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DESIGN BY ENVIRONMENTAL MONITORING SYSTEM IN HEN HOUSE BASED ON GSM

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ABSTRACT

In modern chicken farming, monitoring environmental factors such as temperature, humidity, ammonia concentration, and light intensity is critical for optimizing poultry health and productivity. A henhouse online monitoring system was developed using wireless sensor networks (WSNs) and Internet of Things (IoT) technologies to address this need. The system employs wireless sensor nodes to collect environmental data, which are transmitted to a central server for real-time analysis and remote monitoring. Innovative software-based data compensation and correction algorithms were integrated to enhance the accuracy and reliability of the sensor readings. Furthermore, a data loss recovery strategy was implemented to mitigate the impact of connectivity interruptions, ensuring the integrity of transmitted data. Missing data during monitoring were addressed using a self-decision and online filling method, which estimated and filled gaps with high precision. The system supports remote visualization through a web interface, allowing farm managers to monitor critical environmental parameters from anywhere. Operational tests demonstrated the system's economic feasibility, reliability, and accuracy, confirming high estimation accuracy, with root mean square errors (RMSEs) for the four monitored environmental factors measured at 0.1698, 3.0859, 77, and 0.094. These results highlight the system's potential to enhance modern henhouse management by providing consistent, real-time, and actionable insights. The proposed monitoring system offers numerous advantages, including cost-effectiveness, ease of deployment, and scalability to various farm sizes and configurations. It automates environmental monitoring, reduces labor costs, and improves resource efficiency by optimizing the use of ventilation, heating, and other systems. Beyond henhouses, the system can be adapted for monitoring in related agricultural applications such as greenhouses, aquaculture, and livestock barns. By leveraging IoT technologies and advanced data processing methods, the system addresses key challenges in agricultural monitoring, including data loss, sensor inaccuracies, and missing information. Its ability to provide accurate and reliable data ensures optimal environmental conditions, reducing the risk of disease and enhancing poultry welfare. This innovation sets a benchmark for smart farming practices, promoting sustainability and efficiency in agricultural operations. As a flexible and adaptable solution, this monitoring system has significant potential for driving the digital transformation of agriculture, paving the way for smarter, more sustainable farming practices in diverse scenarios.

KEYWORDS-henhouse environmental parameter; IoT technology; remote monitoring.

I.INTRODUCTION

Modern poultry farming increasingly adopts closed henhouses with multilayer cage systems, designed to optimize breeding density and productivity. These advanced setups, while efficient, impose stringent requirements on environmental parameters critical to poultry health and welfare. Key factors such as temperature, humidity, carbon dioxide (CO_2) concentration, and ammonia (NH_3) concentration must be meticulously controlled to ensure optimal conditions for chicken health and productivity. Addressing these challenges, modern technological solutions offer significant opportunities for environmental monitoring and management in henhouses. The Internet of Things (IoT), an innovative technology integrating data acquisition, processing, and intelligent control through interconnected sensing devices, is gaining traction in agricultural applications. Its implementation in henhouse environmental monitoring provides managers with a scientific basis for decision-making, enhances operational efficiency, and lowers production costs. IoT's versatility has seen widespread application in smart farming domains such as greenhouse monitoring, agricultural product traceability, and urban environmental management, illustrating its potential to revolutionize traditional farming practices.Existing research highlights diverse technological approaches to henhouse environmental monitoring. Studies have explored solutions such as AVR controllers integrated with LabVIEW software for visual interface design and fuzzy control for environmental regulation. ARM and Zigbee technologies have also been employed to reduce labor intensity and enhance efficiency, while GPRS-enabled systems provide over-limit warning notifications. Wireless sensor networks (WSNs), powered by low-cost modules like CC2430, facilitate temperature, humidity, and CO_2 monitoring, reducing the costs and complexities associated with wired systems.Despite these advancements, challenges persist, particularly in wireless data reliability within steel-frame henhouses, where interference often results in duplicated or missing data. While IoT-based monitoring systems are favored for their ease of deployment and low maintenance costs, reliable wireless data transmission remains an underexplored area. This study introduces a novel wireless transport protocol featuring a loss recovery strategy to mitigate data packet dropout and enhance system reliability. Additionally, capabilities such as automated filtering of duplicate data, real-time filling of missing data, and remote monitoring through a web-based interface ensure user-friendly, efficient, and practical management solutions for henhouse environments. This innovative system addresses existing gaps, setting the stage for widespread adoption of IoT technologies in poultry farming and beyond.To further enhance the functionality and practicality of henhouse monitoring systems, this study incorporates a comprehensive approach to address critical limitations of existing technologies. By implementing a wireless transport protocol with an advanced loss recovery strategy, the system ensures reliable data transmission even in environments prone to interference, such as steel-framed henhouses. The integration of automated duplicate data filtering and online missing data filling enhances the accuracy and consistency of environmental monitoring, providing real-time and dependable insights. The design also emphasizes remote accessibility, offering a user-friendly web-based interface that allows authorized users to monitor and manage the henhouse environment from PCs or mobile devices. This remote access capability streamlines management processes, reduces on-site labor requirements, and supports timely interventions to maintain optimal rearing conditions. By tackling challenges such as wireless data reliability and user accessibility, this study lays a robust foundation for modernizing henhouse management systems, fostering the adoption of IoT-driven solutions across the agricultural sector.

II.METHODOLOGY

A) System Architecture

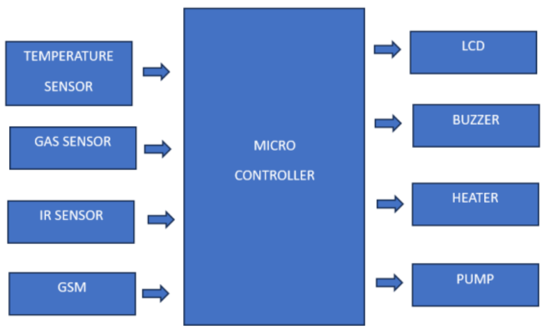

Fig1 .Block Diagram

The system architecture for an environmental monitoring system in a hen house based on GSM consists of several interconnected components to ensure the well-being of the poultry. Sensors such as temperature, humidity, gas (ammonia), and light sensors are deployed within the hen house to continuously monitor environmental parameters that affect poultry health. These sensors are connected to an embedded microcontroller, which processes the sensor data in real time. The system uses GSM (Global System for Mobile Communications) technology to send alerts and notifications to the farm manager's mobile phone if any parameter exceeds predefined thresholds, such as high temperature or humidity. Additionally, the microcontroller can control actuators like fans, heating systems, or ventilation based on the data to maintain an optimal environment. The GSM module allows for remote monitoring and management, offering convenience and real-time intervention capabilities. This system ensures that the hen house environment is consistently maintained for optimal poultry health and productivity.

B) Proposed Raspberry pi

The Raspberry Pi Pico is an affordable microcontroller board created by the Raspberry Pi Foundation. Unlike full-fledged computers, microcontrollers are small and have limited storage and peripheral options, such as the absence of devices like monitors or keyboards. However, the Raspberry Pi Pico is equipped with General Purpose Input/Output (GPIO) pins, similar to the ones found on Raspberry Pi computers, allowing it to connect with and control a variety of electronic devices. Introduced in January 2021, the Raspberry Pi Pico is based on the RP2040 System on Chip (SoC), which is both cost-effective and highly efficient. The RP2040 SoC includes a dual-core ARM Cortex-M0+ processor that is well-known for its low power consumption. The Raspberry Pi

Pico is compact, versatile, and performs efficiently, with the RP2040 chip as its core. It can be programmed using either Micro Python or C, providing a flexible platform for users of various experience levels. The board contains several important components, including the RP2040 microcontroller, debugging pins, flash memory, a boot selection button, a programmable LED, a USB port, and a power pin. The RP2040 microcontroller, custom-built by the Raspberry Pi Foundation, is a powerful and affordable processor. It features a dual-core ARM Cortex-M0+ processor running at 133 MHz, 264 KB of internal RAM, and supports up to 16 MB of flash memory. The microcontroller provides a wide range of input/output options, such as I2C, SPI, and GPIO. The Raspberry Pi Pico has 40 pins, including ground (GND) and power (Vcc) pins. These pins are grouped into categories such as Power, Ground, UART, GPIO, PWM, ADC, SPI, I2C, System Control, and Debugging. Unlike the Raspberry Pi computers, the GPIO pins on the Pico can serve multiple functions. For instance, the GP4 and GP5 pins can be set up for digital input/output, or as I2C1 (SDA and SCK) or UART1 (Rx and Tx), though only one function can be used at a time.

C) Design Process

The design of embedded systems follows a methodical, data-driven process that requires precise planning and execution. One of the core elements of this approach is the clear separation between functionality and architecture, which is crucial for moving from the initial concept to the final implementation. In recent years, hardware-software (HW/SW) co-design has gained significant attention, becoming a prominent focus in both academia and industry. This methodology aims to align the development of software and hardware components, addressing the integration challenges that have historically affected the electronics field. For large-scale embedded systems, it is essential to account for concurrency at all levels of abstraction, impacting both hardware and software components. To facilitate this, formal models and transformations are employed throughout the design cycle, ensuring efficient verification and synthesis. Simulation tools are vital for exploring design alternatives and confirming the functional and timing behavior of the system. Hardware can be simulated at different stages, including the electrical circuit, logic gate, or RTL level, often using languages like VHDL. In certain setups, software development tools are integrated with hardware simulators, while in other cases, software runs on the simulated hardware. This method is generally more suited for smaller parts of an embedded system. A practical example of this methodology is the design process using Intel's 80C188EB chip. To reduce complexity and manage the design more effectively, the process is typically divided into four main phases: specification, system synthesis, implementation synthesis, and performance evaluation of the prototype.

APPLICATIONS

Embedded systems are being increasingly incorporated into a wide range of consumer products, such as robotic toys, electronic pets, smart vehicles, and connected home appliances. Leading toy manufacturers have introduced interactive toys designed to create lasting relationships with users, like "Furby" and "AIBO." Furbies mimic a human-like life cycle, starting as babies and growing into adults. "AIBO," which stands for Artificial Intelligence Robot, is an advanced robotic dog with a variety of sophisticated features. In the automotive sector, embedded systems, commonly referred to as telematics systems, are integrated into vehicles to offer services like navigation, security, communication, and entertainment, typically powered by GPS and satellite technology.

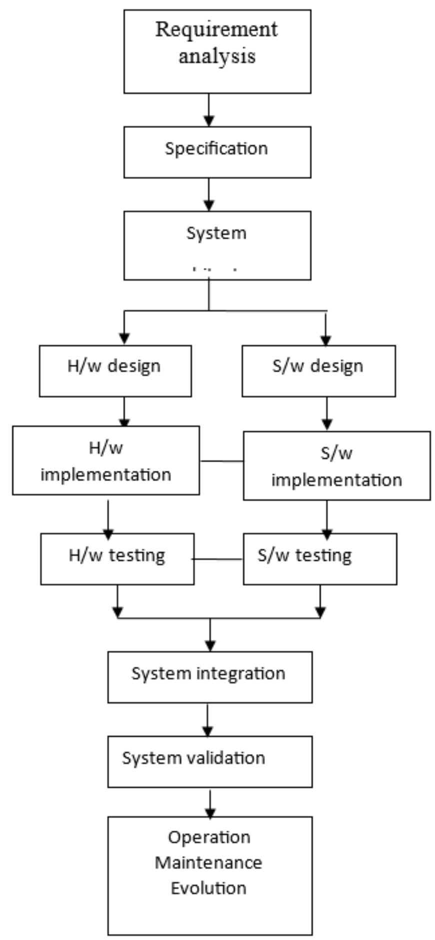

Fig 2. Embedded Development Life Cycle

The use of embedded systems is also expanding in home appliances. For example, LG's DIOS refrigerator allows users to browse the internet, check emails, make video calls, and watch TV. IBM is also developing an air conditioner that can be controlled remotely via the internet. Given the widespread adoption of embedded systems across various industries.

III.CONCLUSION

This study successfully developed an IoT-based henhouse environment monitoring system tailored to meet the stringent requirements of modern poultry farming. The system demonstrated reliable monitoring capabilities for critical environmental parameters, including temperature, humidity, CO_2 concentration, and NH_3 concentration, offering significant advantages over traditional systems. Its low packet loss rate, high reliability, and scalability make it a practical solution for modern agricultural applications. Furthermore, the system's web-based information dissemination allows authorized users to remotely access environmental data, ensuring real-time oversight and meeting the demands of efficient and sustainable poultry farm management. Innovative approaches, such as data fitting for sensor compensation, a loss recovery-based transport protocol, and a self-decision online filling method, were implemented to enhance data accuracy and reliability. By leveraging temporal-spatial correlations of sensor nodes and utilizing multithread programming for real-time data processing, the system achieved a significant reduction in data loss and improved the overall integrity of monitoring data. These enhancements ensured the system's practicality and adaptability to real-world farming conditions. This research not only addressed key challenges in henhouse monitoring but also established a robust foundation for the broader application of IoT technologies in agriculture, paving the way for smarter and more efficient farm management systems.

IV.FUTURE SCOPE

The future scope of an environmental monitoring system for hen houses based on GSM lies in enhancing its capabilities with IoT integration, allowing for more advanced data collection and analysis through cloud platforms. By using machine learning algorithms, the system could predict environmental trends and make proactive adjustments, optimizing conditions for poultry health. Integration with smart sensors could offer more precise measurements of air quality, feed levels, and real-time behavioral monitoring of the hens. Additionally, the system could incorporate automated control systems for climate regulation, reducing the need for manual intervention. With advancements in 5G, remote monitoring would become faster and more reliable, enabling real-time adjustments from anywhere. The system could also include data analytics for long-term trends, offering insights into improving farm productivity and sustainability.

V.REFERENCES

1.Wu, J.F.; Zhan, K.; Li, J.Y.; Liu, W.; Chen, G.Y.; Zhu, Y.C.; Tang, Y. Effect of environment parameters of semi-enclosed layer house on production performance and egg quality of primiparity laying hen in winter. China Poult. 2011, 33, 16–20.

2.Bai, H.W.; Teng, G.H.; Ma, L.; Yuan, Z.D.; Li, C.Y. Layer healthy breeding management information system based on Internet. Trans. CSAE 2006, 22, 171–173.

3.SerDio, C.; Boaventura, C.J.; Morais, R.; Couto, C.; Monteiro, J. A networked platform for agricultural management systems. Comput. Electron. Agric. 2001, 31, 75–90.

4.Liopa-Tsakalidis, A.; Sakkopoulos, R.; Saws, D.; Sideridis, A.; Tzimas, G. HydroNet: An intelligent hydroponics web service environment. Neural Parallel Sci. Comp. 2005,13, 15–36.

5.Liopa-Tsakalidi, A.; Tsolis, D.; Barouchas, P.; Chantzi, A.-E.; Koulopoulos, A.; Malamous, N. Application of mobile technologies through an integrated management system for agricultural production. Proced. Technol. 2013, 8, 165–170.

6.Sanchez, L.; Muñoz, L.; Galache, J.A.; Galance, J.A.; Sotres, P.; Santana, J.R.; Gutierrez, V.; Ramdhany, R.; Gluhak, A.; Krco, S.; et al. SmartSantander: IoT experimentation over a smart city testbed. Comput. Netw. 2014, 61, 217–238.

7. Mirzaee-Ghaleh, E.; Omid, M.; Keyhani, A.; Dalvand, M.J. Comparison of fuzzy and on/off controllers for winter season indoor climate management in a model poultry house. Comput. Electron. Agric. 2015, 110, 187–195.

8. Wu, S.; Wu, K.; Liang, J.; Li, Z.M.; Yang, P. Design of remote environment control system of intelligent network henhouse based on ARM9. Proced. Eng. 2011, 15, 1056–1060.

9. Kittisut, P.; Pornsuwancharoen, N. Design of information environment chicken farm for

management which based upon GPRS technology. Proced. Eng. 2012, 32, 342–347.

10. Dong, F.W.; Zhang, N.Q. Wireless sensor networks applied on environmental monitoring in fowl farm. IFIP Adv. Inf. Commun. Technol. 2010, 317, 479–486.

11. Li, L.H.; Huang, R.L.; Huo, L.M.; Li, J.X.; Chen, H. Design and experiment on monitoring device for layers individual production performance parameters. Trans. CSAE 2012, 28, 160–164.

12.Sahin, C.; Bolat, E.D. Development of remote control and monitoring of web-based distributed OPC system. Comput. Stand. Interfaces 2009, 31, 984–993.

13.Stoica, P.; Xu, L.; Li, J. A new type of parameter estimation algorithm for missing data problems. Stat. Probab. Lett. 2005, 75, 219–229.

14. Huang, R.; Zhang, Z.; Xu, G. Predictive model-aided filtering scheme of data-collection in WSN. J. China Univ. Posts Telecommun. 2011, 18, 17–24.

15.Halatchev, M.; Gruenwald, L. Estimating missing values in related sensor data streams. In Proceedings of the 11th International Conference on Management of Data, Goa, India, 6–8 January 2005; pp. 83–94.

16.Qiu, B.Z.; Zhen, Q.Q.; Tang, Y.H. Estimation algorithm for missing data in wireless sensor network. J. Comput. Appl. 2013, 33, 3457–3459, 3464.