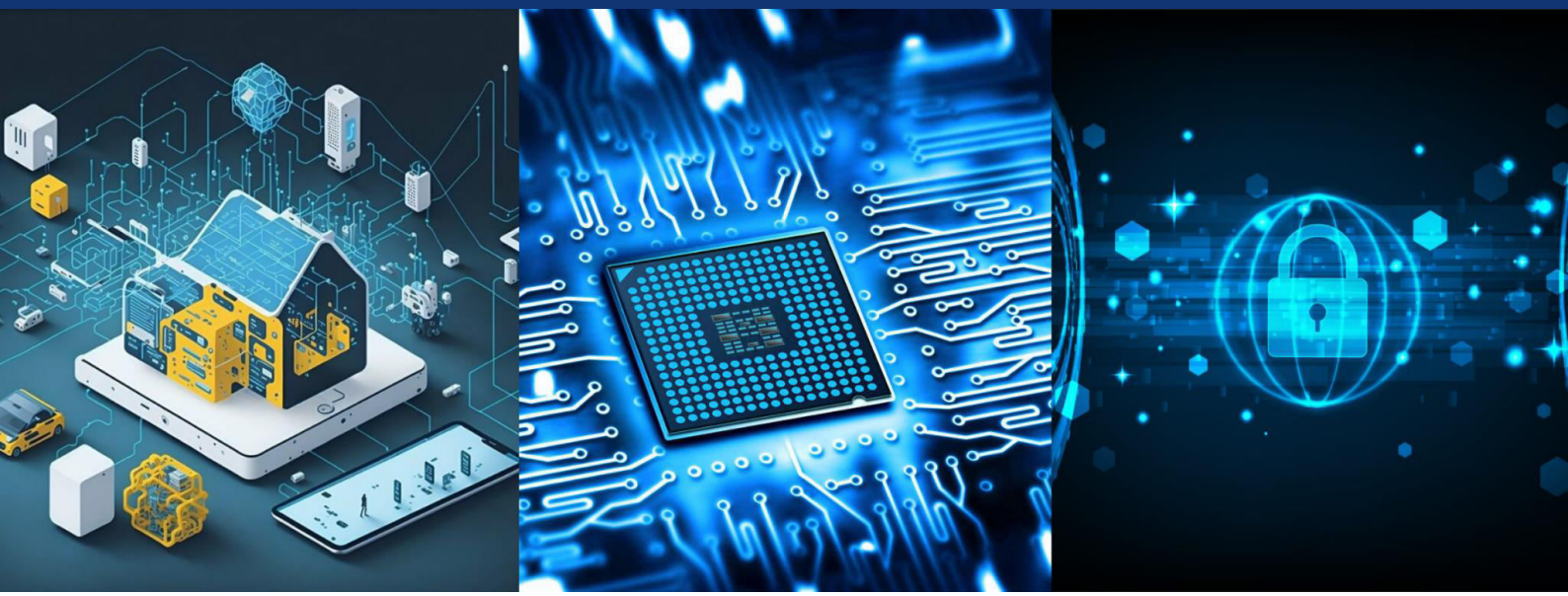
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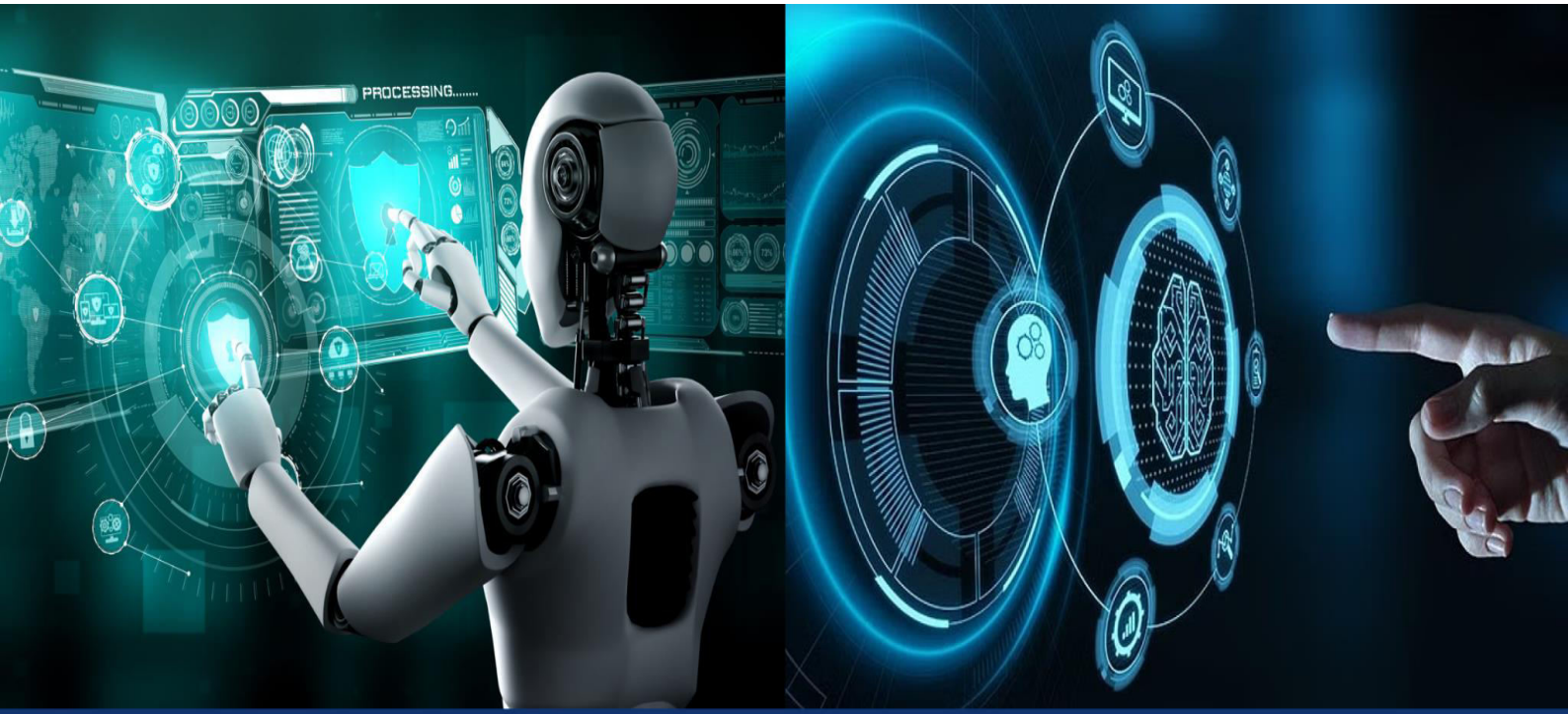
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Sheep Health Monitoring System Using IoT

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ABSTRACT: Sheep farming commonly relies on visual observation and manual record keeping to identify animals and recognize possible health problems. These practices can be time-consuming and may delay intervention, particularly when a flock is large or continuous supervision is not possible. This paper presents the design of a Sheep Health Monitoring System that combines Radio-Frequency Identification (RFID), an ESP32 microcontroller, physiological sensors, and a local data-management application. Each sheep is associated with a unique RFID identifier, while temperature and pulse-related measurements are intended to provide additional information about its condition. The ESP32 collects available sensor readings and transfers them to a processing application, where records can be associated with the relevant animal, stored, displayed, and checked against configurable alert rules. The proposed design emphasizes animal-level traceability, timely access to records, reduced manual data entry, and notifications when measurements require attention. The project specification identifies an MLX90615 temperature sensor, a MAX30102 pulse sensor, MySQL storage, and an Arduino IDE development workflow. The system is presented as a proposed design; quantitative performance, sensor accuracy on sheep, and field effectiveness must be established through controlled testing before being claimed as results.

KEYWORDS: Sheep health monitoring, Internet of Things (IoT), RFID, ESP32, temperature sensing, pulse monitoring, livestock management, real-time alerts.

I. INTRODUCTION

Livestock health management is an important part of sustainable animal production. In conventional sheep farming, farmers often rely on visual inspection, manual identification, and written or spreadsheet-based records. These approaches can require considerable time and may be affected by missed observations or errors when recording information. A health concern may also go unnoticed between routine inspections, especially when animals are kept in groups or grazing areas.

Precision livestock farming uses sensing, communication, and data-processing technologies to support more frequent and individualized monitoring. Recent work on dairy-sheep monitoring describes the potential of IoT sensors, wearable devices, computer vision, and decision-support systems, while also noting practical barriers such as cost, reliability, interoperability, and validation under farm conditions [4].

This paper describes a proposed Sheep Health Monitoring System that uses RFID for animal identification and sensor readings to support health observation. The design links an animal identifier with measured values and stored records, enabling farm personnel to review information and receive alerts when readings cross configured limits. The intended contribution is an integrated, low-complexity architecture for identification, monitoring, record management, and notification—not a claim that disease can be diagnosed from a single sensor value.

II. LITERATURE SURVEY

IoT-based livestock monitoring has been explored for collecting physiological data and delivering alerts to farmers. Jain et al. describe a cattle-monitoring approach that combines sensors, an IoT platform, analysis, and a mobile application [1]. Although cattle-focused, this approach illustrates how continuous data collection can support timely review of animal condition.

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Sowndarya et al. describe a cloud-based livestock monitoring concept using RFID, load cells, temperature sensing, and an embedded controller, with records made accessible through an application [2]. Their work is relevant to the proposed use of unique animal identification alongside sensor measurements and digital records.

Fabiyi et al. present a mobile platform for livestock monitoring and inspection that combines RFID identification, QR-code access, a mobile application, a web service, and a database [3]. This work highlights the value of linking animal identity with accessible records. In comparison, the system described in this paper focuses on a sheep-oriented monitoring workflow using an ESP32 and a specified temperature and pulse-sensing arrangement.

The reviewed precision-livestock literature indicates that sensor readings become more useful when they are connected to animal identity, stored over time, and translated into clear actions for farm personnel [4]. A practical system still requires testing of sensor placement, measurement repeatability, connectivity, alert thresholds, power consumption, and usability in the intended farm environment.

III. PROBLEM STATEMENT AND OBJECTIVES

Manual animal identification and periodic observation can make it difficult to maintain timely, consistent health records for each sheep. The proposed system aims to reduce dependence on manual record entry by linking RFID-based identification with sensor data and a digital record store.

The main objectives are:

- Associate each sheep with a unique RFID identifier and retrieve the corresponding record.
- Collect temperature and pulse-related readings from the configured sensors through a microcontroller.
- Store measurements with animal identity and timestamps for later review and history tracking.
- Display current readings and generate alerts when configured rules identify values that need attention.
- Reduce the time and effort involved in routine data collection while supporting—not replacing—veterinary assessment.

IV. PROPOSED SYSTEM

The proposed system consists of an animal-identification unit, a sensing and control unit, a data-processing and storage unit, and a user-notification interface. An RFID tag provides the identity key for each sheep. An RFID reader obtains the tag identifier when the animal is presented to or passes within range of the reader. The ESP32 acts as the controller for sensor acquisition and communication. Temperature and pulse-related measurements are associated with the identified animal and passed to the application for storage and review.

The project report specifies an MLX90615 temperature sensor and a MAX30102 pulse sensor. These component choices should be confirmed against the final hardware build. In particular, the MAX30102 is an optical sensor whose signal quality depends on physical contact, positioning, motion, and the animal's tissue and fur characteristics; its suitability for reliable sheep pulse measurement must be validated experimentally. Temperature readings also depend on measurement location and sensor setup, so thresholds should not be treated as a veterinary diagnosis.

4.1 Functional Modules

- Animal identification: reads the RFID tag and retrieves the associated sheep record.
- Sensor acquisition: obtains available temperature and pulse-related readings from the connected sensors.
- Data processing: checks data validity, attaches the animal identifier and timestamp, and applies configurable alert rules.
- Record storage: stores animal details and measurement history in a MySQL database, as specified in the project report.
- Dashboard and notifications: presents records to the user and signals readings that require inspection.

4.2 Existing and Proposed Approaches

In a manual approach, identification and health observations are entered by a person, and monitoring frequency depends on available staff. In the proposed approach, RFID assists with identification and electronic sensing supports

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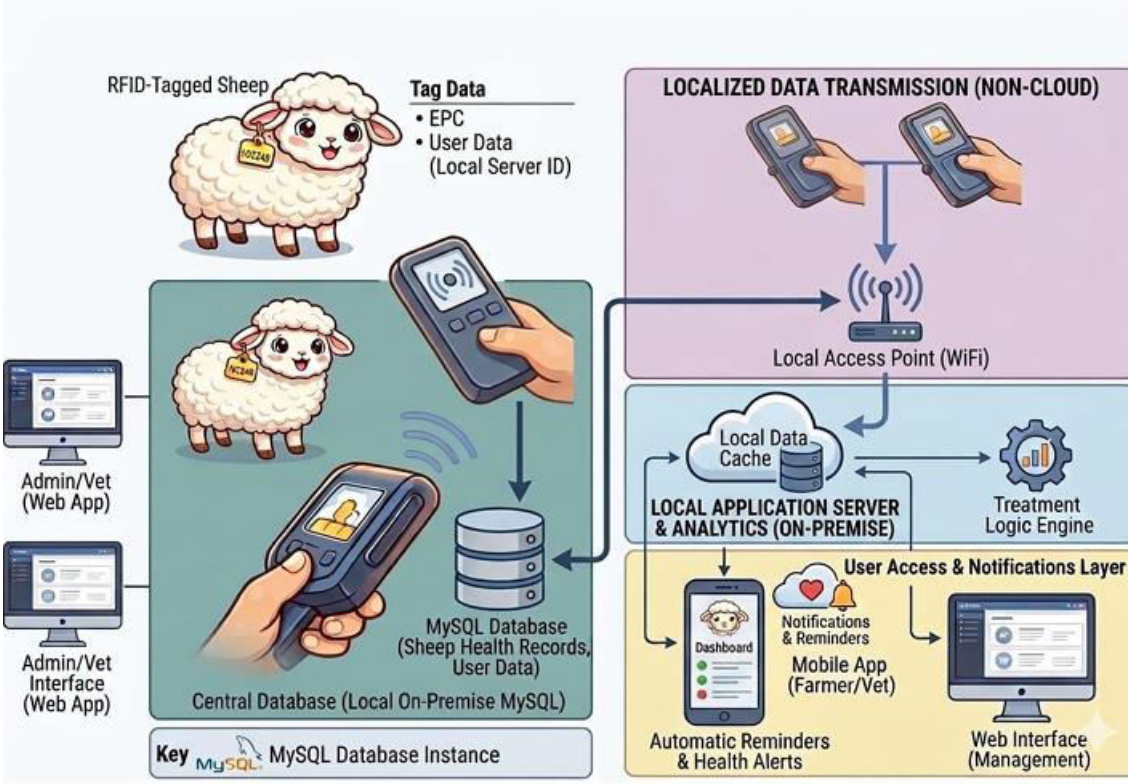
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more consistent recording. The proposed design can improve traceability and reduce repeated manual entry, but these benefits depend on correct RFID reads, functioning sensors, reliable data transfer, and a usable interface.

V. SYSTEM ARCHITECTURE



The architecture follows a data path from animal identification and sensing to local processing, storage, display, and notification. The project report describes local processing and storage as a way to retain control of farm data and reduce dependence on an external cloud service. A network connection may still be required for remote access or external messaging, depending on the final implementation.

- Animal layer: each sheep is associated with a unique RFID tag.
- Identification layer: an RFID reader captures the tag identifier and passes it to the controller or application.
- Sensing layer: the temperature sensor and pulse sensor provide readings to the ESP32, subject to the final wiring and interface design.
- Processing layer: the controller/application validates readings, associates them with the sheep ID, and evaluates configured rules.
- Storage layer: the application stores animal records and timestamped measurements in MySQL.
- Presentation and alert layer: a dashboard displays the latest data and history; notifications are raised when configured conditions are met.

Fig. 1. Conceptual data flow: RFID tag and sensors → ESP32/data acquisition → processing and threshold checks → MySQL records → dashboard and alerts.

VI. METHODOLOGY AND MONITORING WORKFLOW

The following workflow describes the intended operation. The exact sequence must be aligned with the final hardware and software implementation.

- Start the controller and initialize the RFID reader, temperature sensor, pulse sensor, and communication interface.
- Read an RFID tag when a sheep is identified; retrieve or create the associated animal record.
- Acquire sensor readings and check whether the data are available and within the sensor's valid output range.

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- Attach the animal identifier and timestamp to each valid reading.
- Transmit the record to the application and store it in the database.
- Compare the reading with veterinarian-informed, configurable alert thresholds and the animal's historical pattern where available.
- If a rule is triggered, show an alert for the responsible user to inspect the animal and seek veterinary advice when appropriate.
- Display the latest record and retain the measurement history; repeat the monitoring cycle.

The system should distinguish a sensor fault or missing reading from an abnormal animal measurement. Alerts should be treated as prompts for inspection rather than definitive disease diagnoses. Normal ranges and alert thresholds should be selected with qualified veterinary guidance and validated for the measurement method used.

VII. HARDWARE AND SOFTWARE REQUIREMENTS

Component	Role in the proposed system	Specification in project report
Microcontroller	Reads sensors and coordinates data transfer.	ESP32
Animal identification	Provides a unique identifier for each sheep.	RFID tag and reader
Temperature sensing	Provides temperature measurements for review.	MLX90615 listed in report; confirm final part number
Pulse-related sensing	Provides optical pulse-related measurements, subject to validation.	MAX30102
Database	Stores animal details and timestamped records.	MySQL
Development environment	Used to develop and upload controller firmware.	Arduino IDE
Programming / application layer	Processes readings and supports user access.	C++,JavaScript, HTML and CSS
Power	Supplies portable electronics.	Battery / power supply

VIII. IMPLEMENTATION CONSIDERATIONS

The ESP32 firmware should initialize the connected modules, acquire measurements, and transmit structured records to the application. A measurement record should include at least the animal identifier, timestamp, measured parameter, value, and a status field indicating whether the reading was valid. The database should maintain a stable relationship between the animal table and its measurement history.

The software interface should allow an authorized user to view animal identity, recent readings, and historical records. Where alerts are supported, the alert message should identify the sheep, the parameter that triggered the rule, the reading, the timestamp, and the recommended next step (for example, recheck the measurement and inspect the animal). User authentication, backups, and restricted access should be considered if the system is deployed on a real farm.

The final paper should list only components and features that are actually implemented. For example, SMS or mobile notifications should be described as implemented only if the required gateway, service, and end-to-end notification test have been completed.

IX. EXPERIMENTAL EVALUATION

No verified experimental measurements or test results were supplied in the project material used to prepare this manuscript. Therefore, this section defines an evaluation plan rather than reporting performance claims.

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9.1 Test Plan

- RFID identification: test repeated reads for each tag and record successful, missed, and duplicate reads.
- Sensor operation: compare temperature readings with an appropriate reference instrument and evaluate repeatability under the intended measurement conditions.
- Pulse-sensor feasibility: assess signal quality and repeatability with a safe, consistent sensor placement; compare with a suitable reference method under veterinary supervision.
- Data transmission and storage: check that each valid reading reaches the application and is stored against the correct sheep ID and timestamp.
- Alert behaviour: test values below, within, and above configured limits, plus missing or invalid sensor data, to confirm correct alert handling.
- System reliability: measure end-to-end delay, packet/data loss, uptime, battery duration, and usability during a defined trial.

9.2 Metrics to Report

Once testing has been completed, report the number of sheep and observations, test duration, measurement conditions, reference instruments, and the method used to set thresholds. Useful metrics include RFID read success rate, sensor measurement error, data-delivery success rate, alert sensitivity and specificity against a clearly defined reference label, average notification delay, and battery life. Numerical values must be calculated from the collected data and must not be estimated or invented.

X. RESULTS AND DISCUSSION

The main design benefit is the association of animal identity with timestamped measurements and accessible records. This can help farm personnel review an individual sheep's history rather than relying exclusively on memory or isolated observations. Local data processing may also support operation where internet connectivity is limited, provided the selected architecture and interface are implemented accordingly.

Important limitations remain. Sensor accuracy on sheep cannot be assumed from component specifications alone; placement, movement, coat, ambient conditions, and handling may influence readings. A temperature or pulse deviation is not sufficient on its own to diagnose a disease. The system also depends on reliable identification, power, calibration, data integrity, and user response to alerts. A field trial and veterinary input are necessary before making claims about early disease detection or improved animal outcomes.

XI. FUTURE SCOPE

Future work may include a field evaluation on a defined flock, validation of sensor placement and thresholds with veterinary support, and analysis of individual baseline trends. Further improvements could include low-power wireless communication, a mobile-friendly dashboard, secure remote access, offline data synchronization, automated reports, and carefully validated anomaly-detection models. Any machine-learning component would require a representative labelled dataset, a documented evaluation procedure, and testing across different animals and environmental conditions.

XII. CONCLUSION

This paper presents a proposed Sheep Health Monitoring System that combines RFID-based animal identification, ESP32-based data acquisition, temperature and pulse-related sensing, digital records, and configurable alerts. The design aims to improve traceability and make health-related measurements easier to access and review. The project specification identifies MLX90615, MAX30102, and MySQL among the intended components; their integration and field performance should be verified in the final implementation. Future work should measure identification reliability, sensor validity, data-transfer performance, alert behaviour, and usability before quantitative claims are made.

XIII. ACKNOWLEDGMENT

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