Development of an AI-Powered System for Early Detection of Canine Skin Diseases

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Project Proposal Report

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B.Sc. (Hons) Degree in information Technology

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Declaration of the Candidate & Supervisor

To the best of my knowledge and belief, this proposal does not contain any previously published or written by another person material, except where the acknowledgement is made in the text. I declare that this is solely my own work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or Institute of higher learning.

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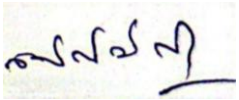
Supervisor	Mrs.	Bhagyanie	Chathurika	
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• Adaptive Question Generation: Come up with meaningful questions that aid in the collection of supplementary information to narrow down diagnosis based on the preliminary assessments that shall be made. 16

• Health Profile Integration: Development of a dynamic health profile for every dog by integration of continuous health monitoring data, including inputs from wearable devices and veterinary records. 16

• Personalized Treatment Recommendations: It shall give treatment plans commensurate and proportionate to the diagnosed condition and the general health profile of the dog, accounting for a variety of factors that include breed, age, and any previous medical history. 16

• General user interface: This system shall have an easy-to-use interface that clearly displays diagnostic results, health assessments, and treatment recommendations. 16

• Data Management and Privacy: The system shall handle data management and storage in a secure way to comply with the regulations relevant to the protection of data and ensure safeguarding of sensitive information. 16

• Testing and Validation: This should be extensively tested across breeds and several health conditions so that the accuracy and reliability of the system go through scrutiny; likewise, user experience must be perfected. 16

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Declaration

I hereby declare that this individual research project titled "Developing an AI-Powered System for the Early Detection of Canine Skin Diseases" is my own work and that all sources of information have been acknowledged by means of complete references.

This research project is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science (Hons) in Information Technology and has not been submitted for any other degree or diploma at any other institution.

I do hereby affirm that the data and research findings presented in this document are, to the best of my knowledge and belief, true.

Abstract

Findings indicate that students diagnosed with procedural dyscalculia faced challenges at understanding and acting on any serial mathematical task. This paper presents a research project aiming to develop an artificial intelligence-based system for early detection of canine skin diseases. An interactive system based on gesture technology is integrated to equip dyscalculic students with more focus and problem-solving skills. It does this by tracking students' movements during arithmetic exercises, providing personalized feedback, and generating adaptive learning activities tailored to their needs.

The study is an investigation of the tasks based on machine learning algorithms like Convolutional Neural Networks and Random Forest Classifiers for analyzing the data produced through students' gestures in general and gesture data towards potential predictions of diverse areas where students may need support. The goal of the platform will be to increase the engagement and enhance the proficiency of these students with procedural dyscalculia through a more intuitive and accessible means of interaction: gestures.

This study will be narrow in focus in that it attempts to offer a solution aimed at bridging this critical gap existing in current educational technologies by considering the uniqueness of the problem with which the student presents, in particular Dyscalculia. This is expected

to contribute to significant improvements in the performance levels of the students in terms of effective understanding and execution of mathematical operations.

Keywords:

Canine Skin Diseases, Early Detection, AI-Powered Diagnosis, Image Analysis, Breed-Specific Analysis, Multimodal Input, Personalized Treatment, Veterinary Medicine, Machine Learning, Animal Health

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List of Abbreviations

- AI- Artificial Intelligence
- CNN- Convolutional Neural Network
- ML- Machine Learning
- SDK- Software Development Kit
- API- Application Programming Interface
- UI- User Interface
- UX- User Experience
- AWS- Amazon Web Services
- OS- Operating System

- iOS- Apple’s Mobile Operating System
- Android- Google’s Mobile Operating System
- Firebase- Google’s Cloud-Based Database Management System
- DynamoDB- Amazon’s NoSQL Database Service
- TensorFlow Lite- Lightweight TensorFlow for Mobile and Embedded Devices
- Core ML- Apple’s Machine Learning Framework
- NLP- Natural Language Processing
- DPI- Dots Per Inch
- SSL- Secure Sockets Layer
- TLS- Transport Layer Security
- R&D- Research and Development
- FDA- Food and Drug Administration
- IRB- Institutional Review Board
- FDA- Food and Drug Administration
- HIPAA- Health Insurance Portability and Accountability Act

Introduction

Background of the Study

Over the last few years, early detection has become significant in veterinary medicine, more so regarding the diagnosis and management of canine skin diseases. These diseases range from mild irritation to severe infection and may present a serious effect on an individual dog's health and well-being if not timely diagnosed and treated. Traditionally, diagnosis of dog skin diseases has relied on a lot on physical examinations and laboratory tests conducted by veterinarians. This process is time-consuming, expensive, and often stressful both for the dog and its owner.

AI in health has opened new vistas for early diagnosis and intervention, increasing the diagnostic accuracy and speed of diseases. AI-powered systems have already acquired remarkable success stories in human medicine, particularly in fields like dermatology, where image analysis played a very critical role in diagnosing conditions. All these developments are an inspiration to the present study that investigates the applicability of AI in veterinary medicine, with an eye on early detection of skin diseases in dogs.

AI algorithms will be proposed to analyze images of canine skin, besides user inputs on observed symptoms and level of activity. This effort is aimed not only at an accurate diagnosis but also at empowering the dog owner with an effective tool for monitoring the health of their pets. Through early intervention, this system attempts to reduce the seriousness of conditions, decrease the cost of veterinary care, and ultimately improve the quality of life for dogs.

This might be very important research because, in the long term, it will help to transform veterinary care to be more accessible, efficient, and productive. The deepening human-animal bond will increase demand for tools for proactive health management in pets. The present study is an attempt to contribute to this rapidly expanding area with an AI-driven but user-friendly solution that would easily fit into the routine care of dogs, enabling improvement in health outcomes and further exploration into knowledge about canine dermatology.

Literature Survey

AI in veterinary medicine is a developing area of research that lately has gained much attention. The ability of AI to enhance the accuracy of diagnostics and facilitate treatment procedures within human medicine is very well documented, especially in fields like dermatology where image-based analysis is very relevant. This literature survey shall seek to appraise existing research into AI applications in veterinary care, with particular focus on the early detection of canine skin diseases.

AI in Veterinary Medicine

Several studies have been conducted on the integration of AI in veterinary diagnostics, which show that it can really transform traditional practices. In a study by Undersold and Undersold, the authors describe how AI does what many people associate with humans: the analysis of medical images to examine them for patterns that human practitioners might miss. This is quite relevant to veterinary medicine, since the diagnosis of conditions is most often based on visual assessments.

Smith et al. (2020) conducted research on the application of machine learning algorithms in veterinary diagnostics. This study focused on the detection of respiratory diseases in cattle and concluded that AI could significantly reduce the time needed for diagnosis, thus speeding up intervention and treatment. Although these studies were not conducted specifically on canine skin diseases, they convey knowledge of the general application potential of AI within the different fields related to animal health.

AI in Dermatology

AI has made immense strides in the field of dermatology, more so in human health. Esteva et al. (2017) created a CNN that realized dermatologist-level classification of skin cancer with images. The paper points out how AI can bring accuracy while diagnosing any skin conditions by image analysis, which in turn can be translated into veterinary care. It is quite conceivable that similar models could be developed for the identification of skin diseases in dogs, just by training on images of their skin, also with a high degree of accuracy.

A more relevant study conducted by Brinker et al. (2019) investigated the differentiation of benign from malignant skin lesions using deep learning algorithms. The authors observed that AI could be very instrumental in aiding early detection, hence improving patient outcomes. Indeed, this research creates a basis for applying AI in diagnosing canine skin conditions, where early detection is equally paramount.

Challenges of Using AI for Canine Skin Diseases

Though very promising, there are quite a few challenges that must be addressed before AI can establish a strong foothold in veterinary diagnostics. Patel et al. pointed out the challenge of obtaining high-quality and large volumes of datasets for training AI models within the veterinary context settings. Unlike in human medicine, where huge databases of medical images exist, veterinary data is often scattered, fragmented, and less accessible. This limitation poses one of the major problems to the development of robust AI systems for diagnosing canine skin diseases.

Brooks and Higgins, 2022, also addressed the ethical considerations associated with AI integration into veterinary care, especially in terms of data privacy and the potential for misdiagnosis. A focus was given to the rigorous validation of the models of AI to ensure reliability and accuracy. These are very important concerns, for misdiagnosis of skin conditions in dogs can lead to inappropriate treatments with serious adverse outcomes.

There are clear prospects for AI that the literature highlights in revolutionizing the veterinary diagnostics industry in relation to early disease detection. Much progress has already been made toward applying AI in human dermatology, whereas its application toward dog skin diseases remains relatively unexplored. Careful navigation through various challenges presently impeding data availability, model accuracy, and ethical considerations is important in developing a reliable AI-powered system for the diagnosis of canine skin diseases. There is some basis for the proposed research in this literature survey, as it sets out the need for innovation in solutions using AI to enhance the health and well-being of dogs.

Research Gap

A survey on AI-empowered systems for diagnosis in canine skin diseases points out some critical gaps that exist in the present research and at the hand of available technologies. The most serious insufficiency noted is the lack of early detection capacity, since the early detection of these diseases in dogs has far-reaching implications on both early intervention and improved health outcomes for dogs with skin conditions. However, most of the systems that exist do not support this feature, and it is only one system in the survey that provides early detection, which rather seems a bit limited. Hence, there is a dire need for developing an AI-driven system that would aid in detecting the early signs of skin diseases in dogs to their owners for effective and timely treatment.

The other obvious gap is that the solutions available lack breed-specific analysis. Skin conditions vary across different breeds of dogs, so breed-specific analysis will be necessary for appropriate diagnosis. The effectiveness of all current systems is limited without this feature and points to the opportunity for developing a system that gives diagnostic and treatment recommendations specific to the needs of each breed.

Moreover, most current systems are based on a single mode of input and simply cannot utilize other rich sources of information, including the owner-reported symptoms and activity levels. This narrow approach reduces the accuracy of diagnosis and suggests a major opportunity for innovation. Just considering such a system, based on multiple inputs of images, symptoms, and activity levels, would allow a holistic and much more accurate assessment of the skin health of dogs.

Finally, the absence of treatment recommendations in accordance with the diagnosis and a specific dog's profile in existing systems further aggravates their limitations. Customized care against the specific diagnosis and the individual profile of the dog is an important part of the treatment. That clearly creates a need for a system which, other than diagnosis, also provides treatment recommendations tailored to the circumstances, raising the applicability and efficiency of veterinary care.

There is a plethora of research gaps—early detection, breed-specific analysis, and multimodal input—affecting the present AI-driven diagnostic systems for canine skin diseases. These deficiencies provide a huge window of opportunity for innovation. The proposed research is intended to fill up those identified gaps by developing an all-inclusive AI system that embeds early detection, breed-specific analysis, multimodal inputs, and personalized treatment recommendations. This would then be a more accurate, efficient, and user-friendly way to diagnose and manage canine skin diseases, all aiming toward improved health outcomes for dogs.

Research Problem

An early and correct diagnosis of canine skin diseases is a challenge in veterinary medicine due to the great variability of skin conditions occurring in dogs, as well as due to the varied factors affecting manifestation. Applied diagnostic techniques are predominantly based on external inspection and subjective reporting by owners, probably leading to misdiagnosis, delayed treatment, and thus deterioration in the health status of the dog.

Although AI and machine learning are by themselves very advanced, there are several limitations and inadequate scopes of the present diagnosis systems of canine skin diseases. The critical deficiencies in most of the systems are that they could not provide an early detection system, breed-based analysis, or the integration of multimodal inputs like image analysis with owner-reported symptoms and activity levels. Further, most of them are not going to give any individual treatment advice relevant for the skin condition being managed by the dog.

Therefore, the problem statement for this research would be to develop a comprehensive AI-driven system capable of solving these limitations. This system would have to answer the need for detecting skin diseases at an early stage, considering breed-specific vulnerabilities; integrate diagnostic input from various sources; and provide recommendations for personalized treatment. By addressing this problem, improvement in the accuracy and timeliness of diagnosis of canine skin diseases can be done, leading to better health and well-being for dogs.

Background of the Research

One of the most common problems in dog health concerns canine skin diseases. They can range from simple, annoying lesions to severe bacterial infections and considerably affect a dog's quality of life. Canine skin diseases in dogs could be related to allergies, parasites, infections, or systemic health issues. Varied and complex, these disorders require an accurate diagnosis immediately followed by treatment to avoid further complications and ensure the well-being of the affected dogs.

Traditional diagnosis of pet skin diseases is by physical examination and visual evaluation of the symptoms reported by the owners. Symptom reporting in these methods is subjective, and in visual diagnosis, there are chances of human error. Hence, misdiagnosis or late diagnosis is quite common, ultimately leading to a longer period of suffering for the animal and additional treatment costs.

During the past years, with the great advancement of artificial intelligence and machine learning, many opportunities have opened for enhancing the accuracy of diagnosis in several medical disciplines, including veterinary medicine. AI-driven systems can process quantities of data, detecting subtle patterns that might elude the human eye, to offer more precise and timely diagnoses. To date, very few of these techniques have been applied toward early detection and diagnosis of canine skin diseases.

Most of the existing diagnostic tools on canine skin diseases driven by AI suffer from a lack of very critical features, including the ability for early detection, breed-based analysis, use of multimodal inputs—imaging analysis combined with owner-reported symptoms—and treatment recommendations that would be possibly customized for every case, key to effective management. These limitations underline the requirement for a much more holistic AI-powered solution that aids in identification and treatment of real challenges related to canine skin diseases at almost every level.

In this regard, the proposed research will fill this gap by developing a competence-based AI system in enhancing early detection and making accurate diagnoses of canine skin diseases. This system will be able to integrate advanced image analysis with owner-reported data, considering breed-specific vulnerabilities, in providing treatment recommendations. This will ultimately serve to equip dog owners with a reliable means of very early intervention, which will greatly improve health outcomes for dogs by reducing the intensity of visits to veterinary institutions. Initiatives like this will transform the existing notion of veterinary care by access, efficiency, and individualization based on the needs of each dog.

Objectives

Main Objective

Design a universal and integrated system for diagnosis and detection of canine skin diseases. In this system, the latest diagnostic tools will be combined with continual health compatibility estimation to provide accurate, personalized treatment recommendations. This holistic system will work toward health and well-being for the dogs by ensuring skin conditions are identified at an early stage and successfully treated by considering the health profile of the dog.

Specific Objectives

Development of Canine Skin Disease Detection Algorithms:

- Objective: To design and implement advanced machine learning algorithms that can accurately identify and classify a wide range of canine skin diseases based on image analysis and symptom recognition.
- Description: This objective focuses on creating the core diagnostic technology of the system. The algorithms will be trained on a large dataset of annotated images and veterinary records to ensure high accuracy. They will be capable of distinguishing between different skin conditions, such as dermatitis, fungal infections, and autoimmune diseases, even when symptoms are subtle or overlap with other conditions.

Integration of Ongoing Health Monitoring Tools:

- Objective: To incorporate continuous health monitoring into the system, using data from wearable devices, owner-reported symptoms, and veterinary check-ups to build a dynamic health profile for each dog.
- Description: This objective aims to ensure that the system has access to up-to-date health data for each dog, allowing it to make more informed diagnostic decisions. The health monitoring tools will track metrics such as activity levels, skin temperature, and general health indicators, which will be analyzed in conjunction with the skin disease detection module to provide a comprehensive health assessment.

Creation of a Personalized Treatment Recommendation System:

- Objective: To develop an AI-driven engine that generates personalized treatment plans based on the diagnosed skin condition and the dog's overall health profile.
- Description: This objective involves the design of a sophisticated recommendation engine that considers the unique characteristics of each dog, such as breed, age, and medical history. The system will suggest treatments that are tailored to the dog's specific needs, including medication, topical treatments, dietary adjustments, and preventive measures. The recommendations will be evidence-based and continuously updated as new research and data become available.

User Experience and Interface Design:

- Objective: To create a user-friendly interface that enables easy interaction with the system for both veterinarians and pet owners, ensuring that the diagnostics and recommendations are easily accessible and understandable.
- Description: This objective focuses on the design and usability of the system's interface. The interface will present diagnostic results, health assessments, and treatment recommendations in a clear and concise manner. It will also provide educational resources to help users understand the condition and the recommended care. The interface will be designed to work seamlessly across different devices and integrate with existing veterinary software.

Implementation of a Continuous Learning Framework:

- Objective: To establish a feedback loop within the system that allows it to learn from each case, improving its diagnostic accuracy and treatment recommendations over time.
- Description: This objective aims to ensure that the system remains dynamic and adaptive. By collecting data on treatment outcomes and incorporating feedback from veterinarians and pet owners, the system will refine its algorithms and recommendations. This continuous learning framework will help the system evolve, becoming more precise and effective in diagnosing and treating canine skin diseases as new data is gathered and analyzed.

Validation and Testing of the System:

- Objective: To rigorously test the system in a variety of real-world settings, ensuring its reliability, accuracy, and effectiveness before full deployment.
- Description: This objective involves conducting extensive validation trials, where the system will be tested on a diverse population of dogs with different skin conditions

and health profiles. The trials will assess the accuracy of the diagnostic algorithms, the relevance and efficacy of the treatment recommendations, and the overall user experience. Feedback from these trials will be used to make any necessary adjustments before the system is launched commercially.

METHODOLOGY

Functional Requirements

• Detection and Classification of Various Canine Skin Diseases: Accurately detect and classify different canine skin diseases from images and identify some conditions.

• Adaptive Question Generation: Come up with meaningful questions that aid in the collection of supplementary information to narrow down diagnosis based on the preliminary assessments that shall be made.

• Health Profile Integration: Development of a dynamic health profile for every dog by integration of continuous health monitoring data, including inputs from wearable devices and veterinary records.

• Personalized Treatment Recommendations: It shall give treatment plans commensurate and proportionate to the diagnosed condition and the general health profile of the dog, accounting for a variety of factors that include breed, age, and any previous medical history.

• General user interface: This system shall have an easy-to-use interface that clearly displays diagnostic results, health assessments, and treatment recommendations.

• Data Management and Privacy: The system shall handle data management and storage in a secure way to comply with the regulations relevant to the protection of data and ensure safeguarding of sensitive information.

• Testing and Validation: This should be extensively tested across breeds and several health conditions so that the accuracy and reliability of the system go through scrutiny; likewise, user experience must be perfected.

Non-functional Requirements

- Scalability: The system should be scalable to handle a growing number of users, including veterinarians and pet owners, without compromising performance.
- Usability: The system must be user-friendly, with an intuitive interface that is easy for both veterinarians and pet owners to navigate.
- Performance: The system must operate efficiently, with fast processing times for diagnostics, data analysis, and treatment recommendations.
- Reliability: The system should deliver consistent and accurate results, with high availability and minimal downtime.
- Security: The system must ensure data privacy and security, protecting sensitive health information from unauthorized access or breaches.
- Accessibility: The system should be accessible to users with varying levels of technical proficiency, adhering to relevant accessibility standards.
- Maintainability: The system should be easy to update and maintain, allowing for quick implementation of improvements and bug fixes.

User Requirements

- Veterinarians: Veterinarians should be able to easily upload patient data, view diagnostic results, and access personalized treatment recommendations tailored to each dog's health profile.
- Pet Owners: Pet owners should be able to interact with the system to provide relevant health information about their dogs, receive clear diagnostic results, and follow easy-to-understand treatment plans.
- System Administrators: System administrators should have the ability to manage user accounts, monitor system performance, and ensure data privacy and security across the platform.
- Researchers: Researchers should be able to access anonymized data for study, contribute to continuous system improvement, and stay informed on emerging trends and findings in canine health.

- Support Staff: Support staff should have access to tools that allow them to assist veterinarians and pet owners with troubleshooting, ensuring smooth operation of the system and timely resolution of any issues.

System Requirements

Software Requirements:

- Operating System: The mobile app should be compatible with major mobile operating systems, including Android and iOS.
- Development Tools: Utilize development frameworks and languages such as Flutter or React Native for cross-platform mobile app development, along with JavaScript, Dart, and Swift/Objective-C where necessary.
- API Integration: The app should integrate with external APIs for health data synchronization, cloud storage, and real-time communication with veterinary systems.
- Database: A scalable cloud-based database management system, such as Firebase or AWS DynamoDB, to store user data, health profiles, and diagnostic logs.
- AI and Machine Learning Libraries: Implementation of AI/ML libraries like TensorFlow Lite or Core ML for on-device processing of diagnostic algorithms.
- Push Notifications: Support for push notifications to keep pet owners and veterinarians informed of updates, reminders, and diagnostic results.

Hardware Requirements:

- Mobile Devices: Compatibility with a wide range of smartphones and tablets, ensuring that the app runs smoothly on devices with varying screen sizes and processing capabilities.
- Server Requirements: A reliable cloud server infrastructure (e.g., AWS, Google Cloud) capable of handling real-time data processing, with sufficient CPU, memory, and storage resources to support multiple users simultaneously
- Wearable Device Integration: The app should support integration with health monitoring devices (e.g., smart collars, fitness trackers) that sync data via Bluetooth or Wi-Fi.
- Network Requirements: Stable internet connectivity with adequate bandwidth to support real-time synchronization, cloud-based diagnostics, and seamless user

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System Overview

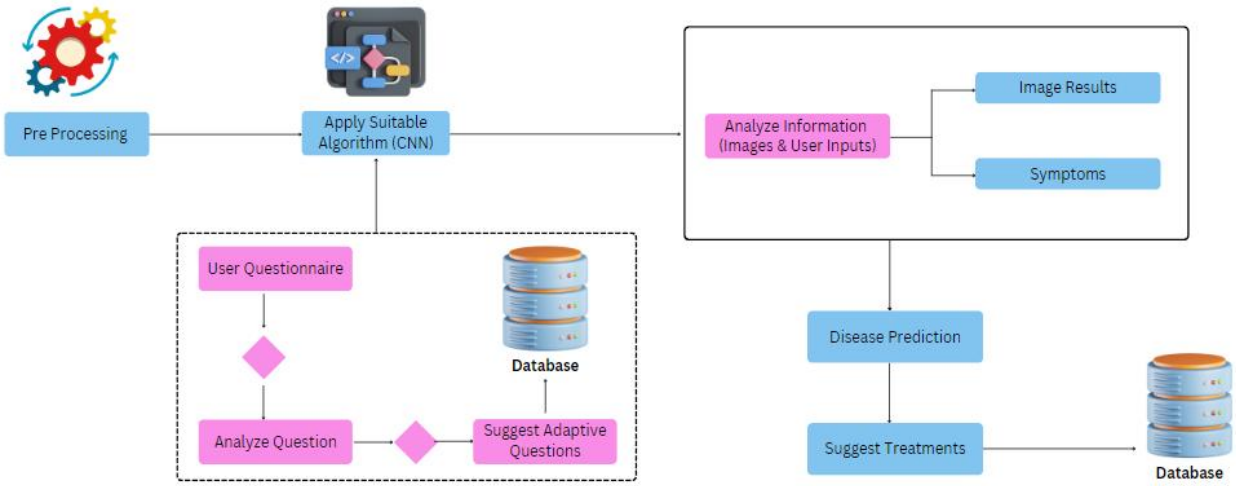

Figure 1system overview

Requirements

Functional requirements

- User login.
- Canine Health Monitoring

- Personalized Recommendations
- Performance Tracking
- Report Generation

Non-functional requirements

- Availability
- Usability
- Security
- Reliability

Stakeholders

- Veterinarians
- Pet Owners
- Researchers
- System Administrators
- Support Staff

System Requirements

- Software
    - User End
    - Developer End
- Hardware
- Mobile

Conclusion

Early detection and diagnosis of canine skin diseases are important in maintaining the health and well-being of dogs. Traditional ways of diagnosis, as invaluable as they are, mostly are impractical at arriving at effective and timely assessments, hence likely to yield misdiagnosis and delayed treatment. This research focuses on developing a system with the aid of artificial intelligence and backed by advanced image analysis in tandem with multimodal inputs from breed-specific information to owner report data.

The proposed system herein intends to make improvements in the diagnosis process by adding to it the capability of early detection and allowing for customized treatment recommendations based on the needs of each dog. This project looks to reduce the burden of frequent visits to the vet and to improve health outcomes in dogs overall by empowering dog owners with a reliable tool for early intervention.

This AI-enabled system, therefore, has been put to practice successfully to revolutionize veterinary science by providing a package solution that enhances not only diagnostic accuracy but also enables the proactive management of healthcare for dogs. This adds to the rapidly emerging field of AI in animal health and opens the doors for further innovations that will directly affect improvement in the quality of life for pets and a lightening burden for veterinary professionals.

This is the perfect example of how AI technologies integrated into veterinary practice can drive the critical redefinition of our approach to canine skin disease diagnosis and treatment today. The expected benefits of this system will therefore go beyond individual cases, involving broader implications for animal healthcare and veterinary science.

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Appendices

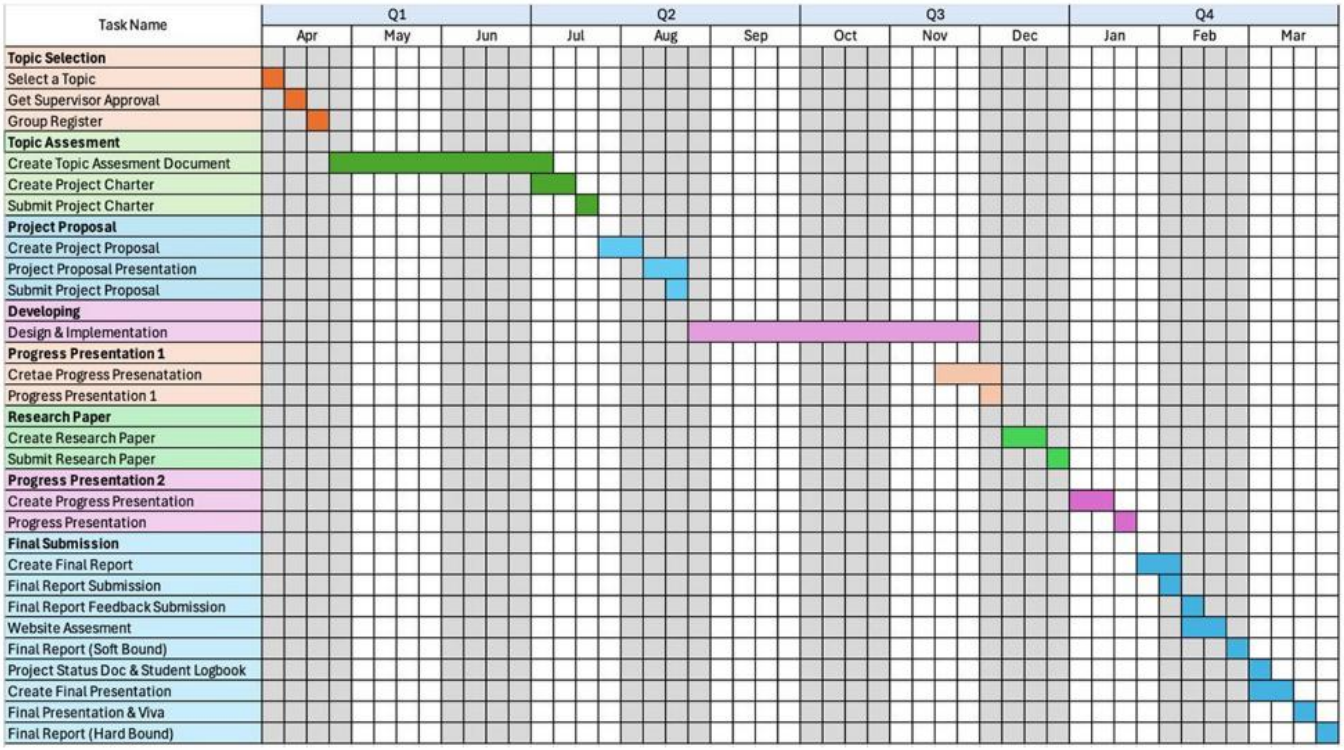

Figure 2 Gantt Chart

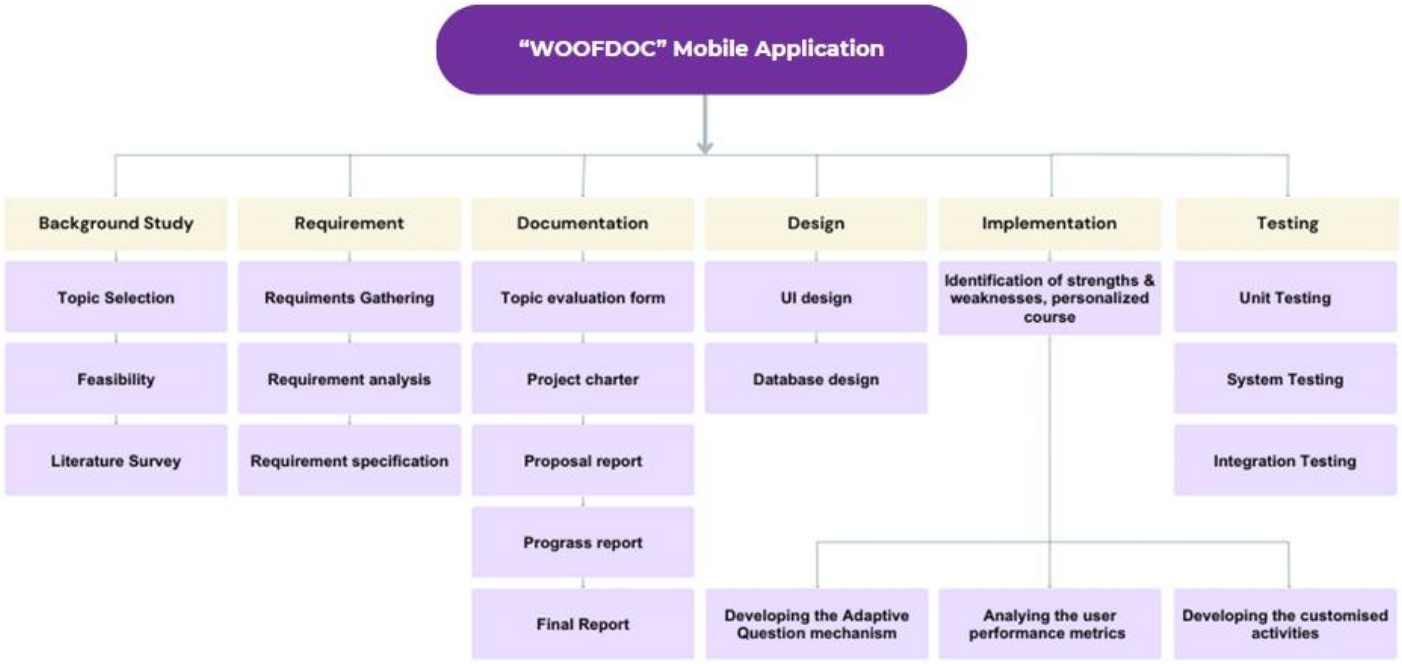

Figure 3 Work Breakdown Chart