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Animalia: An IoT-based Temperature Monitoring System for Piggery Farming

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Abstract- ***The constant monitoring of pigs' medical conditions is essential for ensuring their health and productivity. Effective monitoring allows for early disease detection, outbreak prevention, and optimal living conditions. IoT devices are among the technological solutions considered in prior works to improve real-time monitoring through advanced sensors. This study introduces Animalia, an IoT-based temperature monitoring system for piggery farming that integrates an ESP32 board, stainless steel temperature sensors, a charger module, and a lithium battery. For long-term temperature monitoring, Animalia provides vital real-time data to inform pig health management. The sensors send temperature data to the ESP32 board, which uploads it to the cloud for analysis. A mobile-friendly interface was designed to allow farmers to monitor and access temperature data seamlessly. The system is built to withstand the harsh environment of pig farms and operate continuously. The effectiveness of the system was evaluated through user feedback using the Unified Theory of Acceptance and Use of Technology (UTAUT) model. Results show that 81.8% of respondents agreed that Animalia enhances health management and monitoring efficiency, while 81.9% believe it reduces disease risks. Social influence was also significant, with 81.9% indicating that recommendations from other farmers impacted adoption. Furthermore, 72.8% trusted the system's compliance with data security standards. These results demonstrate that Animalia significantly contributes to piggery farming by providing a reliable, IoT-based solution for temperature monitoring.***

Index Terms- ***Internet of Things, IoT-based temperature monitoring, Piggery Farming, Unified Theory of Acceptance and Use of Technology (UTAUT)***

I. INTRODUCTION

The farming of pigs and the consumption of pork have long been integral to human societies worldwide. However, pig farming faces significant challenges, particularly concerning disease management and prevention. Diagnosing pig diseases promptly is critical to preventing outbreaks and maintaining herd health (Jiao & Jiao, 2022). The Internet of Things (IoT) has emerged as a transformative technology, enabling remote monitoring, automation, and data-driven decision-making in various sectors, including agriculture. IoT applications allow farmers to track vital signs such as temperature and heart rate, improving early detection of health issues (Chairunnas & Putra, 2024).

The current use of IoT has also borne fruit in remote monitoring. One example of the everyday use of IoT is smart metering which can control and monitor the use of public services such as electricity, water, gas bills, and others in real-time through applications installed on cell phones (Misto & Haryono, 2019). Feeding practices in pig farming also play a significant role in maintaining hygiene and preventing disease transmission. While pigs can consume table scraps, caution should be exercised due to the potential spread of diseases such as African swine fever (Dorca-Preda et al., 2023). The increasing demand for pork products requires the evolution of pig farming practices to meet consumer preferences and ensure sustainable production (Papakonstantinou et al., 2024).

Body surface temperature is an essential indicator of pig health, often showing abnormalities before visible symptoms occur. By integrating IoT sensors with wireless communication, farmers can remotely monitor pigs' health, ensuring timely interventions to reduce mortality rates and improve productivity. This study proposes Animalia, an IoT-enabled temperature monitoring system designed to address these challenges.

II. RELATED STUDIES

The research conducted by Sena and Kaiwman (2022). aims to develop a smart farm prototype using Internet of Things (IoT) technology. The objectives are to design and construct environment monitor and control systems of the housing and to design and

build an IoT feeding control system. This system utilizes an ESP8266 Wi-Fi micro controller, which functions to connect different sensor data to server and control the actuators. The MQTT protocol for data transferred over a secure wireless local network. Node-RED for designing the flow of data is stored on the server using a No SQL database such as InFluxDB. Users can access data and control the system via a web application with a smartphone or a computer in real-time. Implementing environment monitoring systems and an IoT feeding control system helps in automating tasks, ensuring optimal conditions for the pigs, and improving overall farm management. The study indicated that the built IoT system may be used as a prototype for smart farming applications and scaled up for larger farms or other agricultural settings, demonstrating its versatility and potential for widespread use.

The research by Priya et al. (2023), stated that the IoT has introduced numerous changes on the current technologies as well, where its applications are extensive which includes industry automation, biomedical applications, agriculture, transportation and smart cities etc. IoT enabled livestock management in real time will allow that type of records be maintained and farmers can rapidly diagnose and treat animals quickly to reduce the spread of illness or disease, track gazing cattle and predict loss events monitor grazing patterns, historical data analysis for trends in cattle health or trace the outbreak tracking spread of disease, readiness for calving allowing less new calves cost losses and optimize breeding practices. A smart animal health monitoring system is designed in this paper, to monitor the parameters (body temperature, heart rate and rumination pattern) as mentioned above. These sensors apply on the body of the animals and record related data which is then stored over an internet and can be fetched by authorized person. The way how the method is performed using Raspberry Pi done here, where the information is fetched by various sensors and stored on to the cloud so that we can access them from mobile through internet. Data is collected on them using devices such as the ADXL335 accelerometer. This led to a realized animal health monitoring system which monitored parameters such as body temperature, heart rate, and rumination pattern in real-time to enable rapid treatment of animals as well as disease prevention through the implementation of 3-axis acceleration measurements using an ADXL335 accelerometer which was used to measure the cow's rumination patterns for early detection of diseases related to food digestion, mastitis and metabolic problems after calving.

The research by Jiao & Jiao. (2022), the potential of uncooled IR thermography has been revealed for body rapid screening of temperature of pigs. But temperature measurements can yield devastating measurement errors depending on variations in body surface emissivity from skin stains or emissivity errors between body parts. Until recently, uncooled infrared thermography has demonstrated great potential in providing an rapid Pigs' body temperature screening Temperature readings, however, may result in significant deficiencies caused by skin stain or differences in body surface emissivity in body part emissivity. This question was solved by a methodology which utilized a The smartphone-based uncooled infrared camera with rotable infrared filter in its optical path detector in this paper. Obtaining Infrared Radiation the addition and subtraction. The equation now for temperature measurement will be one of spectrum in different wavelengths, akin to this: built to minimize the effect of emissivity discrepancies on measurements of temperature.

This study by Lee et al. (2019), presents an IoT framework for monitoring cattle in a massive cattle pigs with IC tags to study their life history, specifically social status in their pigpen and some biological data. It is observed that the authors suggest a channel state perception system based on measuring dwell time based on the power of IC tags attached to each pig, All these reduce weight, stress levels and movement amount (Lee et al., 2019). The control system works on the basis of use active IC tags which transmit ID information and strength of microwaves. Some farms are used as reference pig farm where correct location of each single pig in the pig farm is measured. Antennas Located at all feed and resting sites in the pig pen, they strategically monitor the movement of pigs and then pointed the devices towards the known paths of wild pigs and had the main control PC collect information on where the pigs traveled, and at what times. The system is expected to enhance efficiency in daily breeding operations, facilitate novel breeding programs, and find applications beyond pig farms in various livestock settings.

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III. MATERIALS AND METHODS

The system consists of IoT-enabled temperature sensors integrated with an ESP32 microcontroller as shown in Figure 1, stainless steel DS18B20 sensors in Figure 2, and a lithium battery module in Figure 3 enclosed in a wearable belt. Data is collected every 10 seconds and wirelessly transmitted to a cloud database for analysis. The mobile application, built using Flutter, provides farmers with real-time monitoring capabilities, including graphical representations of temperature changes. User feedback was collected through surveys and analyzed using the UTAUT framework.

Figure 1: ESP32 Development Board WIFI+BT W/ Antenna

Figure 2: DS18B20 Temperature Sensor Module Stainless Steel

Figure 3: 5pcs Charger Module Micro USB 18650 Lithium Battery Charging

IV. RESULTS AND DISCUSSION

The experimental results show real-time temperature tracking with updates every 10 seconds. Users reported positive feedback, with 81.8% agreeing that the system improved health management. Tables 1–4 detail responses across Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Include figures and tables as required.

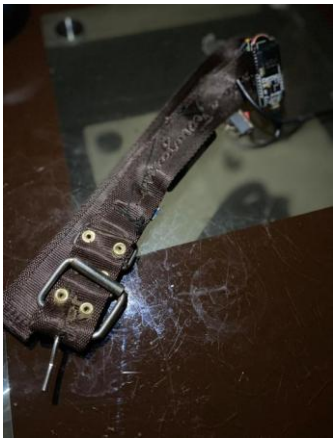

Table 1: Performance Expectancy Items and Response Distribution

Items	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mode
Using Animalia temperature	0	18.2	0	27.3	54.5	5

monitoring system will improve pig health management.						
Animalia temperature monitoring system will increase the efficiency of monitoring and managing pigs in real-time.	9.1	0	9.1	27.3	54.5	5
Animalia temperature monitoring system is expected to reduce the risk of disease outbreaks by providing timely alerts.	0	18.2	0	45.5	36.4	4
Animalia temperature monitoring system will enhance decision-making by providing accurate data on pig health.	0	0	18.2	45.5	36.4	4

Table 2: Effort Expectancy Items and Response Distribution

Items	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mode
Learning to operate Animalia temperature monitoring system is straightforward.	0	0	27.3	45.5	27.3	4
Animalia mobile app's interface is easy to navigate and understand.	9.1	0	18.2	36.4	36.4	4
Animalia temperature monitoring system features are simple to use and access.	0	0	18.2	54.5	27.3	4
Animalia temperature monitoring system app provides clear instructions on how to use the system effectively.	0	0	36.4	27.3	36.4	3

Table 3: Social Influence Items and Response Distribution

Items	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mode
The livestock management community's positive	0	9.1	27.3	18.2	45.5	5

feedback influences my perception of the system.						
Recommendations from other pig farmers impact my decision to use the system.	0	0	18.2	45.5	36.4	4
Industry events and trade shows have increased my interest in this technology.	0	0	9.1	54.5	36.4	4
Expert advice on adopting technology in Animalia temperature monitoring system is crucial to my decision.	0	0	9.1	54.5	36.4	4

Table 4: Facilitating Conditions Items and Response Distribution

Items	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mode
I have the necessary hardware and internet connection to use the Animalia temperature monitoring system effectively.	18.2	0	0	54.5	27.3	4
Animalia temperature monitoring system is compatible with my mobile devices, ensuring accessibility.	0	18.2	18.2	36.4	27.3	4
The provider offers adequate support and documentation to help me use the Animalia temperature monitoring system	0	0	9.1	54.5	36.4	4

V. CONCLUSION AND RECOMMENDATION

The development of Animalia marks a significant advancement in piggery farming technology. It provides a robust, user-friendly solution for continuous temperature monitoring, enabling proactive health management and reducing disease outbreaks. Future enhancements should focus on integrating additional environmental sensors, such as humidity and air quality monitors, and improving wireless infrastructure for remote farms.

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