EMBEDDED SYSTEM-BASED AUTOMATION FOR FEED EFFICIENCY AND AQUATIC HEALTH MONITORING

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Abstract: Arduino serves as an open-source microcontroller platform designed for constructing electronic projects. It is straightforward to program and can manage sensors, motors, and various other components. In this setup, Arduino functions as the primary controller, gathering information from water quality sensors and automatically managing the feeding and pumping systems. The Feed Efficient Fish Health Monitoring System is created to advance sustainable and efficient aquaculture methods. This system automates the process of feeding fish while consistently tracking key water quality indicators to maintain a healthy aquatic habitat. By delivering the correct quantity of feed at optimal times, it minimizes waste, cuts down on operational expenses, and encourages quicker fish development. Real-time observation allows for the early identification of poor water conditions, enabling prompt interventions to avoid fish stress or loss. This comprehensive method boosts productivity, improves fish well-being, and offers a dependable, low-upkeep solution for contemporary fish farming.

I. INTRODUCTION

Fish cultivation involves the controlled management of aquatic organisms for food and commercial purposes. In Indonesia, this industry is expanding quickly, particularly in regions like Pasaman Regency, driven by governmental initiatives and active community involvement. By employing high-quality fish stock, managing water conditions, and ensuring appropriate nutrition, aquaculture supports local economic development, generates employment, and promotes long-term food stability (Mashur et al., 2020). However, irregular feeding practices pose a significant challenge in fish farming. Not only do they raise production expenses, but they can also deteriorate water quality, adversely affecting fish welfare. Farmers frequently deal with limited time and multiple simultaneous responsibilities, heightening the likelihood of feeding inaccuracies. Consequently, fish quality may decline, impacting harvest yields and diminishing potential profits (Fernanda, 2022). Automated feeding systems utilizing IoT technology present a viable solution to guarantee timely and accurate feed distribution. This approach enables efficient management of feeding intervals and quantities, even from a distance, thereby preserving water conditions and fostering ideal fish development (Abu-Khadrah et al., 2022). This study centers on developing an IoT-based automated system for fish feeding and monitoring. The aim is to enhance the precision and effectiveness of feeding routines by leveraging IoT technology with the NodeMCU ESP8266 microcontroller. This device facilitates data gathering and transmission over Wi-Fi, automatically delivering real-time updates on feeding timetables, feed quantity, water temperature, time, and date, while enabling remote oversight and management. Aquaculture is a swiftly advancing sector that is essential for addressing worldwide food requirements. Feeding management stands out as one of the most crucial elements in fish farming, directly influencing growth, health, and overall output. Conventional manual feeding techniques are often inefficient, resulting in issues like excessive feeding, insufficient feeding, and feed loss. These problems not only escalate operating costs but also lead to water contamination and disturbance of the aquatic environment. With ongoing technological progress, the incorporation of automation and IoT in aquaculture offers a novel approach to improve feeding efficiency. An automated fish feeder integrated with IoT monitoring can optimize feeding schedules, reduce waste, and allow real-time tracking via mobile or web applications. The Arduino ESP8266 microcontroller serves as an affordable and dependable platform that supports remote operation and automation of feeding tasks, contributing to more sustainable and productive aquaculture. Monitoring refers to the observation and regulation of a system to ensure all components operate correctly. In automated setups, such as automatic fish feeders, monitoring is applied to supervise feeding schedules, portion sizes, and environmental factors (Safitri et al., 2022). Aquaculture is fundamental to global food supply, offering a sustainable protein source. A primary difficulty in fish farming is the effective management of feeding schedules. Traditional manual methods often cause overfeeding, underfeeding, and feed wastage, which can harm fish health, raise costs, and impair water quality. Establishing an optimal feeding regimen is vital for maximizing fish growth, preserving water conditions, and boosting overall efficiency. Technological advances in automation and IoT provide innovative methods to enhance feeding practices in aquaculture. An IoT-enabled automatic fish feeder allows exact control over feeding times and amounts, minimizing waste and ensuring a balanced diet for the fish. The Arduino ESP8266 microcontroller is a cost-efficient and reliable tool for automating the feeding process while supporting remote monitoring through mobile or web applications. This technology supplies real-time information on feeding activities and water parameters, assisting farmers in streamlining their operations effectively. The Internet of Things (IoT) is a network that permits devices to connect with people or other devices through the internet to exchange data and information. In this context, securing data during transmission is of utmost importance (Rofii et al., 2021). The technology integrated into these devices enables IoT to adjust to both internal states and external surroundings, aiding in decision-making processes. IoT links devices to the internet, allowing them to communicate and share data concerning usage and environmental conditions (Febrianti et al., 2021).

II LITERATURE SURVEY

A. Related Work

An IoT-based aquaculture monitoring and control system. The IoT approach described in [10] employs technologies for managing water quality. Raspberry Pi-3 is utilized in place of Arduino due to its advanced capabilities, interfacing with sensors for turbidity, pH, temperature, and water level. Time series charts visualize the system's quality metrics via the Wi-Fi module. An aquaculture monitoring system leveraging AWS [11] represents another available technology for data storage and analysis. The ESP32 microcontroller and DHT11 sensor were implemented to monitor temperature, water level, and operate a fish feeder on the farm. Data can be accessed remotely using the Amazon Web Services dashboard, with the MQTT protocol selected for transmitting data from the microcontroller to the AWS cloud. Another study, referenced in [12], presents a wireless sensor network model for monitoring shrimp culture using open-source IoT. An Arduino microcontroller is paired with pH, dissolved oxygen, and temperature sensors. An open-source IoT platform is established using ThingSpeak channels. This system lacks a phone application and web interface, making data presentation inefficient.

B. Problem Statement

A review of existing literature reveals that aquaculture stands out as one of the fastest-expanding sectors within developing nations. Aquaculture refers to the cultivation of marine fisheries in human-made settings like ponds and tanks. When raising these fisheries in such artificially controlled environments, numerous factors must be taken into account. Financial development and food production are vital to this industry and are confronting substantial worldwide challenges. Among the most prominent issues are viral, bacterial, and fungal infections. Each of these has been linked to water quality conditions. Fluctuations in water quality can place stress on the fisheries and endanger their lives. To assess water quality parameters, most aquaculture operations depend on manual techniques. Manual testing is time-consuming and often yields imprecise outcomes due to the number of parameters involved and, additionally, a lack of adequate facilities near their aquaculture sites. The parameters for measuring water quality shift frequently and are not consistent.

III PROPOSED MODEL AND DESIGN

A. System Design

This system design is divided into two main components. The initial category involves the hardware configuration, while the second focuses on software implementation. The first step entails assembling and calibrating the sensors and connecting them to the microcontroller, an Arduino UNO R3. The subsequent phase involves programming the Arduino and setting up a Wi-Fi connection to transmit data to the server.

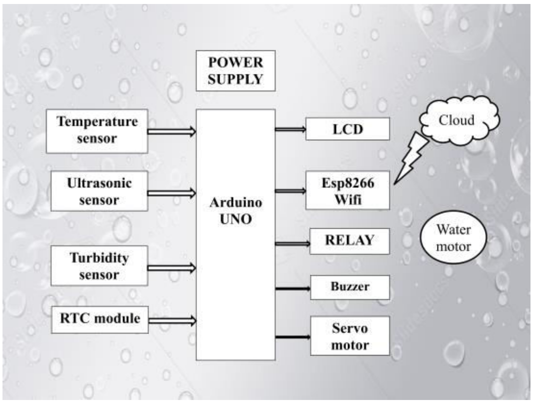


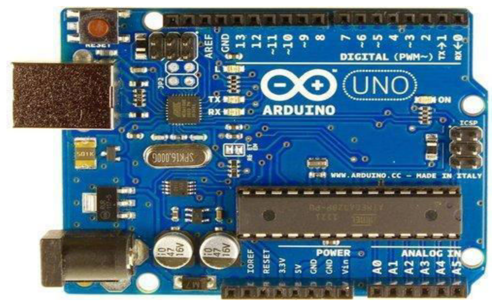
Fig. 1. Block diagram of the proposed System.

Fig. 1 outlines the block diagram of the proposed system. The design relies on four key sensors, all linked to the microcontroller. Communication with the ThingSpeak server is handled by the ESP8266 Wi-Fi module paired with an Arduino UNO R3. Consequently, the health monitoring system is accessible via both a dedicated website and a mobile application.

The assembled hardware of the proposed system utilizes the Arduino Uno R3 microcontroller alongside the ESP6288 Wi-Fi module. It is engineered to measure the four most critical water quality parameters, with data collected from water level, temperature, and turbidity sensors. A fish aquarium serves as the test environment for the system. Sensors are suspended in an aquarium filled with tap water to gather readings. Prior to installation, each sensor is calibrated and its accuracy verified using established methods, including testing the turbidity sensor in a buffer solution, immersing the dissolved oxygen sensor in a zero-dissolved-oxygen solution, and validating the temperature and ultrasonic sensor readings against a physical scale.

IV. SOFTWARE AND HARDWARE

Arduino uno:

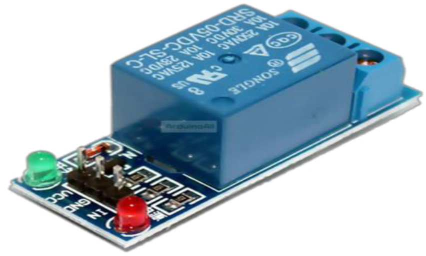


shows Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, six analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, ICSP header, and a reset button. Simply can connect to the computer through a USB cable. This microcontroller is readily available at a low cost [13].

ESP8266:

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 to 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:



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:

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

DC Motor

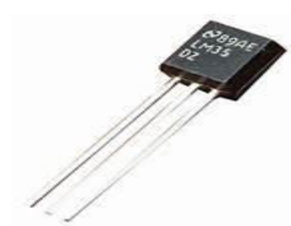
Water Motor:

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:

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:



LM35 is a temperature measuring machine having an analog output voltage proportional to the temperature. It affords output voltage in Centigrade (Celsius). It does now now not require any exterior calibration circuitry. The sensitivity of

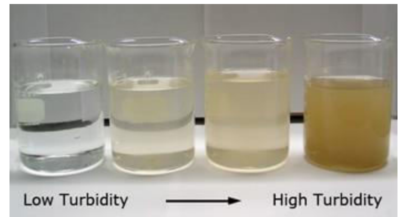
LM35 is 10 mV/degree Celsius. As temperature increases, output voltage moreover increases.

BUZZER:

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:

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.



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.

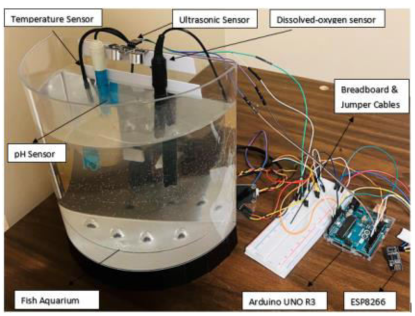
Ultrasonic Sensor:

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:

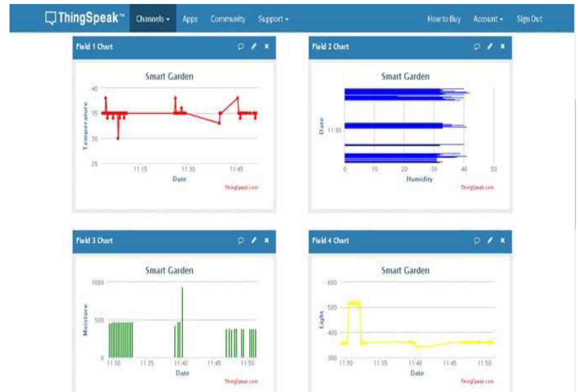
Arduino is an open-source PC tools and programming association. The Arduino Community is recommended to the activity and consumer mastermind that constructions and occupations microcontroller-based motion sheets. These alternate sheets are recognized as Arduino Modules, which are open supply prototyping 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



Project output

The Arduino Uno microcontroller was selected for the proposed system. Consequently, the Arduino Uno was set up by connecting the microcontroller via the library manager, and the ESP8266 Library was installed to enable data transmission over Wi-Fi. Sensor libraries were also required for the Ultrasonic sensor, Temperature sensor, pH sensor, and dissolved oxygen sensor. The ThingSpeak server is utilized for wireless data transmission and display, so the ThingSpeak library can be observed in Fig. 10. Once the necessary libraries were installed, the code was written and compiled. If any errors are detected in the code, the black console button displays the issues. After correcting the code and resolving errors, it is uploaded to the microcontroller, and the system values can be viewed on the serial port by clicking the Toolbar.



Sensor data

Cloud technologies have gained widespread recognition in recent times, fundamentally reshaping the world through their provision of data storage and IoT services. Numerous cloud platforms are accessible online, including Azure, AWS, ThingSpeak, and many others. For this proposed system, ThingSpeak was selected due to its status as a free and open-source IoT analytics platform with integrated data storage. In contrast, alternative sources tend to be more costly. The ThingSpeak library is readily available within the IDE, simplifying the configuration process for users. ThingSpeak provides 8 channel fields for data access and reading, enabling the one-time setup of multiple sensors through its platform.

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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