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ECOFARM AI: SUSTAINABLE IoT SOLUTIONS FOR AQUA AND POULTRY

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ABSTRACT:

In the recent past, the livestock and agricultural sectors have seen increasing demands for automation, real-time tracking, and sustainable processes owing to increased global demands and labor shortages, as well as environmental and climate fluctuations. Aquafarm and agriculture, especially poultry, are extremely vulnerable to climate changes and need continuous monitoring for animal wellness, yield optimization, and ecological balance. In order to meet these urgent needs, our final-year project "EcoFarm AI: Sustainable IoT Solutions for Aqua and Poultry" presents a smart, holistic, and environmentally friendly system that harnesses the fundamental principles of Electronics and Communication Engineering.

The system employs a range of low-power IoT sensors strategically placed throughout the aqua and poultry environments. These sensors can monitor a number of key parameters like water temperature, pH value, turbidity, dissolved oxygen (for aquaculture application), room temperature, humidity, ammonia level, and levels of feed (for poultry). The data sensed is gathered and analyzed in real time by a central microcontroller like ESP32 or Arduino, which is coded to identify deviations from normal conditions. In order to improve decision-making and farm operation, we have integrated elementary AI methods that scan sensor readings and detect patterns or anomalies. On crossing thresholds, the system initiates automated actions—like switching on water pumps, feeders, or ventilation systems—thus reducing manual intervention. The information is also saved for historical examination, enabling the farmers to know trends, streamline operations, and forecast future needs.

Keywords— Cloud-based, Internet of Things (IoT), Poultry farming, Monitoring system, Sensor network, Livestock management, Remote monitoring, Cloud platform, Data visualization, Poultry health.

Introduction

During the age of digital transformation, agriculture is witnessing a major transition towards smart and sustainable agriculture. With the growing global population and mounting pressure for high-quality food, the conventional practices employed in aquaculture and poultry rearing are found to be inadequate, inefficient, and resource-hungry. Such sectors, as critical to overall global food security as they may be, tend to grapple with issues including unstable environmental variables, excessive use of vital resources like water and power, ineffective disease identification, and labor-intensive monitoring systems. Interventions by hand under such circumstances can result in incorrect information gathering, tardy measures against prospective problems, and eventually lower productivity. In order to overcome these shortcomings, our project entitled ECOFARM AI: SUSTAINABLE IoT SOLUTIONS FOR AQUA AND POULTRY presents a novel solution that integrates the most advanced embedded systems, Internet of Things (IoT), and artificial intelligence (AI). The system is designed to automate, optimize, and smartly control aquaculture tanks and poultry conditions through real-time monitoring and intelligent control mechanisms.

Ecofarm AI is an integrated system that consolidates hardware devices such as sensors and actuators, communication modules, microcontrollers (e.g., Raspberry Pi and ESP32), and cloud-based software tools. It integrates all these to monitor and regulate important parameters. In aquaculture, these parameters are water temperature, dissolved oxygen, ammonia content, turbidity, and pH. In poultry environments, parameters including air quality, ambient temperature, feed amount, humidity, and lighting levels are continuously monitored. The information from these environments is wirelessly received by a centralized dashboard via Wi-Fi or cloud services. This dashboard is developed with an intuitive interface to assist farmers in viewing real-time information, getting alarms, and making control commands remotely via their phones or computers. This does away with the need for continuous physical monitoring and enables real-time, data-based decision-making.

Automation is one of the most important aspects of Ecofarm AI. The system is designed to react automatically to changes in the environment. For instance, if the oxygen level in fish tanks falls, the system automatically turns on the aerators. If the temperature in a chicken shed drops below a threshold, heating bulbs are activated. Likewise, automatic feed dispensers, exhaust fans, and water circulation systems are regulated on the basis of real-time sensor inputs, significantly lowering manual labor and human error. The incorporation of AI in the system further boosts its intelligence.
Using historical trends and real-time data, machine learning algorithms can forecast equipment breakdowns, detect unusual behavior in livestock, and suggest preventive measures. This predictive capacity makes farming proactive rather than reactive, making processes more efficient and ensuring

animal well-being. Apart from technical advancement, the project focuses on sustainability. It encourages maximum utilization of electricity and water, minimizes wastage of feed, and avoids unnecessary consumption of medication or supplements. Such measures not only promote environmental protection but also enhance the economic sustainability of small- and medium-scale farms. In conclusion, Ecofarm AI is not only a monitoring device-it is a intelligent, scalable, and green farm management system that applies cutting-edge engineering principles to the world of farming. It showcases how the fusion of electronics, software, and intelligent algorithms can change the old-fashioned practice of farming into an automated, data-driven, and green operation. This project shows how ECE engineering can help tackle worldwide problems such as food security, resource utilization, and rural development.

Literature Survey

M. A. Azim et al. [1] introduced an IoT-based indoor fish farming system for supporting sustainable aquaculture. The system combines Arduino-based microcontrollers with sensors like the DS18B20 temperature sensor and analog pH meters to support real-time monitoring and control of key water parameters. A significant feature of the system is its automation, which supports proactive management of the aquatic environment with minimal manual intervention. Likewise, K. A. Sitaram et al. [2] offered an IoT smart poultry farm management system with environmental monitoring, autonomous livestock care, and green energy harvesting. The system, which uses Arduino Uno microcontrollers and temperature, humidity, ammonia sensing, and light sensors, provides automated feeding, watering, and waste management processes, with live data transmission over a GPRS module to a web-based portal for remote access and control. Automated lighting and threshold-based alarm mechanisms lead to better poultry health and greater operating efficiency. Furthermore, M. V. S. Prasad et al.
Presented "FeatherGuard," a cloud-based IoT system that aims to automate the management of poultry farms using environmental sensors to track parameters like temperature, humidity, ammonia level, light, and poultry movement, whose real-time information is delivered via the Telegram cloud platform. FeatherGuard facilitates remote device control, live monitoring using an integrated camera module, automated alerts, and automates vital functions like food dispensing and door control. In addition, K. Sangeetha et al. [4] have suggested a wireless sensor network (WSN)-based solution for the control and management of smart poultry farms using DHT21 sensors for temperature, MQ137 sensors for ammonia, and ultrasonic sensors for monitoring food and water levels. Arduino Nano and ESP8266 modules provide real-time communication of data to the Ubidots IoT platform, and automation parts like servo motors, heaters, fans, and water pumps are switched on based on sensor data in order to maintain proper environmental conditions. The system further provides alert features for instantly alerting farm managers when the threshold goes out of the safety level, hence providing improved poultry welfare and reduced human intervention.

Methodology

The system suggested combines several components to facilitate smart monitoring and automation for poultry and aquaculture farm management. The Raspberry Pi is the heart of the system, which serves as the central processing unit. It is connected to various environmental sensors like DHT11 sensor (temperature and humidity), ultrasonic sensor (distance-based feed or water level measurement), and a moisture sensor for assessing Water level of the Aqua farm. A pH sensor is employed for checking the water quality. As the pH sensor provides analog outputs, an ADS1115 analog-to-digital converter (ADC) is utilized to connect it with the Raspberry Pi. An LCD display is also attached to display live sensor readings for local observation.
For driving high-power appliances such as the water pump and bulb, relay modules are interfaced with the Raspberry Pi. The system also features an ESP32 microcontroller that talks to the Raspberry Pi for executing specific automation functions. The ESP32 drives servo motors applied in poultry feeding and fish feeding systems to perform scheduled and regulated food dispensing. In order to control the environment, particularly cooling, the ESP32 also communicates with a fan, regulated through an IRF520 MOSFET module for efficient and secure switching. The setup allows for real-time monitoring and automation for poultry and aquaculture farming, increasing efficiency, lowering manual labor, and improving animal well-being.

Block Diagram

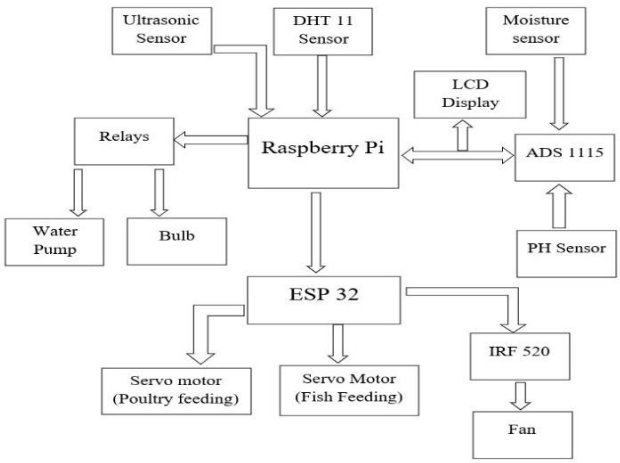

Fig4.1: Block Diagram

The system design is for intelligent management of poultry and aquaculture farms with a Raspberry Pi as the main controller. It receives real-time data from multiple sensors like DHT11, ultrasonic, moisture, and pH sensors. The system operates automatically based on sensor inputs using relays, servo motors, and a fan to provide ideal conditions. An ESP32 microcontroller is utilized to perform specialized tasks such as automated feeding and environmental control, facilitating effective farm management with less manual interference and remote monitoring functionality. This modular and scalable system enables the system to be readily configured for various farm sizes and environmental needs.

System Model

The model features a small farm structure with major components including a Raspberry Pi, ESP32, sensors (DHT11, ultrasonic, moisture, and pH), relays, and actuators like a bulb, fan, and servo motors. There is an LCD display providing real-time sensor information for monitoring purposes. The poultry component features an automated feeding system and programmable lighting, while the aquaculture component features water quality monitoring and automatic feeding. This small-scale configuration well demonstrates the fundamental capabilities of the smart farm, emphasizing its potential for practical sustainable use in integrated livestock and fish farm production conditions. An integrated IoT-driven framework integrating sensor data acquisition, automatic control procedures, and real-time monitoring aimed at optimizing both environmental conditions and resource allocation in poultry as well as aquaculture farming.

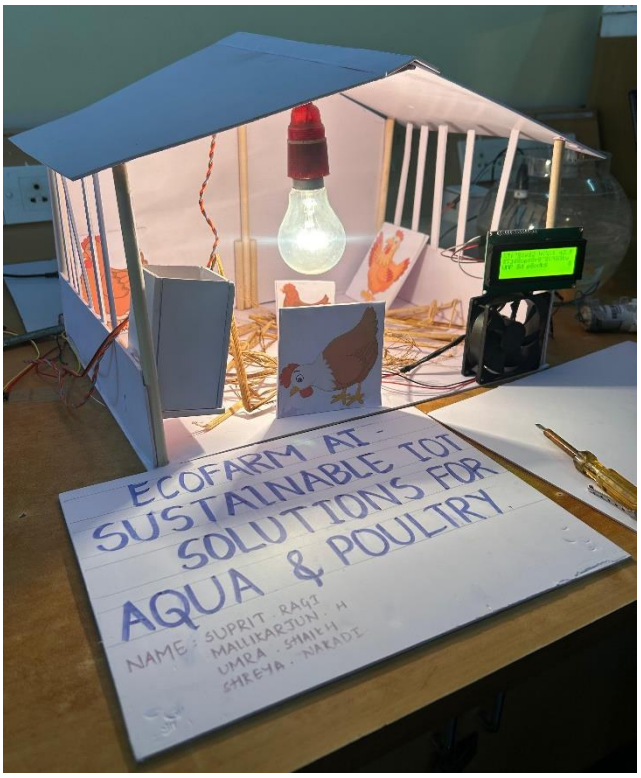

Fig 5.1: System model

A remote monitoring and control dashboard was developed to efficiently manage the smart poultry farm and fish feeding system. The dashboard shows real-time sensor data such as temperature, pH value, humidity, and water level using graphical gauges and indicators. It also shows control switches for important operations like bird water supply, bird feed distribution, and pump status, where users can turn devices ON or OFF remotely whenever necessary. The dashboard promotes operational effectiveness by allowing users to track environmental parameters and system activity from anywhere in the world using a web interface, facilitating timely response and better farm management. The system exhibits the convergence of IoT technologies for smart aquaculture and agriculture applications.

Fig 5.2: Adafruit Dashboard

VI. Conclusion and Future scope

EcoFarm AI is a breakthrough in precision farming technology that provides smart and automated solutions specifically designed for aquaculture and poultry farming. With the power of Artificial Intelligence (AI) and Internet of Things (IoT) technologies, this system facilitates data-driven farming that overcomes some of the shortcomings of conventional farming practices. By integrating smart sensors and automation modules, EcoFarm AI enables real-time monitoring and control of key parameters like water quality, temperature, animal health, and feeding schedules. This proactive monitoring reduces livestock losses substantially, increases productivity, and enhances operational efficiency on the farm.

EcoFarm AI can be extended to include disease detection by integrating camera modules with Raspberry Pi systems. Through computer vision and machine learning, the system has the ability to monitor animals automatically for any symptoms of illness, injury, or unusual behaviors. Early detection of disease would enable farmers to undertake timely interventions, reducing infection spread and enhancing general livestock well-being. This innovation would further improve the contribution of the system to farm productivity, cost savings, and animal welfare, as well as support food safety and quality compliance.

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