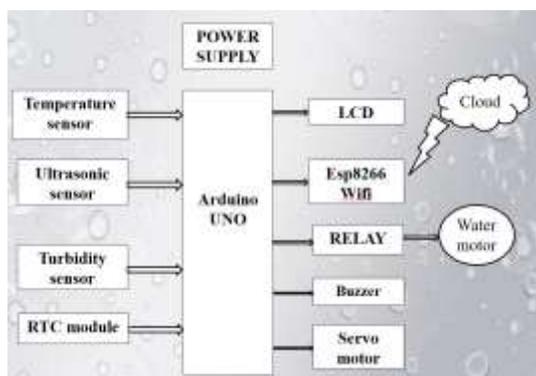


Fig.1 Block diagram

Fig.1 describes the block diagram of the proposed system. The system depends on four primary sensors and is connected to the microcontroller. Wi-Fi module ESP8266 used with Arduino UNO R3 for communication with server ThingSpeak. So, the health monitoring system can also be accessed through a website and phone App.

The hardware assembled proposed system is The microcontroller Arduino Uno R3 is used with the ESP6288 Wi-Fi module. The system is designed for the four most crucial water metrics measurements, and these values are taken by using water level, temperature, and Turbidity sensors. The fish aquarium is used for system testing. An aquarium with tap water and sensors hung into it to get data from the sensors. Sensors are calibrated before installation and precisely checked using standard techniques such as Turbidity sensor in buffer solution, dipping the dissolved oxygen sensor in zero dissolved solution, temperature sensor, and ultrasonic sensor reading using physical scale.

#### IV. SOFTWARE AND HARDWARE

##### Arduino uno:



Fig.2 Arduino Uno

Fig.2 describes Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, six analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, ICSP header, and a reset

button. Simply can connect to the computer through a USB cable. This microcontroller is readily available at a low cost [13].

##### ESP8266:



Fig.3 ESP8266

Fig.3 describes ESP8266 is a low-cost WiFi module that belongs to ESP's family which you can use it to manipulate your electronics duties someplace in the world. It has an in-built microcontroller and a 1MB flash enabling it to be a part of a WiFi. The TCP/IP protocol stack lets in the module to speak with WiFi signals. The most working voltage of the module is 3.3v so you cant provide 5v as it will fry the module.

##### Relay:



Fig.4 Relay

Fig.4 describes A force hand-off module is an electrical switch that is worked by an electromagnet. The electromagnet is initiated by a different low-power signal from a miniature regulator. At the point when initiated, the electromagnet pulls to one or the other open or close an electrical circuit. Profoundly, or solenoid, an iron burden that conveys a low hesitance way for attractive motion, a portable iron armature and at least one arrangements of contacts. The versatile armature is pivoted to the burden and connected to at least one bunch of the moving contacts. Held set up by a spring, the armature leaves a hole in the attractive circuit when the transfer is de-empowered. While in this position, one of the two arrangements of contacts is shut while the other set remaining parts open.

**DC Motor:**



Fig.5 DC Motor

Fig.5 describes Electric shock generator is an digital system that produces voltage round 1200mv & modern of 3microamp. Electronic shock generator is consistent into the sandal. Whenever the rush button is brought on the shock is generated on to the pinnacle of the sandal. In shock generator circuit the thinking of mosquito bat is used. It consists of AC to DC converter, oscillator and a web or Grid

**Water Motor:**



Fig.6 Water Motor

Fig.6 describes A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into hydraulic energy. Pumps can be classified into three major groups according to the method they use to move the fluid direct lift, displacement, and gravity pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, and come in many sizes, from microscopic for use in medical applications, to large industrial pumps.

**LCD:**



Fig.7 LCD

Fig.7 describes LCD stands to get Liquid Do rystal Display. LCD is discovering large unfold utilization substituting. The potential to exhibit characters, numbers and images. It will be in contrast to LEDs, that can be constrained through quantities plus a couple figures. Incorporation of the sterile manage in to the LCD, therefore relieving the CPU of this Endeavor of sterile the LCD.

**TEMPERATURE SENSOR:**



Fig.8 LM35

Fig.8 describes LM35 is a temperature measuring machine having an analog output voltage proportional to the temperature. It affords output voltage in Centigrade (Celsius). It does not require any exterior calibration circuitry. The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage moreover increases.

**BUZZER:**



Fig.9 Buzzer

Fig.9 describes An audio signaling computing device like a beeper or buzzer may additionally moreover be electromechanical or piezoelectric or mechanical type. The most necessary attribute of this is to convert the sign from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. It consists of two pins in precise extraordinarily exact and negative. The amazing terminal of this is represented with the '+' picture or a longer terminal. This terminal is powered with the useful resource of 6Volts whereas the horrific terminal is represented with the '-'symbol or fast terminal and it is related to the GND terminal.

**TURBIDITY SENSOR:**

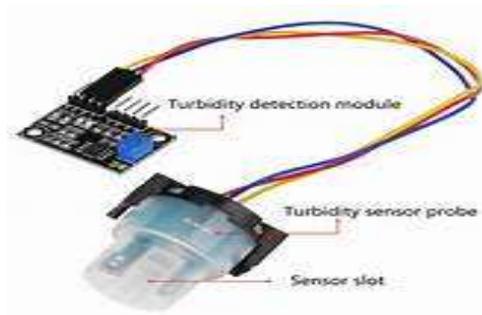


Fig.10 Turbidity Sensor

Fig.10 describes Turbidity is the cloudiness or haziness of a fluid prompted with the aid of giant numbers of man or woman particles that are usually invisible to the bare eye, comparable to smoke in the air. The dimension of turbidity is a key take a look at of water quality.

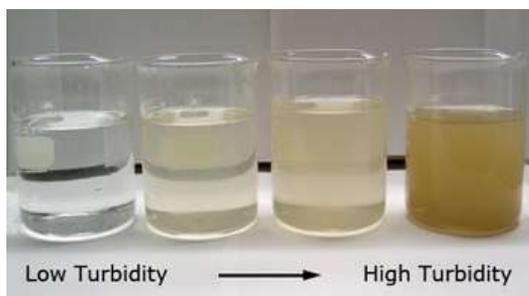


Fig.10.1 Water Quality

Fig.10.1 describes Turbidity is induced by means of particles suspended or dissolved in water that scatter mild making the water show up cloudy or murky. Particulate depend can encompass sediment, specifically clay and silt, satisfactory natural and inorganic matter, soluble coloured natural compounds, algae, and different microscopic organisms.

**Ultrasonic Sensor:**



Fig.11 Ultrasonic Sensor

Fig.11 describes An ultrasonic sensor is an electronic device used for the measurement of the distance of any object by ultrasonic waves and converts the reflected sound into an electric signal [14]. HC-SR04 model is used for automation and control of the pumping system. The sensor comprises a receiver and transmitter side that process the signals as input and output.

**Arduino IDE:**

Arduino is an open-source PC tools and programming association. The Arduino Community is recommended to the activity and consumer mastermind that constructions and occupations microcontroller-based motion sheets. These alternate sheets are recognized as Arduino Modules, which are open supply prototyping stages. The smoothed out microcontroller board indicates up in an assortment of growth board packs. The transcendent significantly perceived programming strategy is to use the Arduino IDE, which corporations the C programming vernacular. This offers you get to an Arduino Library that is industriously making perception to open supply network.

**V. EXPERIMENTAL RESULTS**

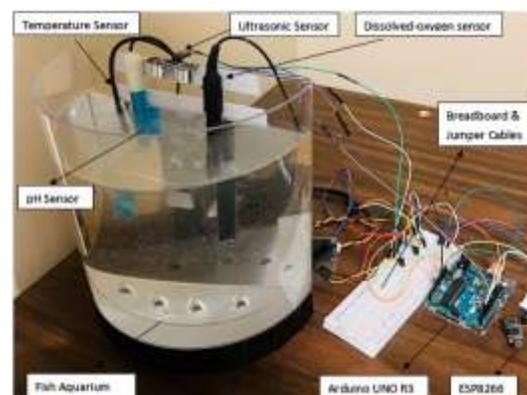


Fig.12 Designed Prototype

Fig.12 describes Arduino Uno microcontroller was chosen for the proposed system. Therefore, Arduino Uno was installed to connect the microcontroller from the library manager, and also installed ESP8266 Library for data transmission through the wi-fi. We also required sensor libraries for the Ultrasonic sensor, Temperature sensor, pH sensor, and dissolved oxygen sensor. ThingSpeak server is used for data transmission and displays wirelessly so that the ThingSpeak library can be seen in Fig. 10. After installing the required libraries, start writing and compiling the code. If any error detects in the code button black console displays the errors. Setting up the correct code after error removal, upload the code to the microcontroller, and can see the values of the system on the serial port by clicking up the Toolbar.



Fig.13 Sensor data

Fig.13 describes Cloud technologies are renowned these days and transformed the world by providing data storage and IoT services. Many cloud sources are available online Azure, AWS, ThingSpeak, and many more. ThingSpeak was chosen for this proposed system because of its free and open source IoT analytics platform and data storage. On the other hand, other sources are more expensive. The ThingSpeak library is available on IDE, which makes the user very easy to configure. ThingSpeak offers 8 channel fields to access for reading the data. It means 8 sensors could be set up one-time using ThingSpeak.

## VI CONCLUSION

The designed proposed system concluded that real-time fish farm health monitoring is suitable for fish farms and can be used in aquaculture, such as hydroponics, riverbed, tank fish farms, etc. The proposed system continuously

monitored the health measure of the fish farm and displayed them on the phone and website in real-time. The system must be evaluated on full-scale industrial trials before being employed on a large scale. Low cost, easy to use, and efficient system for developing countries

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