BSc Engineering Thesis Project Proposal

"PetVet" Feline and Canine Diseases Prediction System

(Tentative Title)

Submitted By

D. R. S. J. Dissanayake

10025048

Supervisors

Ms. Kaumadee Samarakoon

(Senior Lecturer/ Head – Faculty of Engineering – NSBM)

Mr. Iman Ashly

(Senior Lecturer – Faculty of Computing – NSBM)

DEPARTMENT OF ELECTRICAL, ELECTRONIC & SYSTEMS ENGINEERING

FACULTY OF ENGINEERING

NSBM GREEN UNIVERSITY

PITIPANA, HOMAGAMA.

2022/03/19

Supervisory Committee

1. **Ms. Kaumadee Samarakoon (internal supervisor)**
   BSc (Hons) Engineering in Electrical Engineering (UOM)
   MSc in Electrical Engineering (UOM)

   Senior Lecturer/ Head
   Department of Electrical, Electronic, and Systems Engineering
   Faculty of Engineering
   NSBM Green University

   kaumadee.s@nsbm.ac.lk

2. **Mr. Iman Ashly (external supervisor)**
   Bachelor's in Electrical and Information Engineering (UOR)
   MSc in Electronics and Automation Engineering (UOM)

   Senior Lecturer
   Department of Computer Science and Software Engineering
   Faculty of Computing
   NSBM Green University

   iman.a@nsbm.ac.lk

Table of Contents

Introduction

According to the National Pet Survey conducted by the American Pet Products Association (APPA), there are about 70% of US households (approximately 90.5 million families) own at least one pet. Not just in the US but many people around the world tend to own a pet. According to a Harris Poll done in 2015, more than 90% of pet owners treat their pets as a member of their family. As much as pets bring happiness to people's lives, they may have downsides. New research has determined that people tend to get more depressed, anxious, or show signs of caregiving distress when their pets get sick. Many of them had pets who were suffering from a chronic or terminal disease.

Many pets die at an early age due to various diseases. It could be either a chronic or terminal illness. Most of the deaths could have been prevented if those illnesses were diagnosed at an early stage. But due to the lack of knowledge of pet owners about these diseases, either the symptoms go unnoticed, or the owners tend to disregard the symptoms. Regular health checkups performed by a certified veterinary surgeon can benefit the pet's health and will be able to identify such illnesses at an early stage. But some pet owners fail to take their pets to regular health checkups due to various reasons, for instance, some may avoid going to the vet regularly due to financial issues, some may be having transport issues, or some may find it hard to find a free time for it because of their busy work schedule.

There are many diseases that can be seen in felines and canines commonly. Some of the common feline diseases are epilepsy seizure [6], rabies [10], heart disease, and upper respiratory infection (URI). Some of the common canine diseases are parvovirus [7], distemper, canine influenza, rabies, and urinary tract infection (UTI). Also, there are parasites that cause various health issues in felines and canines such as heartworms [4], fleas [8], ticks, and ear mites. Apart from parasites, there are other types of diseases caused by different reasons, for instance, fungal infections, bacterial infections, immune-mediated diseases, tumors, and cancers.

My goal is to design a system called "PetVet" that can diagnose feline and canine illnesses by using artificial intelligence and image processing. This system will be able to predict diseases and recommend suitable medicines and/or remedies to treat them. PetVet will reduce the number of vet visits and the pet owners will be able to easily get an idea about their pet's health whenever they show signs of mental or physical distress or discomfort. But if the system fails to predict the correct disease, or needs emergency treatment, the AI model will

suggest the owner seek further medical assistance from a veterinary surgeon. If it does not require any further checkups performed by a veterinary surgeon, the system will prescribe suitable medicines and give instructions on how to use them accordingly. PetVet will be very useful for pet owners as well as pets.

Literature Review

Artificial intelligence (AI) is a broad term that refers to a variety of ideas and technologies that are used to address issues with high logical or algorithmic complexity. Mechanistic modeling, software engineering, data science, and statistics are just a few of the fields involved. AI has created a wide range of concepts and methodologies to address these issues. This includes machine learning (ML), language recognition, image recognition, neural networks (NNs), robotics, natural language processing, and expert systems [15]. Machine learning is a popular AI technique that has been around since the 1980s. Since the early 2000s, deep learning has evolved in tandem with the emergence of big data and the continual expansion of computer power, allowing for the study of huge amounts of data that are inaccessible to traditional statistical approaches [11].

These technologies can be used to help with illness diagnosis and individual case identification, more accurate forecasts and fewer mistakes, faster decision-making and better risk analysis, and better intervention targeting in Animal Health (AH) [11]. Since the data of AH is diverse, it is a must for the developers to consider the availability, quality, and reliability of data. although there is an uprise in these AI methods can be seen in the human health sector, they are rarely used to solve animal health-related issues.

The first objective of PetVet is to diagnose diseases using AI. There are similar experiments done in this area by various researchers. Many existing models do not explicitly incorporate human decision-making, despite the fact that control choices are frequently made by users. A review done by Schaefer et al. shows how machine learning is used in rare diseases detection [12].

A system was proposed by Pingale et al. to predict diseases using machine learning. The machine learning model was trained using a dataset including symptoms of various human diseases. The project is set up in such a way that the system accepts the user's symptoms as input and generates output. Naïve Bayes Classifier is implemented to this system. Both structured and unstructured data will be considered by the proposed system to enhance the accuracy of predictions [16].

Another system that is similar to the system proposed in [16] was introduced by Jamgade and Zade. This research [17] focuses on the creation of a system that would combine symptoms collected from multisensory devices with other medical data and store it in a healthcare

dataset. This system was able to achieve 95% of accuracy by combining both structured and unstructured data.

The goal of this paper is to use data mining to forecast diabetic illness. According to this paper, KNN and Naive Bayes algorithms are employed for disease prediction and accuracy comparisons using a disease dataset. They were taking the disease dataset and analyzing and processing it to create the required output for disease prediction. Around 2000 diabetic patients' data are contained in the datasets. When comparing the accuracy of Bayesian and KNN algorithms, they found that both perform better on larger datasets than smaller datasets [18].

According to the research and proposed systems above, it is evidently proven that the accuracy of disease predictions done using the machine learning model can be increased by using both structured and unstructured data.

The second objective of PetVet is to predict skin diseases of canines and felines using image processing. Skin illness detection is a critical step in lowering death rates, disease transmission, and skin disease progression. There is numerous research done on skin detection using image processing. Arfin et al. [13] have proposed a technique for dissecting skin diseases of humans using color photographs without requiring clinician interaction. The system has two stages: the first detects infected skin using color image processing techniques, k-means clustering, and color gradient algorithms to identify sick skin, and the second employs artificial neural networks to classify disease types. The technique was evaluated on six different types of skin illnesses, with an average accuracy of 95.99% for the first stage and 94.02% for the second stage.

Another new method for detecting skin disorders that combines computer vision and machine learning has been presented by Krizhevsky et al [14]. Computer vision is responsible for extracting features from images, while machine learning is responsible for detecting skin problems. With a 95 percent accuracy rate, the system was evaluated on six different forms of skin conditions.

The method which was presented by ALEnezi and Soliman for detecting skin disorders based on image processing uses image analysis to determine the type of disease by taking a digital photograph of the diseased skin area. It is straightforward, quick, and inexpensive, requiring only a camera and a computer. The method is applied to the inputs of a color image. Then, using a pre-trained convolutional neural network, resize the image to extract features. The

feature was then categorized using Multiclass SVM. Finally, the user is presented with the results, which include the type of sickness, its distribution, and its severity. The technology successfully detects three different forms of skin diseases with a 100% accuracy rate [3].

As mentioned before, not many reviews and research were done based on feline and canine disease prediction systems. Almost all the systems and research mentioned above are designed based on human illnesses. Also, almost all the research mentioned above, and existing technologies are focusing on either skin disorder detection using image processing or other types of illness detection using AI. But none of those systems consist of both functions. To fill up this gap, PetVet's aim is to allow users to use both functions to predict all sorts of feline and canine illnesses

Objectives

Main Objective: To design a system that can help pet owners to detect feline and canine diseases at home and receive a recommendation with suitable medications or treatments.

1. *AI for Disease Detection:* To design a system that can diagnose or predict feline and canine diseases using a trained Artificial Intelligent (AI) model.

2. *Image Processing for Disease Detection:* To be able to detect certain skin conditions such mange, ticks and fleas, and fungal infections using image processing.

3. *Generating Prescriptions:* To be able to prescribe medicine accordingly after the diagnosis and provide instructions on how to use them.

Research Methodology

Artificial Intelligent for Disease Detection

The first objective of this project is to train an Artificial Intelligent (AI) model to predict the disease when the symptoms are given. AI refers to a machine's ability to study how a human learns, such as through image recognition and pattern detection in a challenging setting [2]. In health care, AI is changing the way data is collected, analyzed, and generated for patient care.

Large, multivariate datasets are frequently used to train AI and machine learning algorithms, which are subsequently used to make predictions on fresh data (for example, by classifying tumors in radiological images as benign or malignant). Importantly, the calculations that these approaches use to create their output are not explicitly written by a programmer; rather, the algorithm "learns" from example data implicitly (thus the term "machine learning") [12].

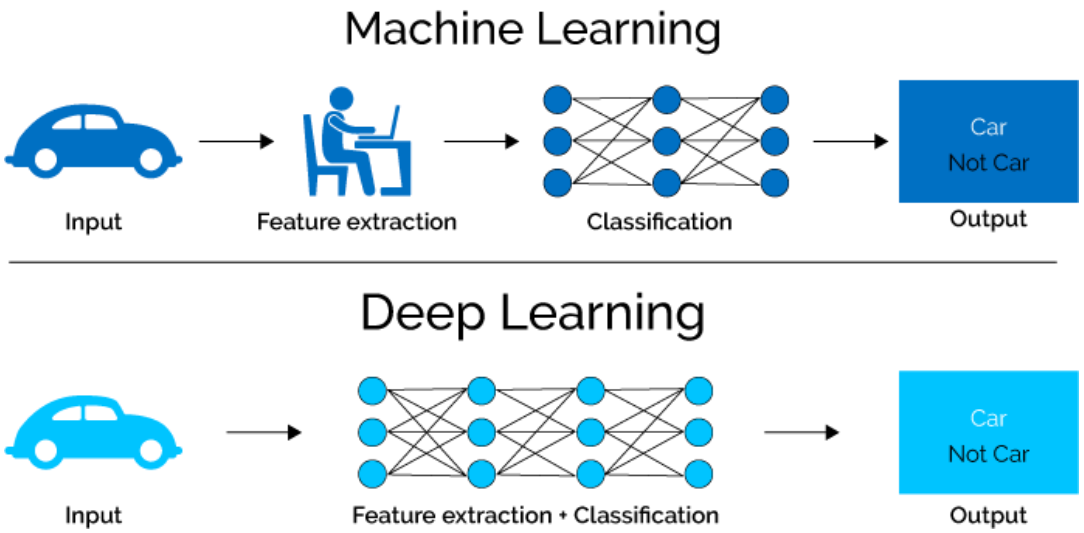

Figure 1. Machine Learning vs. Deep Learning

In order to train the AI model, a significant number of research papers related to feline and canine diseases should be used. Resources can be gathered using various databases and datasets. Real-world data frequently contain inaccuracies in the measures used and the predictions done by the AI model should not be affected by such errors. Therefore, to eliminate such errors, a quality assessment of the data will be performed [1].

The process of training the AI model is shown in the diagram below.

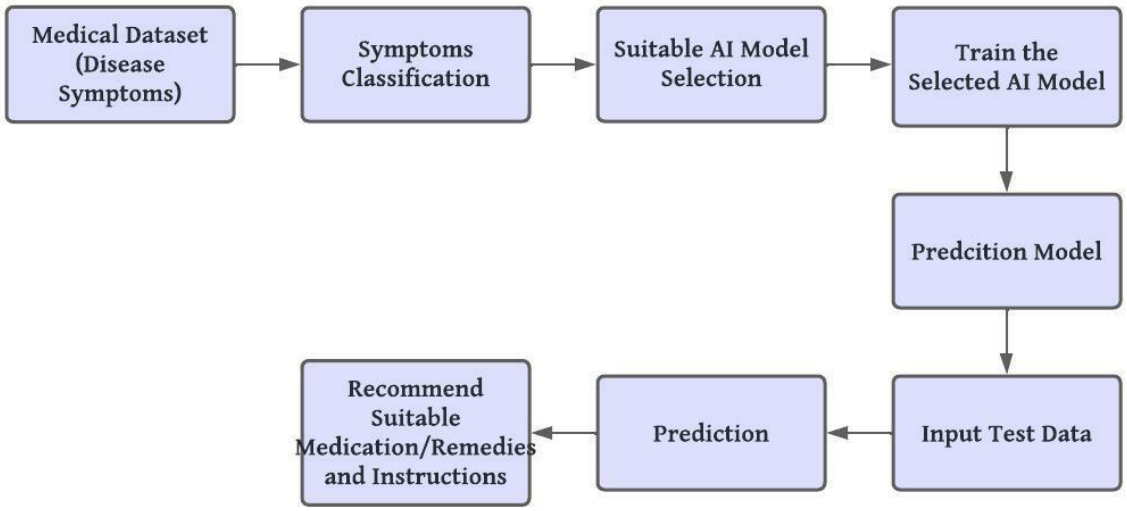

Figure 2. Disease Detection System Framework

Image Processing for Disease Detection

To detect skin diseases or parasites on a pet's skin, image processing will be used in PetVet. A diagram of the skin disease detection process is attached below.

- *Image Segmentation:* is a method for breaking down a digital image into multiple subgroups called Image segments to reduce the image's complexity and make future processing or analysis easier. In simple terms, segmentation is the process of assigning labels to pixels.
- *Feature Extraction:* a step in the dimensionality reduction process, which divides and reduces a large collection of raw data into smaller groupings.
- *Image Classification:* the practice of identifying and labeling groupings of pixels or vectors inside an image based on certain criteria. One or more spectral or textural properties can be used to create the classification law. There are two types of categorization methods: supervised and unsupervised.

  Unsupervised classification is a fully automated approach that does not require any training data. During the image processing step, the specified qualities of a picture are systematically detected using a suitable algorithm. Image clustering and pattern recognition are the categorization methods employed here.

Supervised classification is a process of visually selecting samples (training data) within an image and assigning them to pre-selected categories (i.e., roads, buildings, water bodies, vegetation, etc.) to create statistical measures that can be applied to the entire image. Two typical strategies for categorizing the full image using the training data are maximum likelihood and minimum distance [19].

- *Image Detection:* is the process of recognizing a certain object or feature in a photograph or video. Defect detection, medical imaging, and security surveillance are just a few of the applications.
- *Prediction Model:* is the outcome of the process. This model has the ability to detect a skin disorder and predict it.
- *Prediction:* after providing the test image to the system, the system itself will predict the skin disorder as the output.

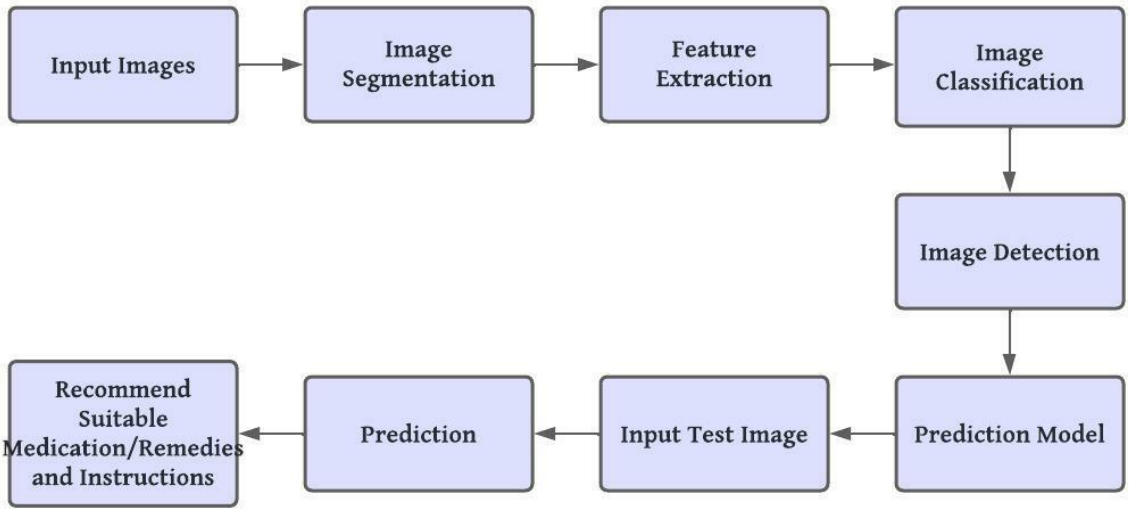

Figure 3. Image Recognition Framework

Generating Prescriptions

After predicting the disease using symptoms or images provided, a list of treatments and medications will be generated along with a set of instructions on how to use them. If the system fails to predict the disease, or if there are two or more similar diseases, then the system will ask the user to get further medical assistance from a veterinary surgeon to properly identify the disease/illness. It is done to make sure that there will be no errors in disease prediction and prescriptions.

This system is created as a web application because it will be accessible from mobile devices as well as computers. This will not require a monthly subscription or any additional charges from the users. It can be used on both Android and iOS devices. Since this is a web application, the user will be able to use the system on a computer as well. If needed, the web application can be converted into a mobile application at any time. Some of the advantages of mobile websites are listed below.

- Compatibility
- Upgradability
- Can be easily found.
- Can be shared easily between users and by publishers.
- Has a broader reach.
- Lifecycle (cannot be deleted)
- Time and cost-efficient
- Easy to maintain

Timeline

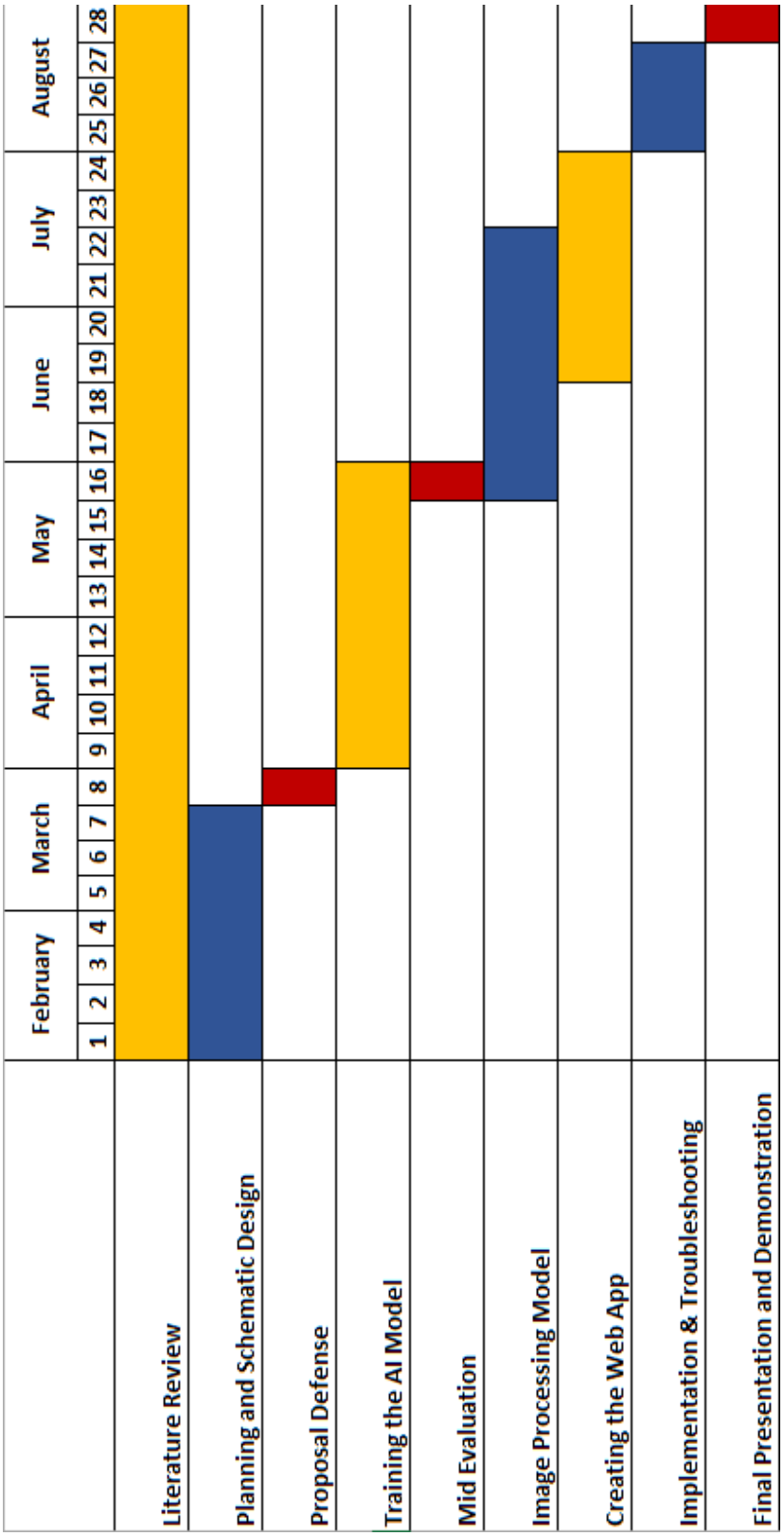

Figure 4. Timeline

Outcomes

The outcome of this project is to design a system called ‘PetVet’ that can be used to predict feline and canine diseases when symptoms and/or images are given as inputs. This can be demonstrated as a web application.

Two of the main objectives of PetVet are to predict diseases and prescribe medicines once the prediction is done by the system. Also, a set of suitable instructions will be provided along with the prescription on how to use medicines.

This app can be used without a monthly subscription or any other additional charges. Which means it is 100% free. Therefore, it will be cost-efficient for the users and more users will tend to use it.

Although the system predicts diseases, there will be diseases with similar symptoms, or the user will not provide enough symptoms to predict the disease properly. In situations like that, the system will suggest the user get further medical assistance from a veterinary surgeon in order to diagnose the illness of the cat or dog properly.

References

[1]Y. Kumar, A. Koul, R. Singla, and M. Ijaz, "Artificial Intelligence in Disease Diagnosis: A Systematic Literature Review, Synthesizing Framework and Future Research Agenda", *SpringerLink*, 2022. [Online]. Available: http://doi.org/10.1007/s12652-021-03612-z. [Accessed: 16- Feb- 2022]

[2]M. Tengnah, R. Sooklall, and S. Nagowah, "A Predictive Model for Hypertension Diagnosis Using Machine Learning Techniques", 2019. [Online]. Available: http://doi.org/10.1016/B978-0-12-816948-3.00009-X. [Accessed: 27- Feb- 2022]

[3]N. Soliman and A. ALEnezi, "A Method Of Skin Disease Detection Using Image Processing And Machine Learning", *ScienceDirect*, 2019. [Online]. Available: http://doi.org/10.1016/j.procs.2019.12.090. [Accessed: 20- Feb- 2022]

[4]A. Litster and R. Atwell, "Feline heartworm disease: A clinical review", 2008. [Online]. Available: https://doi.org/10.1016/j.jfms.2007.09.007 . [Accessed: 15- Feb- 2022].

[5]"Heartworm in Cats", *Cornell University College of Veterinary Medicine*, 2016. [Online]. Available: https://www.vet.cornell.edu/departments-centers-and-institutes/cornell-feline-health-center/health-information/feline-health-topics/heartworm-cats . [Accessed: 13- Feb- 2022].

[6]"Seizures/Epilepsy in Cats | International Cat Care", *Icatcare.org*, 2018. [Online]. Available: https://icatcare.org/advice/seizures-epilepsy-in-cats/ . [Accessed: 22- Feb- 2022].

[7]A. Goddard and A. Leisewitz, "Canine Parvovirus", 2010. [Online]. Available: https://doi.org/10.1016/j.cvsm.2010.07.007 . [Accessed: 06- Mar- 2022].

[8]R. McMillan, "Dog fleas vs cat fleas: What's the difference?", *PetsRadar*, 2021. [Online]. Available: https://www.petsradar.com/advice/dog-fleas-vs-cat-fleas . [Accessed: 08- Mar- 2022].

[9]M. Rust, "The Biology and Ecology of Cat Fleas and Advancements in Their Pest Management: A Review", 2017. [Online]. Available: http://doi.org/10.3390/insects8040118 . [Accessed: 08- Mar- 2022].

[10]M. Weir and E. Ward, "Rabies In Cats", *Vcahospitals.com*. [Online]. Available: https://vcahospitals.com/know-your-pet/rabies-in-cats . [Accessed: 08- Mar- 2022].

[11]P. Ezanno et al., "Research perspectives on animal health in the era of artificial intelligence", 2021. [Online]. Available: http://doi.org/10.1186/s13567-021-00902-4 . [Accessed: 06- Mar- 2022].

[12]J. Schaefer, M. Lehne, J. Schepers, F. Prasser, and S. Thun, "The use of machine learning in rare diseases: a scoping review", *SpringerLink*, 2020. [Online]. Available: https://doi.org/10.1186/s13023-020-01424-6 . [Accessed: 27- Feb- 2022].

[13]M. Arifin, M. Kibria, A. Firoze, M. Amini and H. Yan, "Dermatological disease diagnosis using color-skin images", *Ieeexplore.ieee.org*, 2012. [Online]. Available: https://ieeexplore.ieee.org/document/6359626 . [Accessed: 10- Mar- 2022].

[14]A. Krizhevsky, I. Sutskever and G. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks", *Proceedings.neurips.cc*, 2012. [Online]. Available: https://proceedings.neurips.cc/paper/2012/file/c399862d3b9d6b76c8436e924a68c45b-Paper.pdf . [Accessed: 11- Mar- 2022].

[15]C. Liu, D. Jiao and Z. Liu, "Artificial Intelligence (AI)-aided Disease Prediction: Ingenta Connect", 2020. [Online]. Available: https://doi.org/10.15212/bioi-2020-0017 . [Accessed: 11- Mar- 2022].

[16]K. Pingale, S. Surwase, V. Kulkarni, S. Sarage and A. Karve, "Disease Prediction using Machine Learning", *Mail.irjet.net*, 2019. [Online]. Available: https://mail.irjet.net/archives/V6/i12/IRJET-V6I12122.pdf . [Accessed: 12- Mar- 2022].

[17]A. Jamgade and S. Zade, "Disease Prediction Using Machine Learning", *Irjet.net*, 2019. [Online]. Available: https://www.irjet.net/archives/V6/i5/IRJET-V6I5977.pdf . [Accessed: 28- Feb- 2022].

[18]D. Shetty, K. Rit, S. Shaikh and N. Patil, "Diabetes Disease Prediction Using Data Mining", *Ieeexplore.ieee.org*, 2017. [Online]. Available: https://ieeexplore.ieee.org/document/8276012/ . [Accessed: 05- Mar- 2022].

[19]M. Shinozuka and B. Mansouri, "Synthetic aperture radar and remote sensing technologies for structural health monitoring of civil infrastructure systems", 2009. [Online]. Available: https://www.semanticscholar.org/paper/Synthetic-aperture-radar-and-remote-sensing-for-of-Shinozuka-Mansouri/1adf98c1ab66be0ddd9fbc6ba8b8189b4edb7a71 . [Accessed: 02- Mar- 2022].