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AI-Powered IoT System for Early Detection and Monitoring of Livestock Health

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Abstract

Protection of food production exists through livestock farming operations that advance economic global power. Continuous challenges to agricultural industry practices result in harmed animal health and enable disease spread as well as environmental threats to their welfare. Implementing current innovative solutions right away is necessary to solve these problems. The artificial intelligence (AI) and internet of things (IoT)-based smart livestock health monitoring system functions as the fundamental development approach across this industry. The present integrated solution includes automatic high-tech indicator data collection that allows real-time observation which activates notifications for farmers and veterinarians. The combination of sensors provides better AI analytics and remote solution performance to instantly detect health conditions thereby enabling farmers to make better decisions. The new system raises the quality of life for livestock owners since it improves productivity levels together with environmental sustainability goals. The system demonstrates potential for higher resource efficiency because its configurable design and multi-farm scalability improve operational performance on farms. The inventive system drives livestock management methods toward superior levels and creates sustainable flexible operational systems for agricultural environments. The system enables farmers to keep their animals healthy by receiving immediate health data through real-time predictions that prevent animal-related risks.

Keywords: Livestock, health monitoring, internet of things (IoT) devices, cloud system, machine learning, real-time analysis

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INTRODUCTION

Animal husbandry includes the complete care and management of domesticated cattle along with pigs, chickens, and sheep that produce food and fibers and vital industrial materials for human use. The various operations of breeding and feeding and building and medical treatment help to develop better production levels and animal well-being and welfare under expert control. Dairy cattle receive the utmost attention in animal husbandry practices due to their critical position in the industry. The dairy industry takes the most proficient category of protein-providing livestock with great care due to strict requirements that guarantee product quality of milk and other dairy items. Regular examinations and proactive health protocols for cattle become essential since they include scheduled checkups together with scheduled vaccinations and precise dietary adjustments and prompt medical treatments

for evolving health problems. Future productivity of cattle depends on health monitoring which represents the fundamental way people protect their responsibilities towards the wellness of animals. Identifying health problems at the right time coupled with appropriate treatments serves two functions by reducing animal suffering while stopping diseases and parasites from entering the dairy operation's animal herd [1–5].

MATERIALS AND METHODS

This paper investigates research methods which include internet of things (IoT)-based approaches along with methods based only on machine learning (ML) and IoT approaches with ML components. Most research utilized IoT to measure mainly three parameters.

- Body temperature.
- Heart rate.
- The accelerometer sensor.

This IoT device enables valuable observations for our system by measuring heart rate and activity levels and heat stress along with tracking surrounding temperature and sleep patterns. The measurement of heat stress and sleep tracking capabilities led our team to develop the new feature for general cow health monitoring. Artificial intelligence (AI) uses real-time health status observation to notify users about health issues in their cattle through a new mobile application designed for dairy farm management.

Figure 1 illustrates IoT devices in the initial part when several monitoring elements include skin temperature alongside heart rate and accelerometer function as health trackers for cows.

- Heart rate.
- Activity level.
- Heat stress.
- Surrounding temperature.
- Sleep tracking.

Heart Beat Monitoring

The pulse sensor measures heart beats digitally through readings that present results as beats per minute (BPM).

Activity Level Monitoring

The sensor provides data output in “BPM” digital format. The “Y” and “Z” and “axis of MPU6050” produce digital data for monitoring activity level.

Heat Stress Monitoring

Heat stress readings provided by an MLX90614 sensor deliver digital data on a Celsius scale. Through its design the sensor measures environmental humidity surrounding the cattle.

Sleep Tracking and Monitoring

A pulse sensor is combined with the activity level monitor for sleep tracking.

Firebase Cloud and Mobile Apps

The second section on Figure 1 demonstrates that the end-user obtains access to data visualization through the mobile app which serves as a basic interface for IoT device interaction because mobile apps retrieve real-time data from the Firebase cloud. Java applications based on Firebase real-time databases give developers the tools to rapidly make and operate IoT applications that need immediate data synchronization.

Machine Learning

The third section in Figure 1 displays an ML segment focusing on “AI healthcare” which examines cattle’s overall health status alongside with “air healthcare” for predicting cattle’s overall health status.

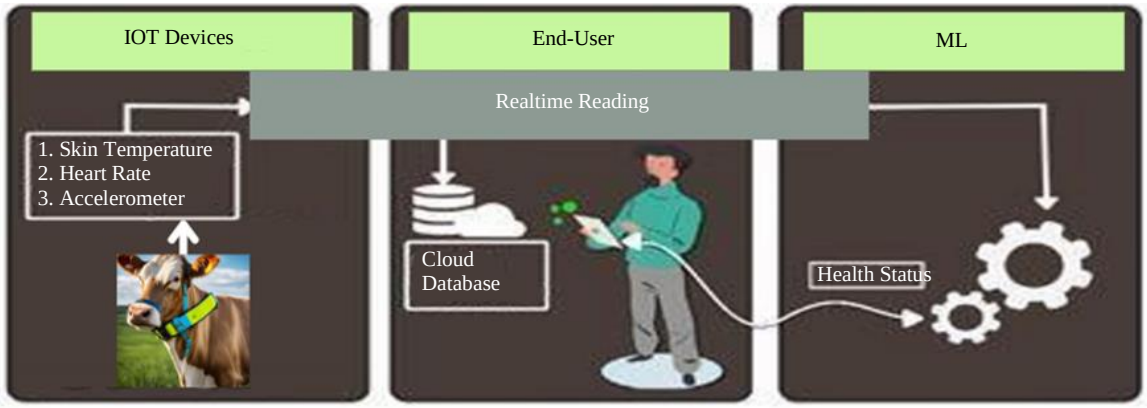

Figure 1. Intelligent systems using machine learning algorithms.

Table1. Activity status of monitoring and definition.

S.N.	Activity Monitoring Status	Definition
1	Getting up and standing	With their heads up or down, the cattle stand upright.
2	Lying on the floor	The cattle sit with their heads up or down on the surface.
3	Standing and pondering	The cattle ruminate with their heads up or down while standing on four feet.
4	Ruminating and lying	The cattle ruminate while sitting on the surface with their heads up or down.

Users can find the status information displayed through mobile application interface. Random forest serves as the algorithm to model the prediction of "air healthcare" that evaluates cattle overall health. Random forest serves as an ensemble learning method that unites a lot of decision trees to enhance both prediction accuracy along with generalization performance (Table 1).

LITERATUREREVIEW

Nootyaskool and Ounsrimung [6] explore how AI algorithms can be applied to analyze sensor data and identify patterns that indicate emerging health issues. This approach offers a powerful tool for early disease detection, allowing farmers to take preventive measures before health problems become critical. The researchers highlighted the benefits of integrating AI with IoT data, as AI's predictive capabilities can enhance the accuracy of disease detection. AI systems can spot minute alterations in cattle behavior or health metrics by evaluating vast amounts of data, giving farmers important information. The researchers suggest that this approach can lead to improved livestock health and reduced veterinary costs by enabling early intervention and disease prevention.

Chatterjee et al.'s [7] framework integrates various IoT technologies such as sensors, wireless communication, and cloud-based data storage to create a real-time monitoring system for cattle health. Farmers can keep an eye on vital health indicators like temperature, heart rate, and activity levels thanks to Live Care's collection and analysis of data from numerous sensors. The system's real-time capabilities allow farmers to take immediate action when abnormalities are detected, reducing the risk of severe health issues or loss of livestock. Live Care also provides a user-friendly interface, enabling farmers to access data from their smartphones or other mobile devices, ensuring they can stay informed regardless of their location. This IoT framework is highly adaptable and can be tailored to different farm sizes and types, making it a versatile solution for smart agriculture. The researchers emphasize that this framework can contribute to improved animal welfare, reduced operational costs, and enhanced livestock productivity.

Chaudhry et al. [8] present an innovative approach using a network of IoT sensors to collect data on cattle behavior, health, and environmental conditions. The data is then processed through ML algorithms to detect irregularities and predict potential health issues. The system is designed to learn from patterns and adapt to changing conditions, making it more effective at identifying early signs of

disease or distress. By implementing this system, farmers can receive alerts and insights that help them take proactive measures to prevent disease outbreaks and other health-related problems.

This device incorporates various sensors to collect data on cattle activity, environmental conditions, and other health-related parameters. Giving farmers a thorough understanding of the cattle's health and behavior will enable them to spot irregularities and take the necessary measures. The sensors measure temperature, humidity, and activity levels, providing insights into the cattle's comfort and well-being. Wireless transmission of the data gathered by "Monitor" to a central system allows for analysis and storage for later use. This real-time monitoring feature lowers the chance of serious health problems by allowing farmers to react promptly to any indications of distress or disease.

Cho [9] has designed a system to improve the efficiency and accuracy of cattle management by leveraging IoT technology to collect and analyze data on cattle health and behavior. The system in corporate various sensors to monitor vital health parameters, activity levels, and environment. The collected data is transmitted wirelessly to a central system, where it is processed and analyzed to detect potential health issues. Cho's design emphasizes scalability, allowing the system to be implemented in various farm environments, The study also explores the challenges involved in designing IoT-based systems for cattle management, such as connectivity issues and data security. To address these challenges, the system uses robust communication protocols and encryption to ensure data integrity and privacy. Additionally, the system is designed with user- friendly interfaces, enabling farmers to interact with the system and access information with ease. By giving farmers the resources, they need to enhance the productivity and health of their animals, this all-encompassing approach to cattle management promotes more environmentally friendly farming methods.

Darvesh et al. [10] have designed a system to collect a range of health data from cattle, such as body temperature, activity levels, and other physiological parameters, using IoT-based sensors. AI algorithms are then used to process this data to find trends and identify any abnormalities that might point to health issues. The system's AI component enables it to learn from the data and improve its accuracy over time, making it more effective at predicting potential health risks. The system emphasizes the importance of user-friendly interfaces, providing farmers with easy access to real-time data on health. This feature allows farmers to make informed decisions quickly and take preventive measures when necessary. To provide a more thorough approach to live animal management, the system can also relate to other farm management software. The researchers suggest that this integrated system can help reduce disease outbreaks and livestock productivity by allowing for early detection.

BLOCK DIAGRAM

This system functions as a cohesive unit. Vital health information is gathered via sensors mounted on farm equipment and animals. Nearby smart devices swiftly process and monitor the data after it is wirelessly transmitted to them over fast networks like 5G (and soon 6G). The data then goes to cloud storage, which functions similarly to a large online information center. There, sophisticated programs evaluate the data, make informed judgments, and maintain organization. Public, private, and hybrid cloud types all contribute to the system's continued flexibility and effectiveness. This configuration facilitates real-time animal health monitoring and prompt, well-informed intervention as necessary. The system architecture is shown in Figure 2.

RESULTS

These smart collars were tested on dairy cattle in multiple cow sheds in Coimbatore (Figures 3 and 4). Prediction of health on *Pashu* collar front end view is shown in Figure 5.

DISCUSSION

Research results demonstrate general health surveillance as a feasible approach to resolving body temperature problems. During health checks of cattle, the MLX90614 sensor fails to properly measure their body temperature because of their thick skin.

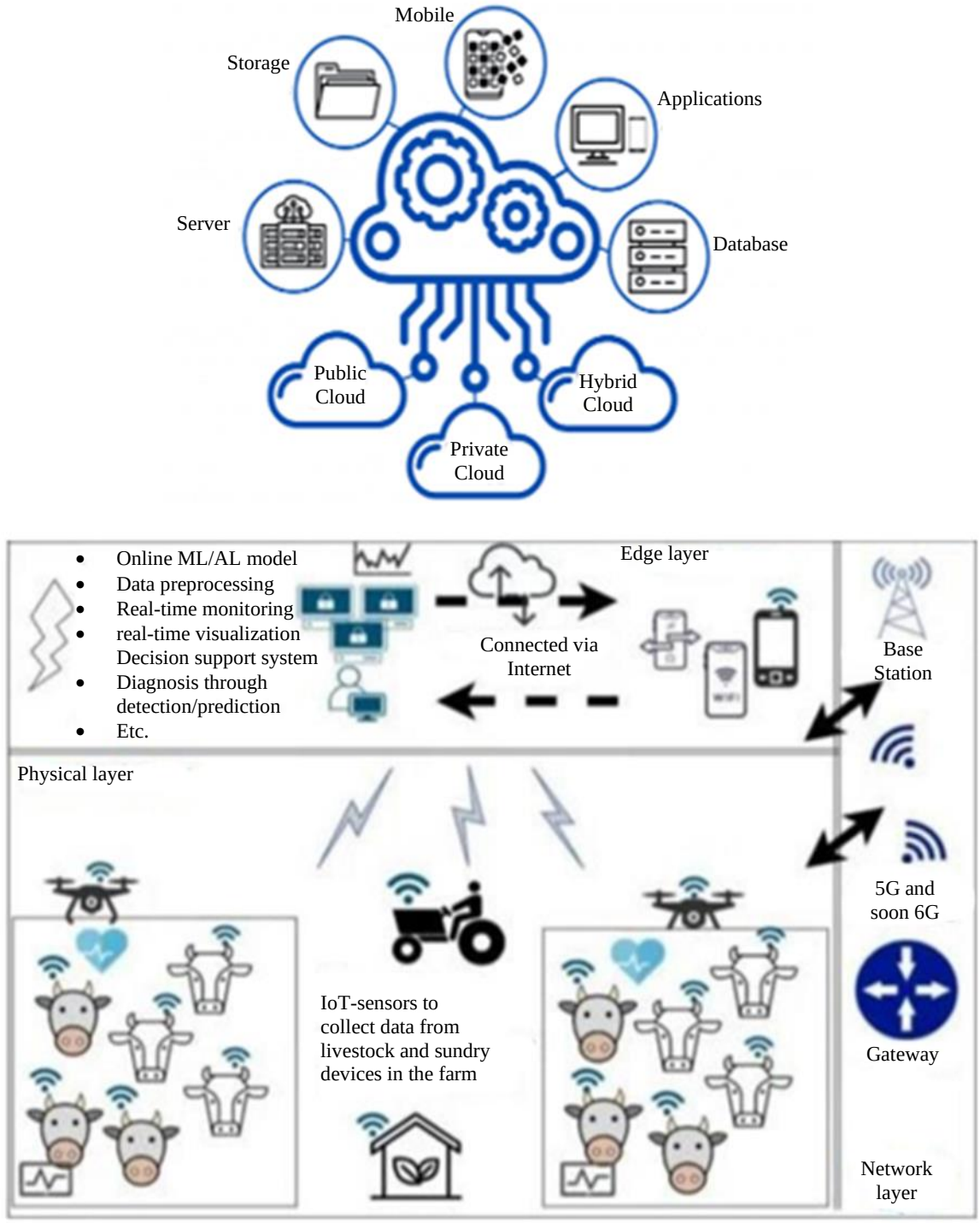

Figure 2. System architecture.

Our test results enabled us to read upper skin temperature accurately therefore we decided to convert body temperature into skin temperature measurements to detect heat stress in cattle. Heat stress occurs when animals experience physical problems because of relative humidity along with solar radiation and air movement and precipitation.

Figures 6 and 7 demonstrate that this research employs ambient temperature along with relative humidity which dairy producers can access regularly to detect various heat stress levels in dairy cattle from mild heat stress (temperature-humidity index [THI] 72–78) to moderate heat stress (THI 79–89)

and severe heat stress (THI > 89). Additionally, our results indicate pulse rate (in BPM) and activity status function to analyze sleep patterns.

Figure 3. The collar with reflective belt.

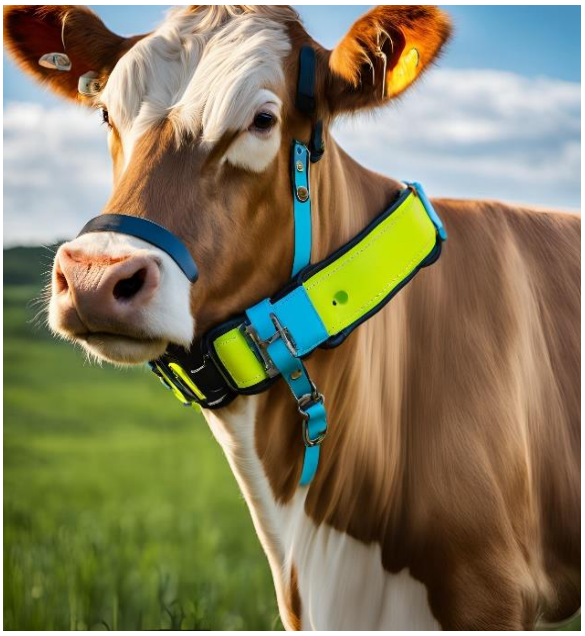

Figure 4. Experiments on cow ready for testing.

Figure 5. Prediction of health on *Pashu* collar (front-end).

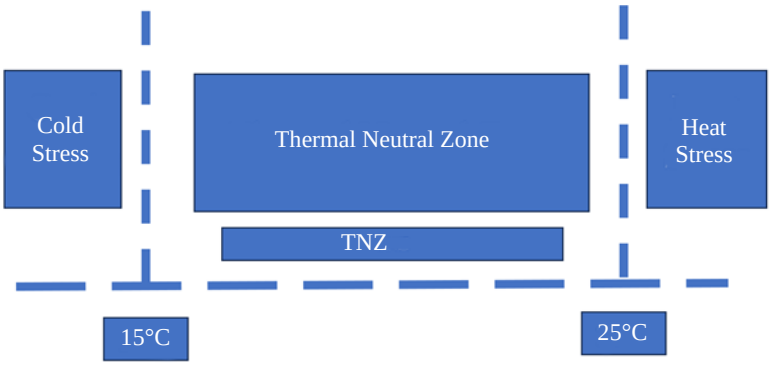

Figure 6. Thermal neutral zone (TNZ) of a lactating dairy cow (modified from C.A.Becker 2002).

TC	Humidity																				
	0	5	10	15	20	25	30	55	40	45	50	55	60	65	70	75	80	85	90	95	100
23														72	72	73	73	74	74	75	75
26							72	72	73	73	74	74	75	76	76	77	78	78	79	79	80
29			72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84	85
32	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90
35	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
37	77	78	79	80	82	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99	
40	79	80	82	83	84	86	87	88	89	91	92	93	84	96	97						
43	81	83	84	86	87	89	90	91	93	94	96	97									
46	84	85	87	88	90	91	93	95	96	97											
48	88	88	89	91	93	94	96	98													

Figure 7. Temperature humidity index (THI) for dairy cows.

CONCLUSION

The shortage of time available to staff on large farms makes physical health checks difficult, thus we have developed a general health monitoring system. As a result, we understand that animal husbandry manages cattle health through automated systems. This paper presents techniques which enable real-time observation of general health conditions in cows. A successful and reliable test occurred with this system when implemented on dairy cattle. The system succeeds as an affordable solution because its electronic components are inexpensive. The system demonstrates the ability to monitor cows through their overall health effectively.

REFERENCES

1. Cho Y, Kim J. AI-based intelligent monitoring system for estrus prediction in the livestock industry. Appl Sci. 2023; 13 (4): 2442.
2. Periyanayagi S, Priya GG, Chandrasekar T, Sumathy V, Raja SP. Artificial intelligence and IoT-based biomedical sensors for intelligent cattle husbandry systems. Int J Wavelets Multiresolution Inform Process. 2022; 20 (6): 2250026.
3. Singh A, Jadoun YS, Brar PS, Kour G. Smart technologies in livestock farming. In: Sehgal S, Singh B, Sharma V, editors. Smart and Sustainable Food Technologies. Singapore: Springer Nature; 2022. pp. 25–57.
4. Gupta S, Nirmala TV, Reddy AD, Kumar D. Smart Livestock Farming: Monitoring and Health Management through IoT. In: Gupta S, Hasan W, Singh S, Kumar D, Ansari MJ, Nisar S, editors. Agriculture 4.0. London, UK: 2024; pp. 202–223.

5. Unold O, Nikodem M, Piasecki M, Szyc K, Maciejewski H, Bawiec M, Dobrowolski P, Zdunek M. IoT-based cow health monitoring system. In: Krzhizhanovskaya VV, Závodszky G, Lees MH, Dongarra JJ, Sloot PMA, Brissos S, Teixeira J, editors. Proceedings of the International Conference on Computational Science. Cham, Switzerland: Springer International Publishing; 2020. pp. 344–356.
6. Nootyaskool S, Ounsrimung P. Smart collar design to predict cow behavior. In: 2020 17th International Joint Conference on Computer Science and Software Engineering (JCSSE), Bangkok, Thailand, November 4–6, 2020. pp. 92–97.
7. Chatterjee PS, Ray NK, Mohanty SP. LiveCare: an IoT-based healthcare framework for livestock in smart agriculture. IEEE Trans Consumer Electron. 2021; 67 (4): 257–265.
8. Chaudhry AA, Mumtaz R, Zaidi SM, Tahir MA, School SH. Internet of things (IoT) and machine learning (ML) enabled livestock monitoring. In: 2020 IEEE 17th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), Charlotte, NC, USA, December 14–16, 2020. pp. 151–155.
9. Cho BH. Analysis and design of cattle management system based on IoT. J Inst Internet Broadcast Commun. 2021; 21 (2): 125–130.
10. Darvesh K, Khande N, Avhad S, Khemchandani M. IOT and AI based smart cattle health monitoring. J Anim Sci. 2023; 14: 211–218.

