**AI-POWERED DERMATOLOGY ASSISTANT FOR CANINE**

**SKIN DISEASE IDENTIFICATION AND MONITORING USING IOT DEVICE**

Undergraduate Thesis

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Bachelor of Science in Computer Science

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**INTRODUCTION**

Canine skin diseases represent one of the most common health issues in veterinary medicine, affecting approximately 25-30% of all veterinary consultations. (P B Hill et al., 2006). The highest infection rate (38.95%) was observed in dogs aged ≥ 13 months. Females showed higher clinical signs (53.18%) than males (43.82%). Toy breeds were the most affected (38.58%), and 68.54% of the cases were unvaccinated.

Canine skin diseases are common health issues that affect dogs of all breeds and ages. However, many of these conditions can be easily overlooked or underestimated by pet owners because the symptoms may appear mild or be mistaken for normal skin changes. Despite their subtlety, untreated skin problems can cause significant discomfort, lead to secondary infections, and even indicate underlying systemic diseases. Recognizing and addressing these often unnoticed skin conditions early is essential to maintaining a dog’s overall health and well-being.

**Statement of the Problem**

Skin diseases are among the most common health issues experienced by dogs, yet many of these conditions remain untreated in their early stages due to lack of awareness among pet owners. Conditions such as seborrheic dermatitis, mild pyoderma, ringworm, and allergic dermatitis often begin with subtle symptoms like dry skin, mild itching, or slight discoloration—symptoms that are easily overlooked or mistaken for normal behavior or minor irritation. *How aware are pet owners of the early signs and symptoms of canine skin diseases?*

Unfortunately, when these early signs go unnoticed, the disease can progress, resulting in increased discomfort for the animal, higher veterinary costs, and in some cases, serious secondary infections. The gap between the occurrence of early, visible symptoms and the recognition or understanding of those symptoms by the average dog owner is a key contributing factor to delayed diagnosis and treatment. *How does relying solely on physical observation affect the accuracy of identifying skin conditions in dogs?*

Currently, most pet owners rely solely on physical observation or internet searches, which can lead to incorrect assumptions and even harmful self-treatment. Furthermore, not all owners have immediate access to veterinary professionals, making it even more crucial to equip them with basic knowledge and tools for early identification of common skin diseases. *How can a system help pet owners or pet shelters prevent the misidentification of skin diseases in animals?*

Theoretical Framework

The theoretical framework (shown in Figure 1) illustrates how users interact with the AI-powered canine dermatology diagnostic system. Three types of users operate within the system: pet owners who need skin condition identification for their dogs, shelter staff managing multiple animals, and veterinarians providing professional oversight. The platform consists of four integrated modules: Scanning and Data Collection, Diagnostic Analysis, Progress Tracking, and Access Management.

Pet owners primarily use the scanning module through their mobile devices to photograph skin conditions on their dogs. They receive diagnostic results with confidence scores and treatment recommendations. The system guides them on whether conditions can be managed at home or require professional veterinary care.

Shelter staff work with enhanced features designed for high-volume screening. They can scan multiple animals in sequence, receive alerts for contagious conditions, and generate reports for facility management. The system helps prioritize treatments based on condition severity and available resources.

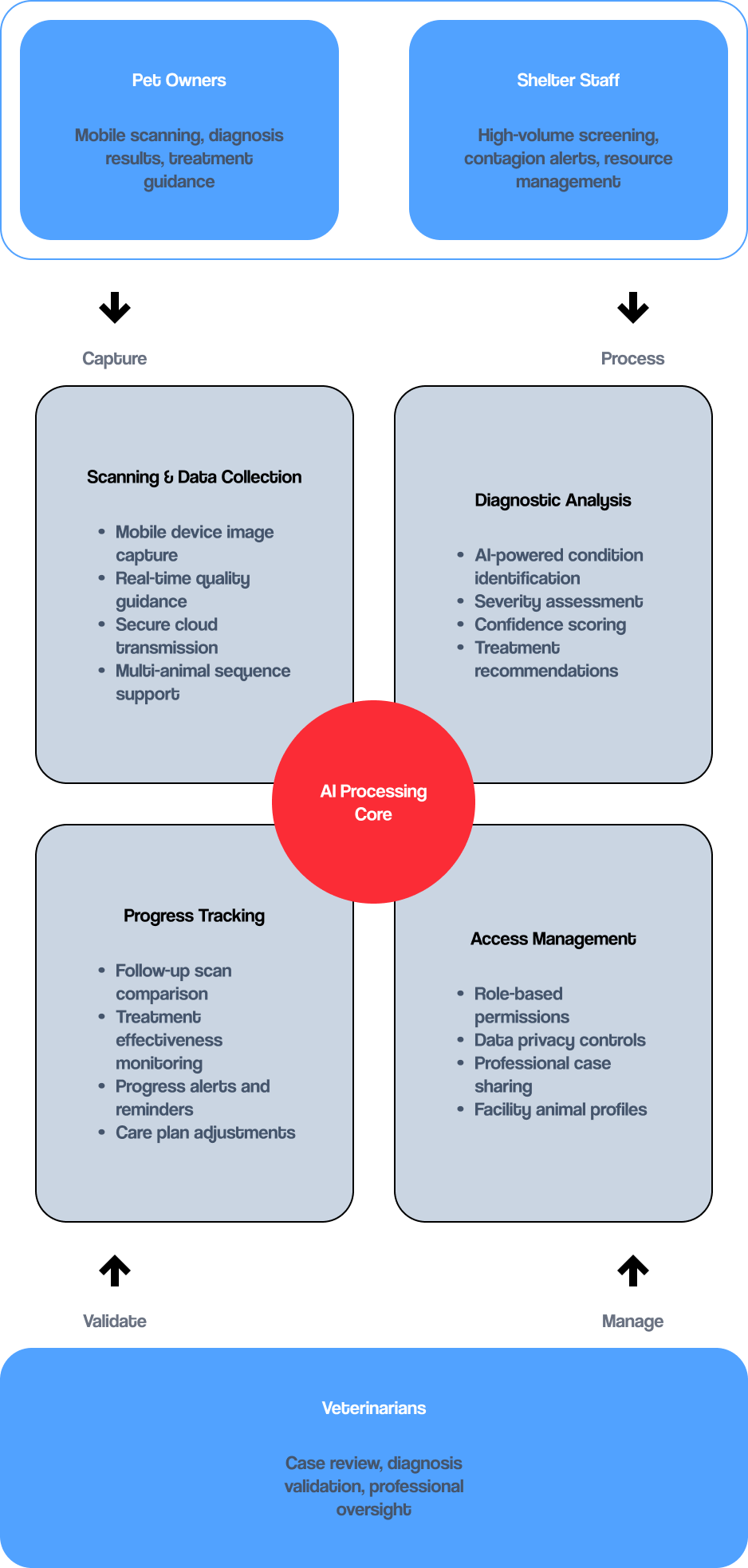
Veterinarians review cases shared by pet owners and can validate or correct AI-generated diagnoses. They access comprehensive diagnostic data including image analysis details and treatment history to support their clinical decisions.

**Scanning and Data Collection Module.** Pet owners and shelter staff use this module to capture images with the handheld device connected to the mobile app. The scanning process includes real-time guidance to ensure proper image quality and coverage of affected areas. Data gets transmitted securely to the cloud processing system.

**Diagnostic Analysis Module.** The AI engine processes uploaded images to identify skin conditions using trained machine learning models. Results include condition identification, severity assessment, and care recommendations. Veterinarians can review the AI analysis and provide professional input when cases are shared with them.

**Progress Tracking Module.** Users monitor treatment effectiveness by taking follow-up scans that get compared with baseline images. The system shows whether conditions are improving or worsening and adjusts care recommendations accordingly. Treatment reminders and progress alerts keep users engaged with their pet's care plan.

**Access Management Module.** Different user roles have appropriate permissions within the system. Pet owners control their data and can choose to share cases with veterinarians. Shelter staff manage animal profiles within their facility. The system maintains privacy while enabling necessary data sharing for professional consultations.

Figure 1: AI-Powered Canine Dermatology Diagnostic System

Objectives of the Study

This study seeks to develop and assess an AI-powered canine skin health assistant equipped with a portable scanning device that will help pet owners and animal shelter workers detect, identify, and monitor visible skin conditions in dogs, enabling them to make better decisions regarding veterinary care.

Specifically, this study aims to:

1. Build an affordable, user-friendly handheld scanning device that captures high-quality images and measurements of canine skin conditions through standardized imaging, basic temperature sensing, and other practical measurement tools.
2. Create an AI system capable of identifying and classifying specific skin conditions that need enhanced detection beyond basic visual inspection, including parasitic infections like Demodex and Sarcoptic mange, fungal infections such as Malassezia dermatitis and ringworm, bacterial skin infections including pyoderma and folliculitis, inflammatory conditions like contact and atopic dermatitis, sebaceous adenitis, and interdigital infections.
3. Design the system to deliver accurate condition identification with confidence ratings, clearly separating conditions suitable for home monitoring from those requiring immediate veterinary attention.
4. Establish a comprehensive tracking system that allows users to monitor identified conditions and treatment effectiveness over time using objective measurements and AI-supported progress evaluation.
5. Develop a mobile application that provides accurate condition identification with confidence ratings, clear explanations in simple language, evidence-based home care recommendations, treatment reminders, progress monitoring schedules, and guidance on when veterinary consultation becomes necessary.
6. Incorporate specialized features for animal shelters, including batch screening capabilities, automated alerts for contagious conditions, treatment prioritization based on severity, and cost-effective monitoring protocols.
7. Test the system's accuracy in identifying common canine skin conditions against veterinary diagnoses, particularly focusing on conditions frequently missed or misidentified by pet owners in early stages.
8. Ensure data privacy and security while allowing the system to enhance its diagnostic accuracy through machine learning as more cases are processed, creating a more dependable identification tool for the pet community.

Significance of the Study

The development of the AI-Powered Dermatology Assistant for Canine Skin Disease Identification and Monitoring Using an IoT Device holds significant value for a diverse range of beneficiaries, including veterinarians, pet owners, dog shelters, the technology and animal health communities, as well as researchers and future researchers.

#### **Pet Owners.** The system offers a convenient and user-friendly platform for monitoring their pets' skin health from home. This promotes early detection of potential skin issues and encourages timely intervention, reducing the risk of complications. It also improves accessibility to veterinary insights and fosters a more proactive approach to pet healthcare, empowering pet owners to play a more active role in their animals’ well-being.

**Veterinarians.** Veterinary professionals stand to greatly benefit from the system as it serves as a diagnostic support tool. It can enhance the accuracy and efficiency of identifying various skin diseases in dogs, enabling more precise treatment planning. By integrating technology into the diagnostic process, veterinarians can reduce human error, streamline workflows, and provide better-informed care to their patients.

**Dog Shelters.** Animal shelters that house multiple dogs often face resource and time constraints in monitoring health conditions. This system can streamline the process of skin disease detection and allow for more effective health monitoring of shelter animals, leading to better overall care and reduced risk of disease transmission.

**Technology Community.** This study contributes to the expanding field of smart systems and applied artificial intelligence, showcasing how AI and IoT can be combined to develop intelligent, automated, and accessible solutions. It serves as a model for future innovations that bridge the gap between emerging technologies and real-world applications, emphasizing the role of tech in addressing health and welfare issues beyond human medicine.

**Animal Health Community.** The study promotes technological advancement in veterinary medicine by introducing a system that supports early detection and consistent monitoring of skin diseases in dogs. It highlights how interdisciplinary approaches can improve animal care practices, set higher standards for veterinary diagnostics, and encourage data-driven, welfare-focused solutions within the community.

**Researchers.** The creation of this system provided the researchers with an opportunity to acquire valuable knowledge and technical expertise in the fields of artificial intelligence, veterinary science, and IoT integration. Throughout the research process, they enhanced their critical thinking, problem-solving capabilities, and innovative mindset. This study not only contributed to their academic and technical growth but also inspired them to pursue impactful technological solutions that address real-world issues, particularly in the area of animal health and welfare.

**Future Researchers.** This research serves as a substantial academic resource for future scholars interested in the application of AI and IoT in veterinary medicine or smart animal healthcare systems. It offers foundational insights, development methodologies, and system design principles that can guide and inspire future investigations. Moreover, it encourages emerging innovators to build upon this study, advance current technologies, and explore new possibilities at the intersection of intelligent systems and animal care.

Time and Place of the Study

This study was conducted during the Academic Year 2024–2025 in Bacoor, Cavite, Philippines. The researchers began gathering information in April 2025 to start developing ideas. Data was collected from various resources available on the internet and used in the study. Research activities—including data collection, prototyping, device testing, and AI training—were carried out within the local community. The area was chosen due to its mix of urban and low-income households, where access to affordable veterinary services can be limited. Selected pet owners and animal shelters in Cavite participated in the evaluation of the device to ensure its real-world applicability and relevance to the needs of underserved communities.

### **Scope and Limitation of the Study**

This study focuses on the development and implementation of an AI-powered dermatology assistant integrated with an IoT-based scanning device designed for pet owners and animal shelters in Cavite, Philippines, where access to professional veterinary services may be limited. The system is developed to assist in the early detection and monitoring of canine skin diseases through multimodal data collection and deep learning technologies.

The system includes the following components:

* A high-resolution imaging system comprising a Standard Digital Camera Module (OV5647) and a USB Microscope Camera (100x Magnification) is embedded in a portable device to capture both macro and micro-level images of canine skin. This setup enables the identification of visible symptoms such as redness, inflammation, lesions, parasites, and other dermatological abnormalities with high precision.
* To complement the visual analysis, the system integrates several environmental and biometric sensors: a Thermal Imaging Sensor (MLX90640) for detecting localized temperature anomalies indicative of inflammation or infection; a Moisture Sensor (Arduino-compatible) to assess skin hydration levels; and a pH Sensor Module (Arduino-compatible) to detect abnormal skin acidity, which may signal infection or disruptions in the skin barrier. These multimodal data inputs enhance diagnostic accuracy by providing critical physiological context to the image data.
* A Multimodal Late Fusion Convolutional Neural Network (CNN) architecture—incorporating DenseNet-121, ResNet, and MobileNetV3—is employed to process and classify both visual and sensor-based inputs. This hybrid model is trained to detect common canine skin diseases such as mange, fungal infections, hot spots, inflammation, and allergic reactions.
* Deployment of the trained models using TensorFlow Lite, enabling mobile-friendly, real-time inference and analysis within the companion Android application.
* A mobile application providing user-friendly diagnostic feedback, basic home care recommendations, medication reminders, visual treatment tracking, and optional veterinarian consultation via a cloud-connected dashboard.
* Shelter-specific functionalities such as batch scanning, automated quarantine flagging, and health status prioritization to support operational needs in high-volume animal care environments.
* Cloud-based storage and analytics to facilitate remote access, data backup, and veterinary collaboration.

The study is geographically limited to selected areas in Cavite; therefore, results and usability insights may not fully represent conditions or behaviors of pet owners in other locations with different environmental, cultural, or economic contexts. System performance may be affected by external factors such as poor lighting, fur coverage, user scanning technique, and the cleanliness of the sensor interface.

While the system provides intelligent diagnostic support, it is not intended to replace professional veterinary assessment. Expert review remains necessary for critical or uncertain cases. Additionally, the current application is limited to Android platforms, with iOS compatibility planned for future phases. Data privacy and security are also acknowledged concerns, requiring robust cybersecurity protocols to ensure the confidentiality and protection of pet health information.

**Definition of Terms**

The definition of terms refers to the clarification and explanation of key concepts, terms, and terminology used in the study. It helps readers understand the specific meanings and context of these terms within the research.

**Accuracy Rate** – a metric that indicates how often the system correctly identifies or classifies skin diseases.

**AI-Powered** – refers to a system that uses artificial intelligence algorithms to simulate human intelligence, including learning, reasoning, and self-correction, particularly in analyzing and detecting skin diseases in dogs.

**Artificial Intelligence (AI)** – a branch of computer science focused on building smart machines capable of performing tasks that typically require human intelligence. It includes subfields such as machine learning and computer vision.

**Canine** – pertaining to dogs. In this study, the term refers to the animal species being monitored for skin diseases.

**Cloud Storage** – an online storage system used to securely store images and diagnostic data, allowing remote access for users and veterinarians.

**Computer Vision** – a field of AI that enables machines to interpret and process visual data from the world. In this system, it is used to analyze skin images for signs of disease.

**Convolutional Neural Network (CNN)** – a deep learning algorithm commonly used in image recognition tasks. CNNs are employed in this study to detect skin disease patterns from images.

**Data Collection** – the process of gathering relevant information, such as images and symptoms, which is essential for training the AI and monitoring skin health.

**Deep Learning** – a subset of machine learning that uses neural networks with many layers (deep neural networks) to model complex patterns in data, often used in image recognition tasks.

**Dermatology Assistant** – a virtual or digital tool that assists in diagnosing and monitoring skin-related issues, providing support to veterinary professionals and pet owners.

**Diagnosis Support** – the function of the system to provide suggestions or possibilities based on input data, assisting veterinarians in clinical decisions.

**Disease Database** – a collection of labeled images and diagnostic information that the AI uses to learn and compare new input data for accurate identification.

**Health Monitoring Dashboard** – a visual interface that displays the dog’s skin health status, history of assessments, and alerts based on the monitored data.

**Identification** – the process of detecting and classifying different types of skin conditions in dogs through the analysis of images using AI algorithms.

**Image Classification** – the task of assigning a label to an image based on its content. The system uses this technique to classify different types of skin diseases.

**IoT Device (Internet of Things Device)** – a physical device embedded with sensors, software, and connectivity to collect and transmit data over the internet. In this study, it captures images of a dog’s skin and sends them to the system for analysis.

**Machine Learning** – a subset of AI that enables systems to learn from data, identify patterns, and make decisions with minimal human intervention.

**Monitoring** – the ongoing tracking and observation of a dog’s skin health to assess the progression or improvement of skin conditions over time.

**Pet Owner** – an individual who owns and is responsible for the care of a dog. In this study, pet owners use the system to monitor their dog’s skin condition at home.

**Prediction Model** – an AI model trained to forecast or determine the likelihood of a specific condition, such as identifying a particular skin disease based on symptoms or images.

**Proactive Care** – an approach to health management where early signs of disease are identified to allow timely treatment, reducing risks of complications.

**Real-Time Processing** – the system’s capability to analyze and provide results immediately after data (e.g., images) are input, allowing prompt monitoring and action.

**Remote Diagnosis** – the ability to assess and monitor health conditions from a distance using internet-connected devices, beneficial for pet owners in remote areas.

**Skin Disease** – a broad term for medical conditions that affect the skin, such as allergies, bacterial or fungal infections, mange, and dermatitis.

**Smart Health System** – a healthcare solution that uses advanced technology like AI and IoT to offer real-time and automated medical services or monitoring.

**System Evaluation** – the process of testing the system’s performance, reliability, and usability to ensure it meets the intended objectives and quality standards.

**Training Data** – pre-collected data used to teach the AI model how to recognize patterns and make predictions.

**User Authentication** – a security feature that ensures only authorized users can access sensitive information and system features.

**User Interface (UI)** – the part of the system that users interact with. A user-friendly UI is crucial for allowing both veterinarians and pet owners to use the system effectively.

**Veterinarian** – a licensed professional who practices veterinary medicine. This system provides diagnostic support to veterinarians in identifying canine skin diseases.

**Wireless Communication** – a feature of IoT devices that allows them to transmit data without physical connections, enabling seamless data flow to and from the system.

**References**