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IoT-Driven Livestock Health Monitoring: A Sensor-Based Software

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Abstract - *Efficient farm management relies on proactive livestock health monitoring, a challenge unmet by traditional methods. This research aims to overcome these limitations by developing a state-of-the-art device integrated with a versatile mobile application, revolutionizing livestock health management. The device employs cutting-edge sensors to continuously monitor vital parameters such as GPS location, environmental temperature, and other environmental conditions. The mobile application swiftly detects signs of stress, illness, or discomfort, enabling early intervention. Additionally, our system features an e-commerce component, facilitating convenient purchases of livestock-related products. This data-driven approach empowers farmers with actionable insights, promoting sustainable agriculture. The project's goal is to ensure the welfare of both livestock and their caretakers. Through the fusion of IoT, sensor technology, and mobile applications, we envision a transformative solution that enhances farm productivity and overall livestock well-being. Integrating advanced technologies positions our system at the forefront of modern agriculture, addressing critical challenges and fostering an efficient and sustainable farming ecosystem.*

Key Words: Livestock, farm, health, sensor, android application, e-commerce

1.INTRODUCTION

One of the main components of a complicated puzzle required for effective farm management is the health of livestock. The paper [18] proposes the integration of livestock farming with agriculture as a mutually beneficial system to enhance agricultural productivity, ensure food security, and improve economic opportunities. The livestock sector accounts for 4.9% of India's GDP and contributes nearly 28.4% to the agricultural GDP [7]. However, the current situation exposes a harsh truth: traditional methods often fail to detect stress, sicknesses, and nutritional imbalances in cattle in their early stages. This leads to untreated health issues that affect the animals' well-being and productivity in the farming ecosystem. To overcome these obstacles, we focused on developing a cutting-edge device for overseeing cattle health, integrated with a mobile application that is both versatile and sophisticated.

Our project's central idea is to develop an innovative livestock health management system that employs sensor technology to constantly track vital parameters. This generates an abundance of real-time data and includes environment temperature, humidity, location, and other ambient parameters. As an analytical engine, the companion mobile application swiftly analyses this data to identify indications of disease, stress, or discomfort in animals, enabling timely interventions. Our integrated solution intends to empower farmers with a proactive and data-driven technique, guiding agriculture toward a more sustainable future by overcoming the gaps that exist in traditional practices.

Technology coming in contact with agriculture has often resulted in a conspicuous void because there has never been a single platform that does well on data collection, analysis, and any direct interventions within a period. This anomaly becomes evident especially when e-commerce features are combined with animal health monitoring. Insufficiency of such integration would make it hard for farmers to manage their herd appropriately, thus putting in jeopardy their livestock's ability to ensure productivity and welfare. Therefore, we aim to solve this market gap by providing an all-in-one technology-driven solution involving up-to-date tools for livestock health monitoring and functioning e-commerce components. It will be an innovative combination that will revolutionize farming practices while ensuring sustainability, increased cattle wellness, and community livelihoods that rely on them.

2. LITERATURE SURVEY

Liwu Pan, Mingzhe Xu, Lei Xi and Yudong Hao [16] in their research paper "Research of Livestock Farming IoT System. Based on RESTful Web Services" published by IEEE 2006, proposed a practical framework for constructing an intelligent livestock farming IoT system using RESTful web service technology. In this paper, IoT applications in agriculture have been emphasized, for example, remote monitoring systems that cater to poultry housing environments in a bid to improve efficiency while reducing cost.

In "Dairy Farm House Monitoring based on IoT Technology" [5] by T Krishnakaarthik, M Abirami Sundari, R Ajeeth, K Nandhini, published in IJERT, the authors propose a Dairy Farm House Monitoring platform utilizing IoT data techniques. The study identifies the innovative prospects of IoT implementation in dairy farming whilst discussing practical considerations which hinder most farmers from adopting it as a result of economic restrictions.

In "IoT Technologies for Livestock Management: A Review of Present Status, Opportunities, and Future Trends" [11] by Bernard Ijesunor Akhigbe, Kamran Munir, Olugbenga Akinad, published by MDPI, the authors employ the systematic literature survey (SLS) methodology, specifically PRISMA, to explore the role of IoT technologies in Livestock Management (LsM). In addition to examining existing literature, this paper highlights seldom-discussed barriers to adopting IoT in LSMs.

In their paper titled "Industry 4.0 and Precision Livestock Farming (PLF): An Up-to-Date Overview across Animal Productions" [23] by Sarah Morrone, Corrado Dimauro, and Filippo Gambella, published by MDPI, the authors embark on a comprehensive review to delineate the contemporary landscape of Industry 4.0 within agriculture, specifically focusing on Precision Livestock Farming (PLF).This review touches on the basic principles of contemporary agricultural systems and outlines how Industry 4.0 technologies can be applied in various animal production systems and processes.

In their paper titled 'Advancements in sensor technology and decision support intelligent tools to assist smart livestock farming,' [2] Luis O. Tedeschi, Paul L. Greenwood, and Ilan Halachmi emphasized the benefits of precision livestock farming (PLF) on various aspects of livestock production, such as health monitoring, behavior observation, and feed intake management. The incorporation of technology including sensors, cameras and artificial intelligence (AI) has significantly improved cattle-rearing efficiency.

T. Vigneswari, N. Kalaiselvi, K. Mathumitha, Amara Niveditha, and Adhithi Sowmiya's work, [25] "Smart IoT Cloud-Based Livestock Monitoring System: A Survey," explores a project that revolves around livestock monitoring. One important aspect of the project is that it encompasses sensor technologies for tracking cows' whereabouts and health status. There are several types of sensors used; they include those that detect movements, heart rate or temperature changes among others for instance regarding cows.

Jianhua Zhang, Fantao Kong, Zhifen Zhai, Shuqing Han, Jianzhai Wu, and Mengshuai Zhu's paper, [12] "Designing and Developing an IOT Monitoring System for Open Livestock Environment" underscores the significance of IOT technology in livestock farming context and provides critical technological support towards modern management practices. The authors explain how they developed a wireless 16-channel monitoring system utilizing IOT technology specifically designed for open field monitoring at farms made suitable for cattle rearing as well as poultry breeding conditions.

Seng-Kyoun Jo Dae-Heon Park Hyeon Park Se-Han Kim in their paper "Feasibility Study on Smart Livestock Farms Utilizing Digital Twin" [24] suggest that digital twin technology is a potential solution to make livestock farming more efficient and safer, including managing an outbreak of diseases and addressing animal welfare.

Muhammad Shoaib Farooq Adnan Abid, Osamaomarsohail, And Saim Rasheed's article titled "A survey on the role of IoT in agriculture for the implementation of smart livestock environment" [19] aims at offering an all-inclusive survey on how IoT has influenced the industry by grouping and summarizing existing studies. It highlights IoT network infrastructure, topologies, platforms, communication protocols and connections used in livestock management.

The paper of S. M. Riazul Islam, Daehan Kwak, Md. Humaun Kabir, Mahmud Hossain, And Kyung-Sup Kwak entitled "The Internet of Things for Health Care: A Comprehensive Survey" [22] arranges current investigations concerning healthcare networks based upon IoT and gives an overview of healthcare services based on IoT; it pins down some industrial efforts towards developing and adopting IOT-compliant healthcare products; security threats, as well as privacy issues, are also discussed there.

In their article titled [8] "Wireless Sensor Networks for healthcare: A Survey", Hande Alemdar and Cem Ersoy argue that wireless sensor network (WSN) technologies should be employed to provide better care to elderly people, children, or those who suffer from chronic diseases thus enabling remote monitoring; immediate identification of life-threatening situations; inexpensiveness as well as context-aware applications among others. This paper also examines some design considerations along with presenting a few state-of-the-art examples/proposals that address such challenges as unobtrusiveness scalability energy efficiency security in future healthcare applications.

The paper by Bin Zhou, Chao Hu, HaiBin Wang and Ruiwen Guo entitled "A pervasive medical supervision system based on wireless sensor networks" [4] implies the use of wireless sensor networks (WSNs) for pervasive health care that enable real-time non-intrusive medical monitoring of patients.

The paper "Field Testing of IoT Devices for Livestock Monitoring using Wireless Sensor Network, Near Field Communication, and Wireless Power Transfer" [15] presents a Near Field Communication (NFC)-based WSN livestock health monitoring system with temperature sensing as one of the key parameters. Additionally, it highlights power management strategies that can be used to improve the battery life span in the monitoring system.

A paper titled [20] "An Environmental Air Pollution Monitoring System Based on the IEEE 1451 Standard for Low-Cost Requirements" discusses an Environmental Air Pollution Monitoring System (EAPMS), which is a semiconductor gas sensors-based implementation of smart transducer interfaces compliant with the IEEE 1451 standard thus providing a compact low-cost way to detect and measure major air pollutant gases.

This paper [26] "Feasibility Study on Ambient RF Energy Harvesting for Wireless Sensor Network" by Teck Beng Lim, Ngai Meng Lee and Boon Kiat Poh examines ambient RF energy harvesting as well as investigates its integration with wireless power transfer towards supplying energy to low-power devices such as that in case of wireless sensor networks. Despite low RF power density challenges mentioned during this research these findings also suggest energy may not be generated directly enough but can be stored throughout other periods, therefore making RF energy harvesting an option carefully worth considering.

In their report titled "A Zigbee-Based Animal Health Monitoring System" A. Kumar and G.P. Hancke [1], a developing Animal Health Monitoring System (AHMS) that monitors physiological trends like rumination time or any other related information is being presented; hence authors employed Zigbee devices and PIC18F4550 microcontrollers through IEEE802.15.4 and IEEE1451.2 standards in the system.

Khalid El Moutaouakil, Brahim Jabir, Noureddine Falih in their paper [14] "Digital Farming: A Survey on IoTbased Cattle Monitoring Systems and Dashboards" stated that IoT-based cattle monitoring systems enable remote health tracking, disease prediction, and location monitoring using advanced sensors, aiding in livestock management and prevention of theft.

The paper [10] proposes an IoT-based animal health monitoring system using Raspberry Pi to monitor parameters like body temperature, heart rate, and rumination pattern. This article [17], a framework incorporating Internet of Things technology and utilizing Blockchain technology to create a Smart Livestock Farming system (IoT-BC-SLF), allowing for a transparent and safe exchange between farmers.

In this paper [9], the authors explored the ways in which IoT can be implemented in livestock farming, including the use of sensor technology and automation, and also discussed the challenges that must be overcome in order to fully realize the potential of IoT in the livestock farming industry.

The paper [13], an IoT ecosystem-based architecture of a smart livestock farm that aims to help farmers improve their farm performance save a lot of waste, and prevent economic losses is presented. The IoT ecosystem-based architecture continuously monitors livestock health, performance, reproduction, feed, milking, and behavior, leading to improved farm performance and productivity.

3. PROPOSED METHOD

We have developed our IoT-based project to completely transform how farmers deal with their animals' health. This cutting-edge app surpasses conventional methods, giving a detailed solution that combines sophisticated sensing technology utilizing an adaptive mobile user interface. The goal is to provide farmers with a real-time understanding of primary specifications such as humidity, temperature, location, and other environmental factors that can detect stress, illness, or pain in animals early enough.

Making certain, the tool operates properly when safely secured onto a cow or bull, users activate the device as well as develop a link with the Android application via Bluetooth. In case of any deviations from normal values, the app gives an immediate alert notifying the person involved about possible future concerns. Moreover, the program goes further by providing suggestions thus improving how fast an individual responds to discrepancies.

Firebase serves as our database system enabling effective data management procedures for our project. It is a secure cloud-based scalable framework that ensures long lasting storage and access to huge amounts of information generated by temperature sensors and other activity-sensing devices. It also enables data collection, real-time monitoring, and control for various applications, emphasizing flexibility, ease of development, and security aspects encountered during these processes [28].

Additionally, the e-commerce application within the project enhances the animal health monitoring care aspect. The platform enables people to sell livestock among themselves making it an active marketplace. In instances of discrepancies in animal health and wellness, the application not only supplies possible services but also guides individuals to certain items offered in e-commerce, making a smooth and integrated approach to attending to the problems.

The paper [27] shows that the majority of farmers are Illiterate (28.7%) followed by Primary School, Middle School & High School all are (51.4%) or High Secondary (10.7%) and graduated are (5.3%) postgraduate (4%). With a variety of users in mind, the app integrates language features. Language switching is enabled for convenience and accessibility practices. This simple language change makes it possible for clients who have difficulties connecting with the application due to their native languages, making sure that everyone feels included.

This comprehensive system ultimately empowers people with real-time knowledge of animal health while at the same time providing an intuitive shopping platform to access related items by reducing livestock farmers' costs on animal healthcare. The language option also enhances customer experience thus making the entire system usable to different types of audiences based on their abilities and preferences. As a result, our project's multifaceted approach underscores its being human-centered and promotes effective caretaking through alternative solutions.

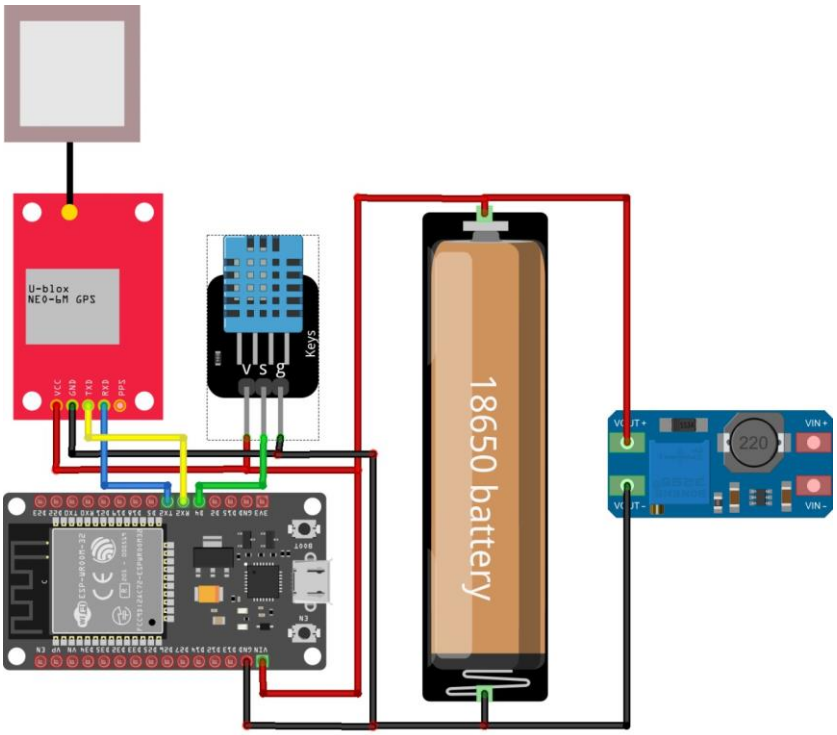

Fig -1: Device Circuit Diagram (The diagram shows the connection between the ESP32 microcontroller, GPS Module, Temperature and Humidity Sensor, Battery, and Power Supply Module)

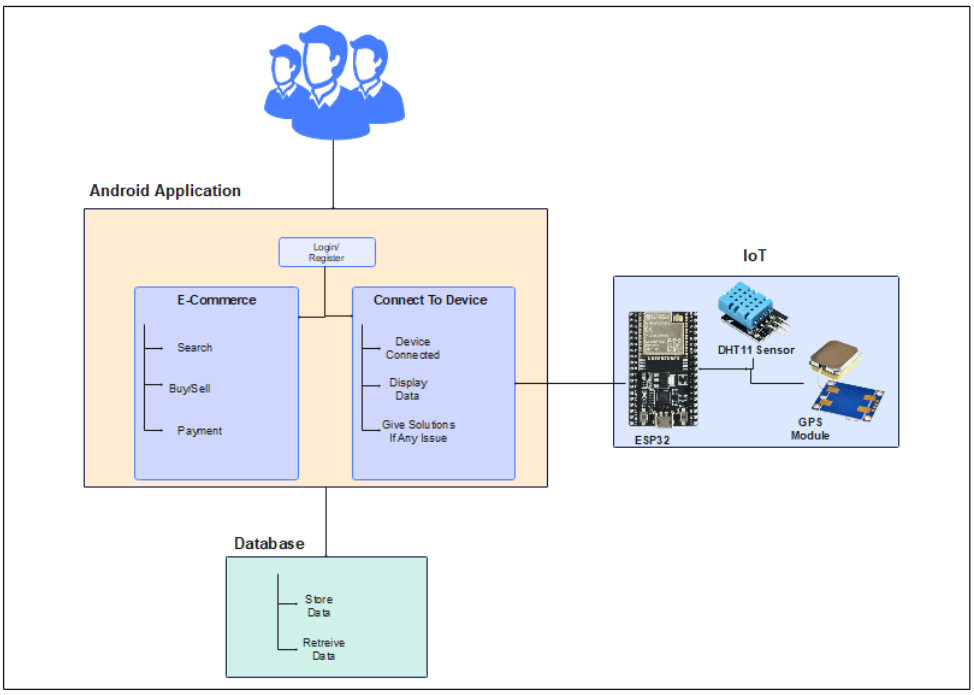

Fig -2: Architecture Diagram

4. IMPLEMENTATION

The execution of an innovative solution includes a meticulously orchestrated procedure that flawlessly integrates hardware and software application parts. At the core of this system is the use of an ESP32 Microcontroller, which interfaces with a selection of sensors for getting important information. These sensing units are tactically positioned to find vital physical properties consisting of humidity, temperature level, and location, developing a structure for detailed animal wellness surveillance.

The second stage focuses on the software development coupled with the sensing unit. Arduino IDE functions as the programming environment for the ESP32 Microcontroller, making sure the implementation of reliable code. NPM scripts are created by making use of Node Package Manager to handle dependencies, while Firebase NPM collection promotes the deployment as well as communication with Firebase solutions. Concurrently, a vital element includes developing robust interaction between the ESP32 Microcontroller and all the sensors, making sure of real-time information acquisition. Accuracy is vital, and with thorough coding, it is assured that we receive exact readings from the sensors.

Coming to the mobile application growth, Android Studio is utilized to produce a cross-platform application. Android Studio is crucial in developing Android applications, as it eases the interface for app creation, file management, and access to the Android SDK [3]. This application works as a customer interface and develops a Bluetooth link with the equipment. The interface is diligently made utilizing Android Studio, where essential details such as humidity, temperature level, and location are represented smoothly. An added function consists of a language component within the UI, improving accessibility for customers who favor various languages.

Detecting the real-time anomaly is the fourth important phase that involves algorithms identifying deviations from usual values. A notification system exists to promptly notify users about any abnormalities thereby giving them valuable insights into possible issues. In addition, an element that provides solutions has been embedded within the application to assist people solve real-time diagnostic problems. The use of Firebase Firestore as the database system guarantees reliable information tracking and offers secure storage space with access to data on animal health and other aspects as well.

The final stage includes cloud-based deployment, e-commerce integration, multilingual assistance, and overall system communication. At the same time, Git acts as the version control tool, taking care of the codebase on GitHub. Git is a version control system that serves as a backup, maintains file history, and integrates with CI systems for automated testing and deployment, as outlined in the paper [21]. In conclusion, the implementation of our IoT-Driven Livestock Health Monitoring

solution showcases a comprehensive and innovative approach to revolutionizing the management of animal well-being. The merging of ESP32, Android Studio, Firebase, as well as Git, specifies the technical foundation of this advanced effort.

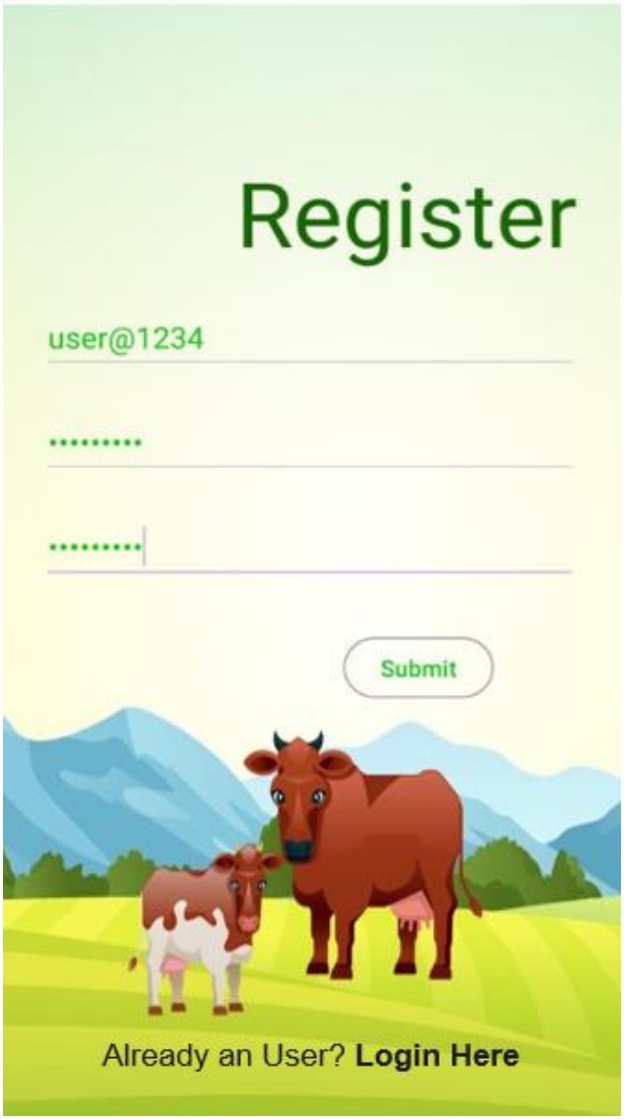

Fig -3: Registration Page of the application, where the user can register a new account.

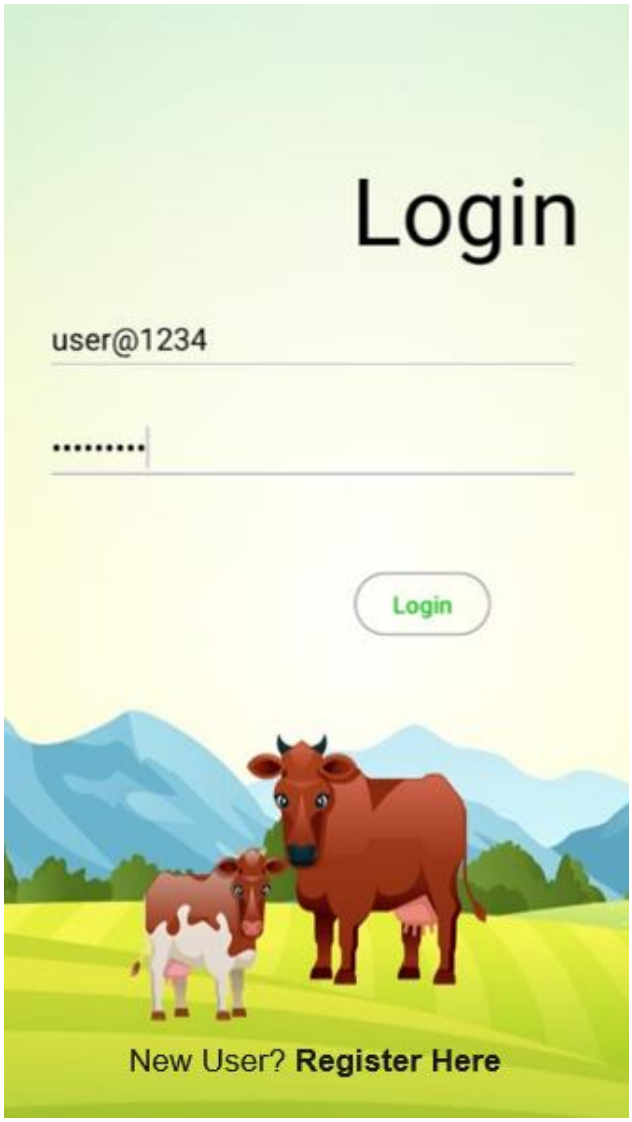

Fig -4: Login Page of the application, where theuser can log in to their account.

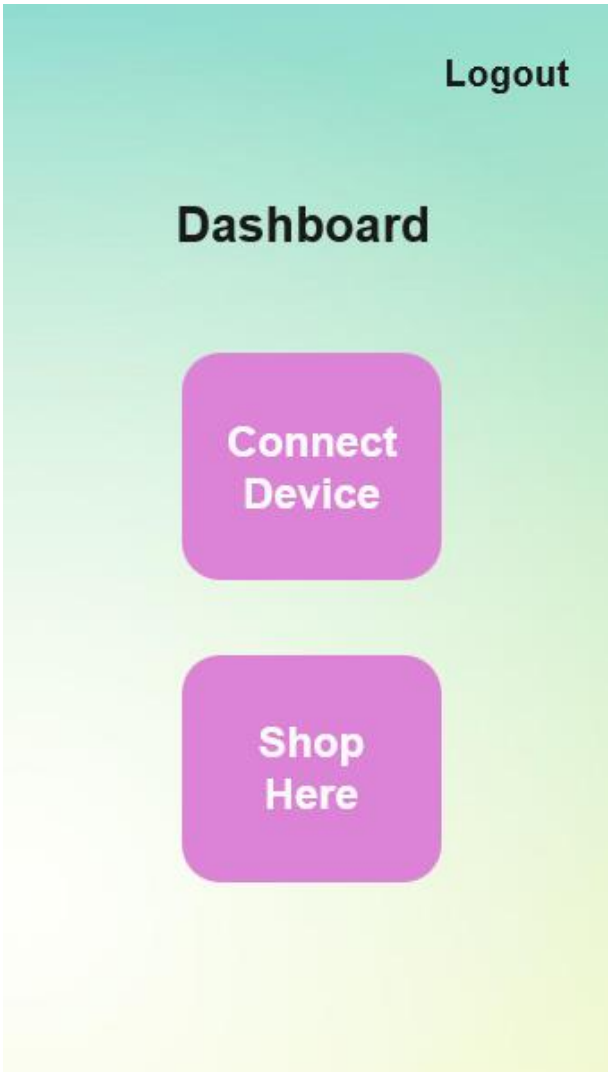

Fig -5: Dashboard Page of the application, either connect to the IoT device or shop anything related to livestock.

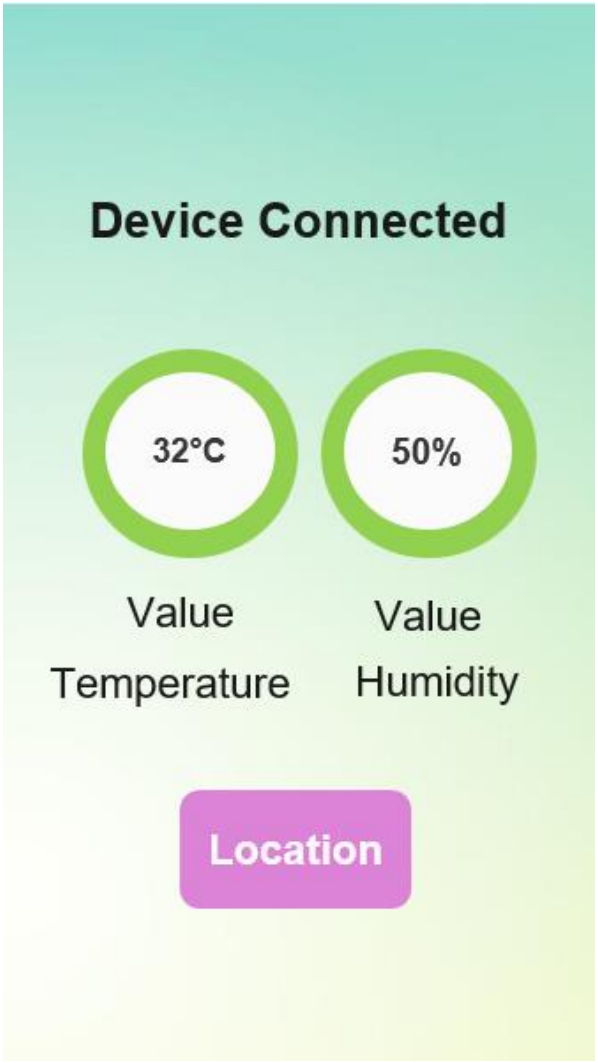

Fig -6: This Page of the application displays the temperature, humidity, and location by connecting to the device

5. CONCLUSIONS

Our project represents a major step in the world of modern farming techniques. It unites advanced sensor technology and flexible mobile applications to address the limitations of traditional techniques and provides alternative remedies for the efficient management of livestock. Integrating temperature with various sensors makes it possible to track important parameters constantly, which facilitates farmers' understanding of real-time livestock well-being. This proactive approach allows early discovery of possible health issues, promoting a responsive and informed farming atmosphere. The project becomes more effective with a combination of ESP32 and Firebase technologies.

The use of ESP32, reduces cost, as it is a low-power system-on-chip microcontroller, and helps develop IoT prototypes hassle-free [6]. With its flexibility, ESP32 can easily connect diverse sensor devices to ensure accurate and instantaneous data acquisition. On the other hand, Firebase acts as a powerful cloud-based database system to guarantee secure and scalable storage space for large amounts of information produced by the system. Therefore, it is not only technical symbiosis that enhances the reliability of the livestock disease prevention tool but also simplifies the process of data monitoring strengthening the overall efficiency of the entire system.

Accessing vital information becomes easy through offering a user-friendly interface supported by a smooth Bluetooth connection by which this project makes everybody using simple systems capable of improving their own lives. Combining such

access with innovative capacities inherent in this approach defines it as a reasonable and effective way to increase farm yields while maintaining sustainability in the agriculture sector. In summary, the livestock health management project signifies a new era heralded by creative integration between technology and agriculture where animal welfare is guaranteed at all costs.

REFERENCES

[1] A. Kumar and G.P. Hancke; "A Zigbee-Based Animal Health Monitoring System", IEEE Sensors Journal

[2] Advancements in sensor technology and decision support intelligent tools to assist smart livestock farming. Luis O. Tedeschi, Paul L. Greenwood, and Ilan Halachmi. Journal of Animal Science

[3] bin Uzayr, S. (Ed.). (2022). Mastering Android Studio: A Beginner's Guide (1st ed.). https://doi.org/10.1201/9781003229070 CRC Press.

[4] Bin Zhou, Chao Hu, HaiBin Wang and Ruiwen Guo; "A of IoT in agriculture for the implementation of smart livestock pervasive medical supervision system based on wireless sensor networks", ICIT 2007

[5] Dairy Farm House Monitoring based on IoT Technology. T Krishnakaarthik, M Abirami Sundari, R Ajeeth, K Nandhini. IJERT

[6] Darko Hercog, Tone Lerher, Mitja Trunti, and Oto Težak; "Design and Implementation of ESP32-Based IoT Devices", MDPI

[7] Department of Animal Husbandry and Dairying (DAHD). Annual Report 2019-2020. New Delhi: Ministry of Fisheries, Animal Husbandry and Dairying; 2020

[8] Hande Alemdar and Cem Ersoy; "Wireless sensor networks for healthcare: A survey", Computer Networks 2010

[9] Internet of Things in Livestock Farming: Implementation and Challenges doi: 10.21203/rs.3.rs-2559126/v1 (2023).

[10] IoT-Based Animal Health Monitoring System using Raspberry Pi. International Journal of Advanced Research in Science, Communication and Technology (2023), 300-307. doi: 10.48175/ijarsct-9509

[11] IoT Technologies for Livestock Management: A Review of Present Status, Opportunities, and Future Trends. Bernard Ijesunor Akhigbe, Kamran Munir, Olugbenga Akinad. MDPI

[12] Jianhua Zhang, Fantao Kong, Zhifen Zhai, Shuqing Han, Jianzhai Wu, and Mengshuai Zhu. Design and Development of IoT Monitoring Equipment for Open Livestock Environment. IJSSST

[13] Jual, Keranda, Kota, Bengkulu. (2023). An IoT Ecosystem-Based Architecture of a Smart Livestock Farm. 283-293. doi: 10.1007/978-3-031-29313-9_25

[14] Khalid, El, Moutaouakil., Brahim, Jabir., Noureddine, Falih. (2023). Digital Farming: A Survey on IoT-based Cattle Monitoring Systems and Dashboards. AGRIS online Papers in Economics and Informatics, 15(2):31-39. doi: 10.7160/aol.2022.150203

[15] Lim Teck Beng, Poh Boon Kiat, Lee Ngai Meng and Phoa Ngee Cheng; "Field Testing of IoT Devices for Livestock Monitoring using Wireless Sensor Network, Near Field Communication and Wireless Power Transfer", IEEE 2016

[16] Liwu Pan, Mingzhe Xu, Lei Xi and Yudong Hao. Research of Livestock Farming IoT System Based on RESTful Web Services. IEEE

[17] Mohammed, Adulrahaman, Alshehri. (2023). Blockchain-assisted internet of things framework in smart livestock farming. Internet of things, 22:100739-100739. doi: 10.1016/j.iot.2023.100739

[18] Muhammad Irfan Said, "The Role of the Livestock Farming Industry in Supporting the Global Agricultural Industry", IntechOpen 14 June 2021

[19] Muhammad Shoaib Farooq Adnan Abid, environment", IEEE Access 2022

[20] Nihal Kularatna, B. H. Sudantha; "An Environmental Air Pollution Monitoring System Based on the IEEE 1451 Standard for Low Cost Requirements", IEEE Sensors Journal 2008

[21] SAP, Certified, Application, Associate, -, SAP, HCM, with, ERP, 6.0, EHP7. (2023). Git and Subversion. 27-42. doi: 10.1007/978-1-4842-8214-4_4

[22] S. M. Riazul Islam, Daehan Kwak, Md. Humaun Kabir, Mahmud Hossain, And Kyung-Sup Kwak; "The Internet of Things for Health Care: A Comprehensive Survey", IEEE Access 2015

[23] Sarah Morrone, Corrado Dimauro, and Filippo Gambella. Industry 4.0 and Precision Livestock Farming (PLF): An Up to-Date Overview across Animal Productions. MDPI

[24] Seng-Kyoun Jo Dae-Heon Park Hyeon Park Se-Han Kim; "Feasibility Study on Smart Livestock Farms Utilizing Digital Twin", ICTC 2018

[25] T. Vigneswari, N. Kalaiselvi, K. Mathumitha, Amara Niveditha, and Adhithi Sowmiya. Smart IoT Cloud-Based Livestock Monitoring System: A Survey. Turkish Journal of Computer and Mathematics Education.

[26] Teck Beng Lim, Ngai Meng Lee, and Boon Kiat Poh; "Feasibility Study on Ambient RF Energy Harvesting for Wireless Sensor Network", IEEE 2013

[27] Vishal Thakur; "Literacy of Farmers and Its Impact on The Income of The Farmers", IRJMET 2024

[28] Wu-Jeng Li, Chiaming Yen, You-Sheng Lin, Shu Chu Tung, and ShihMiao Huang; "JustIoT Internet of Things based on the Firebase Real-time Database", IEEE 2018