PetSync: An IoT-Enabled Smart Neck Belt for Pet Health Care and Activity Tracking

***Abstract*—The increasing global adoption of pets has increased the demand for advanced and accessible pet healthcare solutions. Routine vet check-up is essential but does not check early signs of illness. The Internet of Things (IoT) facilitates real-time monitoring of pet health by identifying health issues promptly and maintaining overall well-being. This research will introduce an IoT-enabled smart neck belt for pets like dogs and cats to continuously monitor important health parameters and very paw-some activities that will help take suitable decisions about the health of pets. The Accelerometer and Gyroscope sensor helps to measure the heart rate, movement and acceleration of the pets and the body temperature sensor will monitor the body temperature of pet without direct contact. The GSM and GPS module enables real-time location tracking by retrieving GPS coordinates and transmitting them over the 2G or 3G mobile network. The ESP32 collects data from sensors and sends it wirelessly to the cloud using GSM, making the information accessible via a mobile application. Ubidots display information about the health of pets and activity and alerts if there is something out of the ordinary. The addition of real-time alerts will allow for medical attention when needed, preventing serious issues. The system can also track the location of pets which prevents them from getting lost. By merging all these features in one solution, this proposed model will be a great initiative in the field of pet healthcare and enable pet owners to keep their pets secure and healthy.**

***Index Terms*—IoT, ESP32, Pet Healthcare, Neck Belt, Global Adaptation.**

I. Introduction

The rise in pet ownership globally has led to a greater demand for sophisticated options for pet healthcare and safety. Although taking pets to the veterinarian regularly is important, they often do not detect early signs of illness or monitor the health continuously. Due to this, pet owners are deprived of real-time insights into the health of pets and any issues waiting till it is too late. The introduction of Internet of Things (IoT) technology revolutionizes various industries and pet care is no exception. The monitoring of pet activity and location in real-time thanks to IoT. This technology is not only useful for diagnosing any health issues in pets at an early stage but also keeps pets safe and secure outdoors with it. The proposed system, as depicted in Fig. 1, designs and develops an IoT-based smart neck belt for pets, which combines health tracking and activity sensing all in one neck belt. The neck belt has been equipped with sensors that measure the essential health parameters of the body such as heart rate, body temperature, movement and all other essential parameters. The neck belt GPS module is also equipped for tracking the real-time location of a person. Data that is collected by the sensors is processed by an ESP32 microcontroller which then wirelessly transmits the data using GSM to a cloud server that is visualized using the Ubidots dashboard. This system is meant for pet owners to better understand pets and get alerted in real-time when their health metrics exceed limits. This smart neck belt helps not just in improving the overall health care of pets but also enhances their security. By making use of IoT, cloud computing and mobile technology enables the smart pet health care system which is one of most efficient ways to care, monitor and track the health of pet other than the traditional methods. The smart neck belt can be very useful for dogs walking business and also an ideal tool for owners who are already actively training and monitoring their pets.

II. Related Work

In recent times, the development of IoT-based pet monitoring systems has witnessed substantial growth, enhancing the safety and health monitoring of pets. Islam et al. built a prototype named ‘PawsTrack’, which combines GPS tracking with environmental monitoring using an ESP32 microcontroller [3]. However, it does not include sensors for monitoring vital health indicators such as heart rate and movement or activity level, which are crucial for comprehensive pet health assessment. Sharma et al. created systems focused mainly on tracking location using GPS and GSM modules [9]. The movement updates were basic, and the devices did not collect health-related data. Tangsripairoj et al. developed Bokk Meow, an application that helps users monitor their pets and reminds them about pet care; however, it was limited to location services and general pet management only [10]. Dombale et al. suggested a collar with heart rate sensors for health monitoring and tracking of vaccinations [2]. Nimonkar et al. proposed a solution, “Pawprints”, which tracks temperature and pulse rate in real-time and makes the health data accessible through a mobile application [5]. Other researchers expanded functionality using new technologies. Xu et al. developed a system integrating various sensors into a cloud system for live alerts of pet vitals, though it was difficult to implement and costly [11]. Aqraldo et al. created an app called DetePet that allows activity alerts and location sharing but does not handle biometric data [1]. Reyu et al. developed a pet health monitoring system for sick pets, which faced increased challenges with power consumption [7]. Even though substantial progress has been made, most existing systems can only handle either tracking or health monitoring. The smart belt proposed in this work aims to fill these voids with a comprehensive solution that is sustainable and offers pet tracking, health monitoring, and more in real-time.

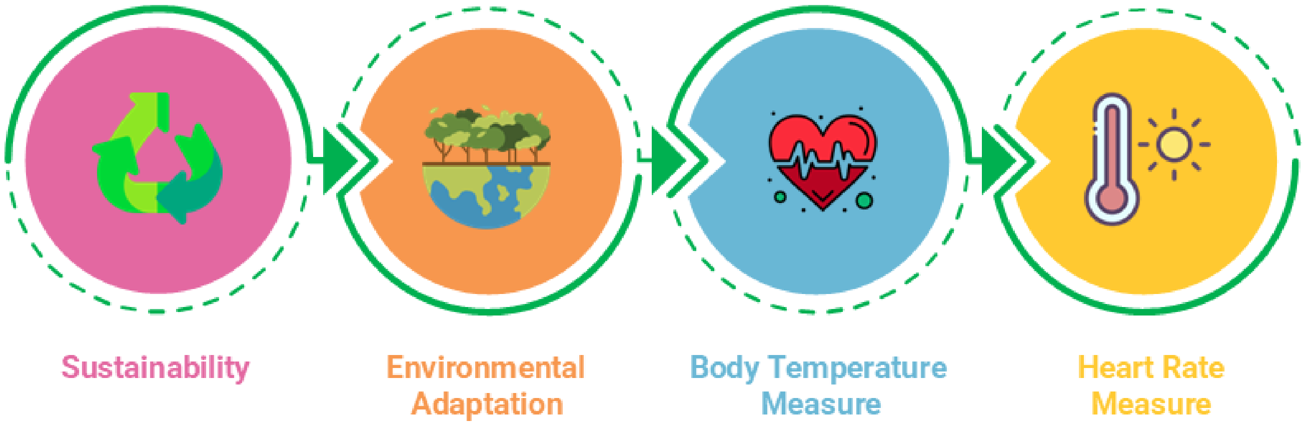

Fig. 1. Features of The Proposed Model

III. Methodology & Workflow of The Proposed System

The methodology outlines the design and implementation of the proposed IoT-smart neck belt for pet health care system, which integrates environmental monitoring, intelligent processing, and user interaction to enhance sustainability and energy efficiency.

A. System Architecture of The Proposed Model

The proposed model of the IoT-enabled smart neck belt, as depicted in Fig. 2, is designed to provide continuous, secure and sustainable pet health monitoring and activity tracking. The smart neck belt combines a heart rate sensor and a non-contact temperature sensor to collect real-time statistical data on critical health parameters and pet movements. Additionally, the integrated GPS tracking system ensures pets do not get lost by providing continuous location updates to the owner. These sensors are connected to an ESP32 microcontroller, which executes edge-level preprocessing of the collected data to reduce transmission payload and conserve energy. For power efficiency like Redwan et al. the system is equipped with a rechargeable lithium-polymer (Li-Po) battery that is charged via a solar panel, enabling sustainable and uninterrupted operation without dependence on disposable batteries [6]. The collected data is encrypted using the AES-256 algorithm, which employs a symmetric 256-bit key to convert readable sensor data into a secure ciphertext format, ensuring that sensitive health information remains protected during transmission. For lower energy consumption, the system uses GSM for data transfer. After the data transmission process, the encrypted data is stored on a cloud server and visualized through a real-time monitoring dashboard named Ubidots [4]. The dashboard offers health insights and reading. If the data exceeds the threshold value, it sends a notification and real-time location to the user via SMS communication. With its combination of solar-powered operation, secure communication, efficient data handling and low-maintenance design, the system supports long-term deployment and promotes sustainable technology-driven pet healthcare.

B. Workflow of The Proposed System

The workflow of the system, as depicted in Fig. 3, begins with the system powering on and initializes the ESP32 microcontroller with the connected sensors. After activation, the system moves into the data collection phase. It receives real-time temperature and heart-rate data inputs from the sensors attached to the edge device. It also fetches real-time location from the GSM module. At the data processing phase, ESP32 processes data and compares them with the predefined thresholds value. It will continuously receive data until it exceeds the satisfactory threshold value. After processing if it receives any abnormal value, it sends a notification to the user via SMS protocol [8]. The SMS notify about the heart rate, body temperature and real-time location. Otherwise, the data is gone from an AES-256 encryption and sent to the Arduino cloud for further calculation. After uploading to the cloud, users can monitor real-time environmental conditions and sensor readings. These alerts are practical information upon which quick response can be taken in preventing any critical situation on pet health tracking. This data is locally processed on the underwater ESP32 edge device, where collected data is checked for quality and raw images are pre-processed for microplastic detection. The processed data is then sent to the floating device. Using AES-256 encryption, it is securely transmitted to the local server. The server receives, stores, and further processes the encrypted data. It is visualized on the Ubidots dashboard, showing trends, alerts, and real-time monitoring. Data transmission occurs via Wi-Fi or GSM (if Wi-Fi is unavailable). If abnormalities are detected, the user can manually control the device for a safe exit. The system also detects anomalies in real-time (e.g., excessive microplastics or abnormal sensor readings) and triggers proactive responses or alerts. When necessary, it can be directed to a pre-defined recovery point or restarted after fault detection. The robot continues to collect and send data until the battery is depleted.

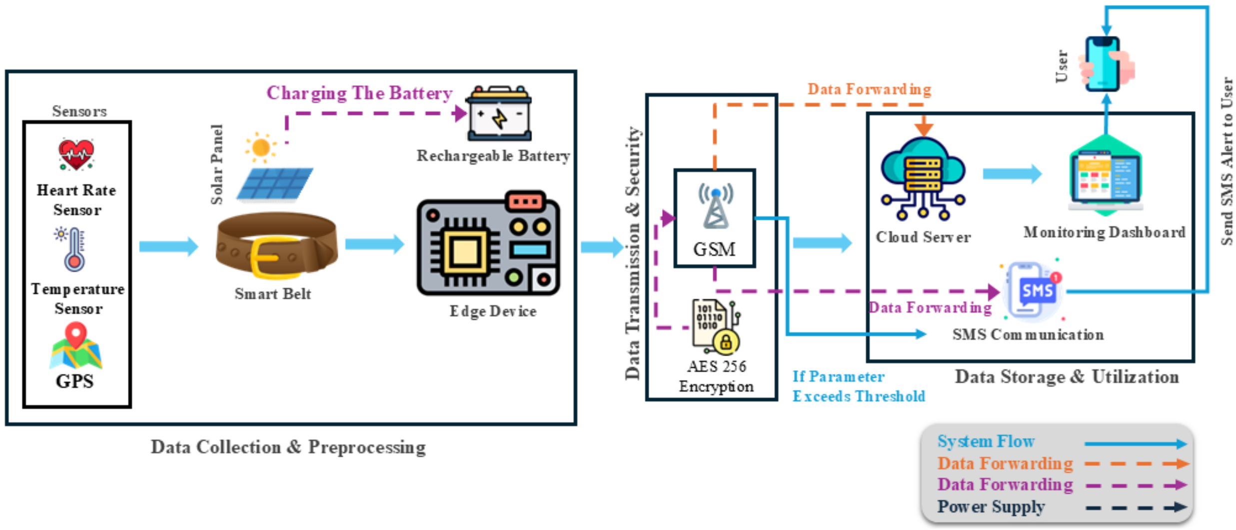

Fig. 2. System Architecture of The Proposed Model

Once the mission is complete, it can return home to recharge or continue monitoring.

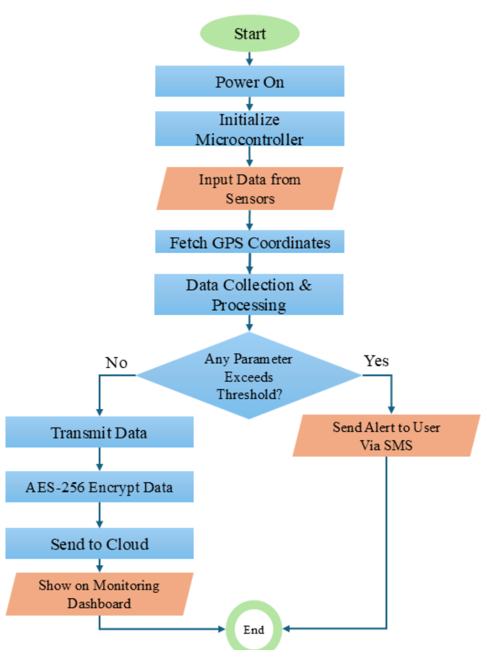

Fig. 3. Workflow of The Proposed Model

C. Simulated Hardware Implementation of The Proposed Model

The hardware simulation of the proposed system, as depicted in Fig. 4, integrates various components to ensure efficient and reliable operation. The ESP32 microcontroller serves as the core processing unit, handling data from sensors and executing commands. GSM with GPS module ensures data communication in areas and gives real-time location information. The power system, comprising solar panels and rechargeable DC battery provides a sustainable energy source, ensuring uninterrupted operation under various conditions. This cohesive integration of hardware components ensures the system's functionality, scalability and adaptability for the pet neck belt. Moreover, the inclusion of body temperature and heart rate sensor allows the system to respond dynamically to check the pet health in real time. Each hardware module is programmed to communicate over a unified control bus by improving synchronization and reducing latency.

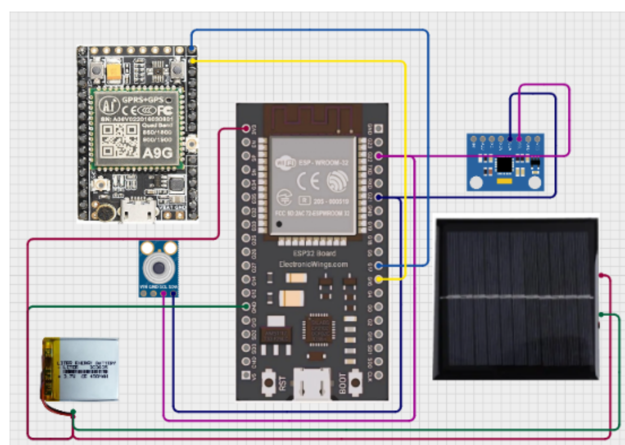

Fig. 4. Hardware Implementation of The Proposed Model

IV. Case Study and Discussion

Traditional pet care generally depends on routine veterinary visits and observational assessments by pet owners. While these methods offer basic health evaluations, but fail to detect early symptoms of illness, sudden health deterioration, or environmental threats in real time. Pets can become lost or encounter unsafe conditions without the owner's knowledge. These limitations emphasize the need for a more advanced, continuous, and automated pet monitoring system.

A. Proposed Solution

The proposed IoT-enabled smart neck belt for pet addresses the existing shortcomings of conventional pet care. The system integrates multiple sensors and modules into a wearable device to provide real-time monitoring of vital health metrics such as heart rate, body temperature and movement. The neck belt comprises a non-contact body temperature sensor and an accelerometer and gyroscopic data to detect movement and infer heart rate through micro-vibrations. A GSM with GPS module has been used for data transmission with real-time location sharing over mobile networks. The ESP32 has been used for edge processing and control. To ensure confidentiality, the data is encrypted with AES 256-bit encryption before it is sent to the cloud server using GSM. The notifications will be sent in real time if any parameter exceeds safe limits. SMS alerts are also sent so that even if the user does not have Internet, they receive notifications. The monitoring dashboard is an interface that allows a quick check-up on pet health and location. In addition, an entire system works by solar panel and rechargeable battery.

B. Key Insights of The Proposed Model

1) Real-Time Pet Health Monitoring: The smart neck belt allows for continuous tracking of physiological parameters such as heart rate and temperature. The inclusion of edge processing and cloud integration in a smart collar of pet allows for immediate detection of anomalies, such as fever or reduced movement. This helps pet owners to act right away. It avoids the risk and less need go too often to the vet.

2) Environmental and Situational Awareness: GPS tracking helps owners access precise, real-time location information, significantly lowering the risk of lost pets. The smart neck belt tracks change in activity level to detect environmental changes or patterns around the pet to predict stress, threat or illness.

3) Energy Efficiency and Sustainability: The presence of solar charging and a rechargeable battery ensures that the device keeps functioning with little human intervention. This is especially helpful in country areas or during outages of electrical energy supply to do charging.

C. Cost Analysis

TABLE I
COST ANALYSIS OF THE PROPOSED MODEL

Components	Units	Estimated Cost (USD)
ESP32 Microcontroller	1	$6.50
Heart Rate Sensor	1	$2.00
Body Temperature Sensor	1	$9.00
Rechargeable Battery (5V, 3Ah)	1	$21.00
Solar Panel (3W)	1	$1.50
GSM + GPS Module	1	$22.50
Mounting Accessories	1	$5.00
Total Estimated Cost		**$67.50**

A detailed cost analysis shown in Tab. I compares component expenses and installation costs against potential energy savings. The modularity of the design allows for easy maintenance and future scalability, reducing future costs and enhancing the system's longevity and return on investment.

V. RESULT & ANALYSIS

To validate the functionality of the proposed IoT-enabled smart neck belt, a hardware simulation has done in a real-world scenario. The system collected and transmitted data for key health parameters, activity and location. The following results were recorded and visualized on the monitoring dashboard.

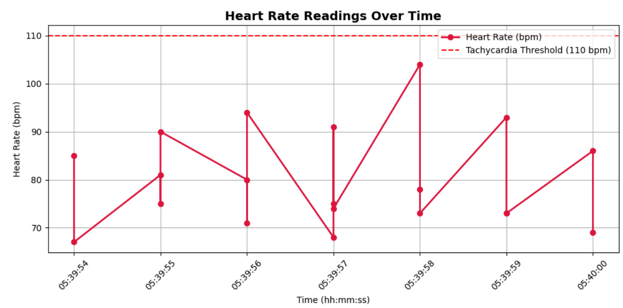

Fig. 5. Heart Rate Sensor Readings

As shown in Fig. 5 The heart rate of the pet was recorded 05:39:54 to 05:40:00. The readings fluctuate considerably between 67 bpm(low) and 104 bpm(high). The pet is resting and being active in a consistent manner which indicates a certain degree of variability. Most importantly, none of the recordings exceeded the "Tachycardia Threshold" of 110 bpm so the pet did not have an abnormally elevated heart rate during this time.

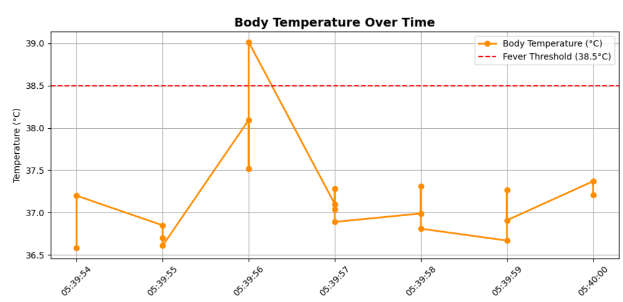

Fig. 6. Temparature Sensor Readings

Fig. 6 The non-contact sensor captured the temperature readings of the body. Fever Threshold is defined as 38.5°C. Throughout the duration of the study, the temperature of the pet animal was normal (between 36.5°C and 37.5°C). Nevertheless, at 05:39:56, a spike was detected at 39.0°C. As this reading was above the fever threshold and as per the workflow of the system (Fig. 2), the system would send an SMS alert to the owner immediately. This finding indicates that the system is successfully able to identify a fatal disease.

The accelerometer and gyroscope data are processed to determine the pet's motion state, as shown in Fig. 7. The system is designed to classify motion into "Normal," "Sudden Jerk," "Resting," or "Falling Detected." During the test period,

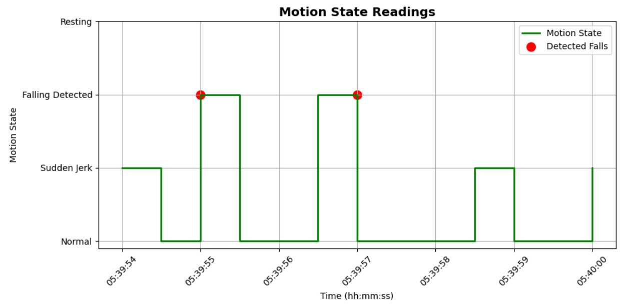

Fig. 7. Motion Sensor Readings

the pet's activity included "Sudden Jerk" and "Normal" states. Notably, the system registered a "Falling Detected" event at 05:39:55 and again at 05:39:57. These events signify high-impact movements that could be caused by a fall, a fight, or a seizure. The successful detection of these anomalies demonstrates the system's capability to alert the owner to potential physical trauma or distress, enabling a rapid response.

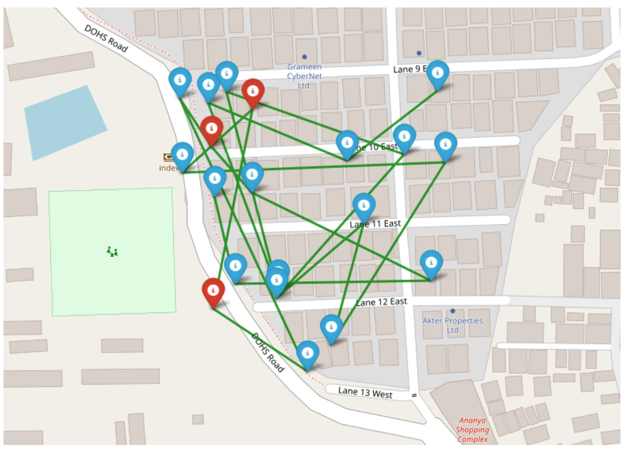

Fig. 8. GPS Locations

In Fig. 8 The map displays a series of location pins connected by green lines, representing the pet's movement path through a residential area. The path shows the pet moving along several streets, including "DOHS Road" and "Lane 11 East." The data points (blue and red pins) provide a clear and continuous track of the pet's whereabouts. This functionality is essential for the system's security aspect, allowing an owner to find a lost pet quickly. The red pins are used to highlight specific events or alerts, correlating with the health or motion anomalies detected at those locations.

Tab. II presents a comparative analysis of existing IoT-based pet health monitoring systems and the proposed Smart Neck Belt. The comparison focuses on key features including sensors, communication protocols, alert mechanisms, power sources, activity tracking, cloud integration, response time, and approximate cost.

The results show that the proposed Smart Neck Belt integrates multiple vital signs monitoring (heart rate and temperature) with motion and activity tracking, providing a more comprehensive health overview compared to existing devices. It combines GSM connectivity, cloud integration, and edge processing for real-time alerts via SMS and dashboard, achieving a faster simulated response time (1.5s) than the other devices. Additionally, the belt incorporates a hybrid solar and rechargeable battery system, offering improved energy efficiency while maintaining a competitive cost (67.50USD). Overall, the table highlights the enhanced functionality and practicality of the proposed system over current IoT pet monitoring solutions.

TABLE II
COMPARATIVE ANALYSIS OF PROPOSED SYSTEM

Features	**Pet Health Band (2023) [12]**	**Smart Pet Collar (2025) [13]**	**Proposed Smart Neck Belt**
Sensors	HR, Temp	HR, SpO_2, Temp, GPS	**HR, Temp, Motion, Activity, GPS**
Communication	Bluetooth	Wi-Fi + Cloud	**GSM + Cloud + MQTT**
Alert System	App Notification	Mobile App Alert	**GSM SMS + Dashboard**
Power Source	Rechargeable Battery	Rechargeable Battery	**Solar + Rechargeable Battery**
Activity Tracking	No	Yes	**Multi-Sensor**
Cloud Integration	Yes	Yes	**Edge + Cloud**
Avg. Response Time	3.0 s	2.5 s	**1.5 s (Simulated)**
Approx. Cost (USD)	80	85	**67.50**

VI. CONCLUSION

This research presents the IoT-enabled smart neck belt for pets that can monitor health and keep an eye on their activities. By integrating heart rate sensor, temperature sensor and GPS tracking system, the system allows people to take care of their pet. Pet owners can stay updated about the well-being of pet with these smart pet feeders. For the most part, this smart neck belt will help in improving pet care through technology as it will keep the pet safe and healthy. Further, cloud technology and solar power make the solution sustainable and easy to manage. Future improvements to the accuracy of the sensor, especially in indoor environments, are needed although the system is promising.

Possible future developments may involve the inclusion of Artificial Intelligence (AI) and Machine Learning (ML) models for the early detection of diseases using abnormal behavior detection and multiple parameter analysis. Predictive analytics can warn of negative health consequences before the onset of any symptoms. It will even enable image-based behavior analysis, fall detection or pet facial recognition for identification purposes by including a small camera module.

REFERENCES

[1] B. W. Aqraldo, Y. Jessen, Y. Sentoman, D. Markos, and H. L. H. S. Warnars, "Detepet mobile application for pet track-

ing," in *2021 International Conference on Emerging Smart Computing and Informatics (ESCI)*, Pune, India, pp. 48–52, 2021. doi: 10.1109/ESCI50559.2021.9397028.

[2] A. Dombale, Z. Jasdanwala, K. Vyas, Y. Niwshekar, V. Warghane, and P. Wagh, "Stray animal tracking, heart rate and vaccination status monitoring smart collar," in *2024 Second International Conference on Advances in Information Technology (ICAIT)*, Chikkamagaluru, Karnataka, India, pp. 1–6, 2024. doi: 10.1109/ICAIT61638.2024.10690779.

[3] S. Islam, A. K. M. Emran, S. Saleh, S. A. Aziz, K. Redwan, K. I. H. Turjo, M. Ahmed, and M. F. A. Al Sohan, "PawsTrack: An advanced IoT-driven solution for enhanced pet safety with environmental monitoring and smart connectivity," in *2nd International Conference on Next-Generation Computing, IoT and Machine Learning (NCIM 2025)*, Gazipur, Bangladesh, pp. 1–6, 2025.

[4] A. Nahar, M. F. A. Al Sohan, K. Redwan, and M. Ahmed, "Advanced IoT-Enabled Forest Management System for Wildfire Detection and Ecosystem Protection: A Case Study in the Sundarbans," in *2025 2nd International Conference on Advanced Innovations in Smart Cities (ICAISC)*, Jeddah, Saudi Arabia, pp. 1–6, 2025. doi: 10.1109/ICAISC64594.2025.10959377.

[5] H. Nimonkar, D. Adhiya, and P. Parmar, "Enhancing pet welfare: A user-centered method for GPS tracking and health tracking using Pawprints," in *2024 4th International Conference on Technological Advancements in Computational Sciences (ICTACS)*, Tashkent, Uzbekistan, pp. 1730–1734, 2024. doi: 10.1109/ICTACS62700.2024.10840599.

[6] K. Redwan, M. Ahmed, K. I. H. Turjo, M. M. Hossain Munna, S. S. Akter, and M. F. A. Al Sohan, "Smart IoT-Driven Shopping Assistance System for Cognitive Impairment Patients: Ensuring Safe and Independent Shopping Experiences," in *2024 10th International Conference on Computing, Engineering and Design (ICCED)*, Jeddah, Saudi Arabia, pp. 1–6, 2024. doi: 10.1109/ICCED64257.2024.10983645.

[7] S. N. W. Reyu and J. P. Princess, "IoT-based pet health monitoring system for sick pets," in *2024 3rd International Conference on Applied Artificial Intelligence and Computing (ICAAIC)*, Salem, India, pp. 1648–1652, 2024. doi: 10.1109/ICAAIC60222.2024.10574965.

[8] M. A. Sarker Emon, M. F. A. Al Sohan, M. M. Hossain Munna, M. Ahmed, and K. Redwan, "CityShield: An IoT-Driven and AI-Based Threat Detection System for Smart City Operations," in *2025 2nd International Conference on Advanced Innovations in Smart Cities (ICAISC)*, Jeddah, Saudi Arabia, pp. 1–6, 2025. doi: 10.1109/ICAISC64594.2025.10959442.

[9] S. Sharma, A. K. Aryal, A. Singh, S. K. Rauniyar, and B. Satpute, "Advanced GPS tracking system for pets," in *2024 International Conference on Smart Systems for Applications in Electrical Sciences (ICSSES)*, Tumakuru, India, pp. 1–6, 2024. doi: 10.1109/ICSSES62373.2024.10561354.

[10] S. Tangsripairoj, P. Kittirattanaviwat, K. Koophiran, and L. Raksaithong, "Bokk Meow: A mobile application for finding and tracking pets," in *2018 15th International Joint Conference on Computer Science and Software Engineering (JCSSE)*, Nakhonpathom, Thailand, pp. 1–6, 2018. doi: 10.1109/JCSSE.2018.8457351.

[11] Y. Xu, R. Wei, R. Mao, Z. Zheng, D. Nie, Z. Xu, and C. Tian, "Intelligent pet protection system based on IoT devices," in *2022 IEEE International Conference on Mechatronics and Automation (ICMA)*, Guilin, Guangxi, China, pp. 629–634, 2022. doi: 10.1109/ICMA54519.2022.9856199.

[12] L. B. Damahe, M. Tayade, N. Nandekar, S. Nathile, V. Jadhav, and A. Pathade, "Animal Health Monitoring Using Smart Wearable Device," in *Proc. 2nd Int. Conf. Signal and Data Processing (CSDP 2022)*, Lecture Notes in Electrical Engineering, vol. 1026, Springer, Singapore, pp. 497–507, 2023. doi: 10.1007/978-981-99-1410-4_41.

[13] M. Sugacini, V. Abinesh, A. Akkash, and S. S. AswinthKumar, "IoT-Enabled Smart Collar for Pet Animals," *Int. J. Innovative Science and Res. Technol. (IJISRT)*, vol. 10, no. 5, pp. 3947–3952, May 2025. doi: 10.38124/ijisrt/25may2186.