

**DOGODO: IOT BASED ENHANCED MOBILE
APPLICATION TO PROVIDE ESSENTIAL HEALTH
SERVICES TO DOGS**

Group project

2021-162

BSc (Hons) in Information Technology
Specializing in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology
Sri Lanka

October 2021

**DOGODO: IOT BASED ENHANCED MOBILE
APPLICATION TO PROVIDE ESSENTIAL HEALTH
SERVICES TO DOGS - BREED YOUR PET**

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2021-162

Dissertation submitted in partial fulfillment of the requirements for the Bachelor of
Science in Information Technology Specializing in Information Technology

Department of Information Technology

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Sri Lanka

October 2021

DECLARATION

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ABSTRACT

The proposed system will mainly cover the relevant areas that are supposed to be covered to full fill the pet owners' expectations by providing the necessary services. Such as Internal Health (what are the issues and what actions should be taken, Voice Recognition and translations, external issues such as skin diseases, and breeding patterns and breeding outcomes). Team priority is to emphasize necessary services that should be included in the mobile application and provide fluid services with fewer interruptions. And also, a service that has been never issued perfectly and solely to the Dog owners in a one go. Finally, this service will provide both the IoT devices and the supportive mobile app

ACKNOWLEDGEMENT/DEDICATION

I want to take this opportunity to express my deepest gratitude to everyone who helped us with the encouragement and support we needed and provide their slightest support. First, we would like to thank Mrs.Disni Sriyathna, the supervisor, and Mrs.Shalini Rupasinghe who are in charge of our project, for leading us in the right direction to make this project a success.

Our gratitude extends to Dr. Janaka, Lecturer in charge of the research project module, for providing his guidance and constant supervision as well as providing necessary information regarding the project and for their support in completing the project.

Also, we would like to mention the staff and lecturers at the Sri Lankan Institute of Information Technology, who have been provided with the ultimate guide and support for the entire four years. Finally, to support and strengthen our family members and friends who have always been pillars in our success.

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LIST OF ABBREVIATIONS

1. KASL - Kennel Association of Sri Lanka
2. CKC- Ceylon Kennel Club
3. IoT – internet of things
4. ML- machine learning
5. AI- Artificial intelligence
6. Rs. – Sri Lankan rupees
7. Mfcc - Mel-frequency cepstral coefficients
8. ANN- Artificial neural network
9. SVM - Support Vector Model
10. CNN-Convolutional Neural Network
11. CSC-Color Space Conversions
12. DL-Deep Learning
13. HSL-Hue Saturation Lightness
14. HSV-Hue Saturation Value
15. NPL-Natural Language Processing
16. NUL-Natural Language Understanding
17. OpenCV-Open-Source Computer Vision
18. POS-Parts-of-Speech
19. RGB-Red Green Blue
20. SVM-Support Vector Machine
21. JSX-Java Script XML
22. XML-Extensible Markup Language

INTRODUCTION

Background Literature

A pet dog can bring love and companionship to a family or a person. That is a well-known fact among the community. To reduce stress, prevent loneliness, people tend to keep a dog around them. Having a dog or in other words, raising a dog is not an easy task. We need to take care of them as well as get benefits out of them in return. Sometimes taking a pet to a doctor might be a tedious task depending on the person's schedule. Or else it would be hard to have a transport system depending on the size of the dog. And also lack of knowledge on dogs' health can be a disaster to prevent long-term risky issues. To answer this gap, we initiate a solution that covers almost every aspect that needs to cover in terms of dog health issues. This solution will offer (smart health tracker which predicts health patterns and suggests activities and prevention methods, dog translator, breeding and predictions based on breeding module, skin-related disease identifier, and remedy suggestion module).

Lets look at this components individually!

- **Smart Health Analyzer**

This module will carry out the task of implementing the smart health tracker and prediction-based IoT solutions providing devices. This module will mainly cover the Heart Rate tracker/ Body temperature tracker and Footstep's tracker. Unlike other devices in the market which provide just the heart rate, Temperature, and footsteps, this device will use the above sensor information for further usage of generating predictions and to identify patterns in dog's health. Identified sensor information will be stored in a server where it uses machine learning algorithms to identify patterns in a dog's health and generate useful predictions for the usage pet owner. Hence the pet owner will be able to identify abnormal temperature patterns of their dog, is their dog less active in general or especially during a certain period. And also, the owner will be able to know about heart rate-related issues. This device will be released with an eye-catching well synchronized mobile app where the owner can use to know about every detail which the device catches in advance.

As humans, we buy dogs for different purposes in our life. Some raise dogs for their protection, some to prevent loneliness, and also, some people raise dogs to play with their kids. Throughout the pet's life, the dog gives their services to humankind. But sometimes

dog's health situation can be a burden to their owners. This happens because of the lack of awareness of the symptoms which owners couldn't identify at the early stages. For humans, we can identify any sort of illness before the actual cause from symptoms. But when it comes to dogs and any other animal which we raise as pets, it's really hard to identify any abnormality in their health statuses.

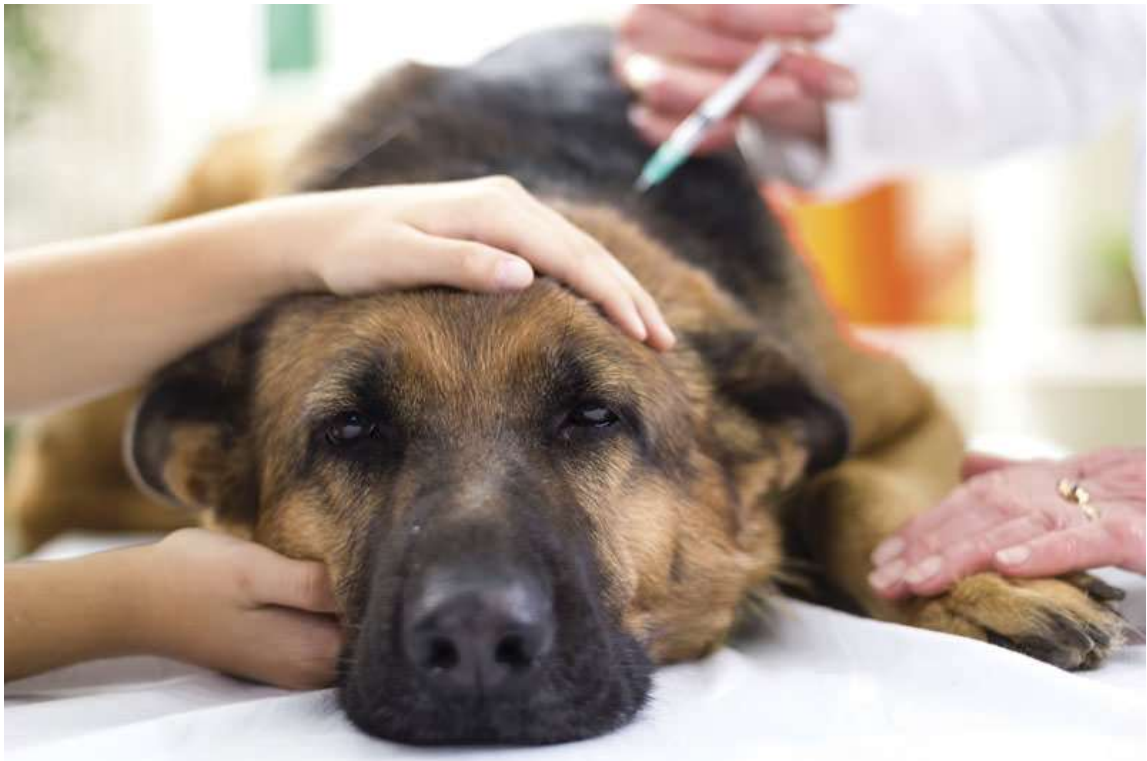


Figure 1 Health Status

This question still hasn't been answered in the industry properly. Pets and their owners cannot establish a proper communication system among them as humans do with each other with languages. Therefore, when it comes to health issues, owners rarely find any differences or behaviors in their dogs. And another problem is "when to visit a doctor?". Often this question leads to a couple of questions back-to-back, Is this a small issue? Or should I take my dog to the doctor for this certain problem?

These problems mostly arise for, people who have some sort of large breed, which in turn becomes a hassle to take the dog to the doctor. As Sri Lanka is a developing country, we do not find easy access to veterinary doctors near every city. Some pet owners might have

to take a couple of extra minutes or hours to visit a Veterinary doctor. Due to all these reasons, the chances of owners neglecting or not seeing minor symptoms which can cause larger health issues are high. To address that we came up with an innovative solution that can easily deliver to every pet owner as a device and a mobile app which will perfectly sync along.

The above solution will provide the owner with the benefits such as measuring and tracking dogs' health statuses whenever required. Especially, this solution will provide predictions and precautions by using daily calculated and measured data. This research will elaborate detailed information's on how this solution has answered certain questions which every pet owner has faced while raising a dog consecutively. And also, how this solution will make a difference in the pet care community as well as how well this solution will ease the tasks of dog owners.

- **Smart Sound Capture**

Many countries have developed new IoT-based devices and mobile applications for dogs for their well-being and dog owners' convenience. The Pet owner can be aware of their pet dog in a second from their mobile phone and take necessary actions accordingly. There is a need to pay attention to the number of stray dogs due to the repeated action of people abandoning dogs. In some cases, dog owners abandon the dog based on their health and behavioral issues.

There are enough systems in the market to calculate Body temperature, BMI, respiratory levels in humans. But there are only limited systems for animals that have been built to do the same thing. But still, those devices don't deliver the necessary factors such as by using sensor values to predict and analyze health-related issues in dogs.

Therefore, one of our primary targets (Smart Health Analyzer) is to use sensor values to predict and analyze data to suggest necessary actions that needed to take by owners for

their dogs (time series analysis of body temperature and use of history data values to identify health patterns, same predictions and analysis will be used for heart rate sensor values and calorie related statuses).

According to the studies, there have been some products which have been published, without any advanced technologies. However, this component will mainly tackle down all the other areas which haven't been answered by the industry as of now.

Dogs are sensitive and loyal animals to their human owners. Unlike experienced dog owners, amateur dog owners don't

have a good idea of what their dog is trying to communicate. There are only a few cases where machine-learning techniques have been used in behavioral research. A research that was done previously has no practical implementations. It has only focused on how machine learning algorithm models will work in behavioral science. How can a dog barking pattern be analyzed to understand what it is trying to say? When different dogs are breeding, what the result is, and the medical routines and food routines? How to identify the skin diseases, what is the treatment used? In some areas, veterinary services are not available 24 hours a day. So that, the lack of alternative treatments directly affects the dog owner and the dog.

- **Skin Disease Identifier**

Here, we mainly consider highlighted component in high level architecture diagram. Most pet owners probably overlook the importance of a pet dog's skin coat. The kindest and most responsible thing pet owners can do for him is to provide appropriate health care. Knowing about common skin dog diseases and how to avoid and treat diseases can make it much easier for pet dog owners to provide that care. The skin is a complex structure that provides an essential function in a dog's overall health. However, it is undeniable that these lovable animals are to various skin diseases, especially their skin, as it is the most extensive and most accessible organ of skin in their body. Comparable to humans, unfortunately, skin diseases are prevalent in dogs.

According to a local veterinarian, dogs have two main types of skin diseases: minor and severe skin diseases. The severe ones range from acute to self-limiting issues, while the incurable one is known as a persistent condition needing lifelong care. Many minor skin diseases originate in dogs, the most common inherited skin disease. For example, contagious skin diseases include parasitic, bacterial, fungal, and viral skin diseases. The non-contagious skin diseases include mange, mites, and lice, all fall within this category, along with flea and tick infestations. Despite technologies, there will still be limited use of the proposed system to identify skin diseases in dogs, which are not properly localized. The current proposed system for diagnosing skin diseases in dogs can only identify two types of skin diseases.

- **Dog breeding predictor**

Dog breeding is one of the very important things for pet owners. Some people know what kind of pet will be born to their dog. But there are a lot of people in the world who do not have much experience about dogs. But they are keeping dogs as their pets. Those people do not know what type of pet will be born, how it will look like, what are the treatments, medical routines, and food routines for newborn pets.

Also, the pet owners have a very big problem which is to identify the result of mix breeds. Because people most of the time know the result of pure breed but they do not know the result of mix breed. Because there are two types of pet owners in the world which are experienced and inexperienced pet owners. Most of inexperienced pet owners would like to know after crossing their dog with some other dog, what kind of pet will be born for their dog. Also, they would like to know how they should take care of them, what are the medical routings and food recommendation for their newborn pet. Using this mobile application, the user can identify the result of pure breed, result of mix breed, what are the treatment and medical routings. Also, they can identify what kind of food is recommended for their newborn pet. In this application we are mainly considering the size of dog for these prediction and recommendations.

When we are talking about dog size, there are 4 kinds of breed sizes are considering in this project. Those sizes are toy, small, medium, and large. When we are talking about toy breed this breed of dog has been considered a very small breed of dog since ancient times. These can come in different sizes, and there are several different types. In general, they are very small compared to other dogs. These dogs are said to be descended from lapdog dogs of the past and are also considered small breeds of hunting dogs or working dogs. They are not used for hunting and are bred by their owners as a symbol of wealth

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Small size dogs are larger than toy dogs and smaller than medium size dog breeds. These are not strong dogs. But their activism is generally higher. Some breeds have a very delicate body, but some dogs are very tough. These dogs are unfamiliar with some types of sedentary lifestyles and prefer to live in quiet environments.

Medium-sized dogs are neither too big nor too small. Many medium size dogs show playful behavior. Furthermore, these dogs in general show a kind nature. Dogs of this type are very friendly and obedient. Because of those things, this type of dog is often bred as a domestic pet.

When we are talking about large size dog breeds, these are larger than all other dog breeds. Generally, they prefer to rest for most of the day. They have been used primarily for hunting in the past. These dogs have an innate instinct. These dogs have been used in recent times for protection and as pets. However, it is best to exercise daily to maintain good physical health.

There are more than 300 breeds of dogs in the world today. Here all the dogs are divided into the 4 groups mentioned above. In this project we are only use 6 breeds for food recommendation. Those things done for the dogs according to their size.



Figure 2 Behavior attention

Small pieces of food are best for small and toy dogs when considering their diet. They are very active and speed up their metabolism. For these reasons, small pieces of food are said to be more suitable for them. Providing a balanced diet in this way also helps them maintain good health.

Medium size dogs can be seen in large numbers nowadays. These dogs need slightly more food than small dogs. Here the food recommendation we issue is made under full medical



Figure 3 Dog walking

supervision. Therefore, giving these food recommendations will enable the dog to lead a healthier life.

Similarly, when considering large size breeds, these dogs have a tendency to eat pet owners unknowingly. They think that these dogs are so big that they need to be fed a lot of food. But that is not correct. They grow very fast at a young age, so you need to consider your diet carefully. Excess growth can have a detrimental effect on health. Usually, the pet owner has to consult a veterinary doctor to get a food recommendation for this. Here we have done the study work and with the approval of the doctors, we have made arrangements to give this food recommendation to the pet owner through our app.

Pet owners should also be concerned about the health of their pets. Pet owners pay special attention to dogs when they are young, and gradually reduce their concern for their health as they age. But most of all, health concerns should be addressed as the dog ages. Puppies should be vaccinated from 6-8 weeks of gestation to 3 years of age.

This usually happens when the pet owner goes to the medical office to find out. The advice given there is usually to treat their pet. But with the medical recommendation given by our app, the pet owner will be able to know all that information. This will allow them to know when to give their puppy the medication. The pet owner will also be able to understand what medications are being offered. The medical recommendation given here is generally suitable for puppies and may vary for dogs with special needs. The medical recommendation given here is issued under full medical supervision. By giving the medical recommendation given here properly, it is possible to give the best care to your pet.

Another important consideration for pet owners is finding a partner for their puppy. Here you can get the details of the dogs of the pet owners who have registered for this app. Here, dogs that are mainly related to their dog breed are shown if this app is registered. This will make it easier for the pet owner to find a suitable partner for his dog. Here you can get things like dog type, dog age, pet owner contact details.

With these points in mind, this component of the project will work. This allows the pet owner to easily know what kind of dog his puppy is born with. You will also gain an understanding and knowledge about food and medical recommendation. They also have the ability to easily find the right partner for their dog. In addition, the details of our survey are discussed below.

A survey was performed to assess the degree of the dog owner. A Google doc was used to build the survey. Around Sri Lanka, dog owners were chosen at random, and the survey was distributed to them via social media such as Facebook and WhatsApp. Also, the survey was also sent to several dog owners by email. The survey had questions to cover our entire group research and here only related to breed your pet which is my topic will be evaluated. Around 58 responses were collected from dog owners. From the survey following figure shows the level of knowledge about dogs of dog owners.

Research Gap

There are multiple solutions in the market to track different aspects of a dog's health. For an instance, there are a couple of devices that can measure the body temperature, footsteps, and heart rate of the dogs. But the main concern is what shall the owner do with the device information? The main reason that pet owners fail to identify and take actions for certain illnesses of dogs is not knowing enough information about the procedures. Even though there are apps and devices in the market, there hasn't been any solution that can provide a **“what can you do next?”** answer along with the system. Here are the gaps which I found in the community and can be filled with an innovative and efficient solution.

Heart rate tracker which can identify patterns and predicts health statuses and activities accordingly

There are a couple of IoT devices in the market that can measure a dog's heart rate. But these devices have been framed just into showing what is the current heart rate for the moment. This solution will never identify any problems with your dog. To further elaborate how this gap has been affected the pet owners is, the current heart rate can be misleading due to the situation. The normal resting heart rate of a dog usually ranges between 70-120 .But this range can be slightly changed according to the weight and height of the dog. Therefore, just by measuring heart rate one time, an owner can't come to any conclusions about the dog's health status. To overcome this issue, pet owners require a device that can take heart rate information daily over a while to identify any pattern of a dog's health.

Temperature tracker which can identify body temperature and inform about abnormal signs during a certain period.

There are devices to track the body temperature of dogs. But as mentioned earlier, there is not much value in calculating current body temperature to come to any conclusion. Here are a couple of factors that can affect the dog's body temperature,

- Sensitivity towards the environment heat changes
- Lack of water consumption
- Consumption of foods that increase the body temperature

By considering the above factors, pet owners can't straight away come to any conclusion with one-time sensor information. If there's enough information to identify sudden body temperature ranges, an owner can take action accordingly. A device that can store data and identify any patterns, can save lots of dogs from health issues.

Foot's step tracker can identify daily footsteps and suggest exercises according to the daily activity level of the dog.

In general, dogs are very active animals. But this factor can get drastically change according to its environment. Here are some reasons that dogs can be less active,

- Dogs tend to play a lot with the owner or some other animal. If they don't get companionship, they tend to become less active and stressed
- When dogs get less attention, they tend to get depressed and anxiety
- Due to the busy routines of the pet owner, they tend to feed fast and process foods for their dogs. This can lead to extreme health risks
- Some breeds are less active in general (Basset Hound, Pug, Great Dane, etc.)

Activeness is one of the main factors which contributes to a long healthy life of a dog. Most of the time dogs stay at home alone without any company. During this period dogs tend to sleep more. This routine can make a dog a less active one. In long run, this issue can lead to several issues. To prevent that owner can track the footsteps of dogs with current devices in the market. But that won't do the necessary actions which require. These activities should be recorded. And this information can be used to identify how many footsteps that the dog has taken as an average per day and week. If there's a solution that can identify these patterns and suggest exercises for the dog, it can prevent lots of dogs from getting victims of heart diseases.

When taking into consideration all the readings illustrated in the literature survey, it is distinguishable that there is a considerable audience in the society who interested in understanding what their pet dog is trying to communicate to them but due to the lack of knowledge and the experience required most dogs are not aware what the dog trying to communicate. Therefore, they may be not able to properly attend to their pet's physical and mental wants and needs. Especially the mental state and mental requirement. Unlike physical requirements, mental needs cannot be seen physically. These can be identified by only carefully listening to the dog's acoustic characteristics of the barks. Veteran dog owners may be able to identify this based on their experience, but most armature dog owners might not understand this. Due to this reason, most inexperienced dog owners are willing to get all the help they can to understand their dogs better. Therefore, most dog owners don't mind spending few bucks on a device that could help the owner understand their dog better.

Even though there is a clear requirement for a dog translator from dog owners, but when a dog owner seeks such a device that can translate their dog's barks there are very limited dog translator solutions available in the market. As we tested most mobile apps are just simulators which has no actual proper translation and other available device has many constraints to them.

Today smartphones are so common and almost everyone owns a smartphone. Smartphone has been evolving and this device has been improving to be almost good as modern computers with plenty of processing power, but this processing power has not been utilized to understand your pet dog's communication properly. With the help of cloud services, this processing power can be improved further for better analyzing performance. Unlike other translating devices if the smartphone can be used

for translation, no additional device is required to carry and since modern smartphones are powerful devices these translations can be done much more efficiently spending much less time. According to research done by "Molnár, Csaba

Kaplan, Frédéric Roy, Pierre Pachet, François Pongrácz, Péter Dóka, Antal Miklósi, Ádám” on the classification of dog barks: A machine learning approach only on how machine learning algorithm models will work in behavioral science of dogs barking patterns. It has been only focused on how the algorithm will be behaving and there are no practical implementations. The study results have only focused on some very basic dog barking behavior. With an IoT device, Smartphones, and cloud service no practical implementations have not been tried before on dog barks translating.

There are some solutions in the market to identify the result of dogs’ breed, recommending the food and medical treatment for the newborn pet. Also, there is not any application to find a perfect partner for your dogs. As for an instance, there are some applications that can identify the result of mixed breed using dogs’ pictures. Some applications recommending food and medical routings without having knowledge about the newborn pet. But the main concern is providing the proper answer for the above problems. The main reason owner is not using an application to find the solution for the above problem which is those application does not get the necessary information about dogs to provide the proper answer about those problems. It is not providing the proper solution, only generate common answers. Here are the gaps which I found in the community and can be filled with an innovative and efficient solution.

“Find your pet’s partner” Using this component owners can find the perfect partner for their pet.

There are some websites available in the market [ref]. But it has a lot of limitations. When creating an account on site it is not requesting medical information, high, weight, dog group, fur type, life span, and their parent information. And only one photo can upload your pet. Because lack of information, pet owners cannot find a suitable partner for their pets. To further elaborate how this gap has been affected to

the pet owners is, withing that information system cannot automatically recommend the partner for their pets.

“Breed your pet” Using this component owner can get a clear idea about the newborn pet. There are some applications available in the market which can find the type of dog using photos[ref]. That means is after born a new pet we can identify what kind of do is it. But from a picture cannot get all the related information and give the proper answer. The owner cannot get a clear idea about the newborn pet before the pet is born. And those applications are not requesting much information as I mentioned earlier. Most inexperienced pet owners do not know what they should do after the pet is born. They do not know the food recommendations and medical recommendations for the newborn pet.

By considering the above requirement there is not any application provide to answer the above requirements. And the same time application and websites in the market have a lot of limitations and those services are very expensive.

RESEARCH PROBLEM

Every living being gets adapted to their environment. Irrespective of the breed, behavior, and capabilities, they get familiar and knowledgeable about their precinct. There are two sides to this matter. In a way, it is an advantage to become knowledgeable about its environment. But being adopted to its environment has its consequences. For example, if we raise any kind of a pet in a domestic environment for a couple of months, it gets adapted to the domestic environment and won't be able to get along with the wild animals and outside. Pet owners need to be aware of their pet's environment and how comfortable the current precinct is to them.

Their immune system

The immunity system is one of the most important parts that pet owners need to be careful about when it comes to their pets' daily routines. Especially what are the foods that they eat and what sort of routines that they follow when it comes to a particular day? For an example, dogs can have a different kind of a routine compared to a cat. Usually, cats like to stay neat and clean and usually in clean surroundings. Therefore, they don't attract many digestives and immunity-related health issues. For a cat pet owner, it can be an added advantage that comes from the behavior of cat breeds.

But for dogs, it's the other way around dog's sniff and licks pretty about everything, so their bodies have a different method of coping with dirty things. However, this does not negate the need of keeping a dog clean. The most important aspect in strengthening a dog's immune system is maintaining adequate cleanliness. Your dog's immune system has to cope with dirt and germs daily. Of course, some germs and parasites can assist your dog's immune system,

but there should be a healthy balance. Regularly washing your dog will reduce the number of germs in his system, allowing his immune system to focus on more vital battles. Keep in mind, however, that frequently does not imply constantly. Your dog's immune system may become weakened if he is kept excessively clean.

Reaction to the environment changes

When the weather gets warmer, some dogs get thrilled, while others seek out cool, shaded locations to relax. While all dogs are exposed to the dangers of hot weather, some dog breeds are more heat resistant than others. Normally when dogs get raised in a colder environment, they tend to get rashes when they move into a warmer environment. Its all due to being adopted to its precinct and being comfortable accordingly

Bulldogs, French Bulldogs, Pugs, and Boston Terriers are brachycephalic breeds that fare best when kept cold in hot weather since they have trouble breathing in high heat.

Large breeds, as well as longhaired breeds like the Komondor, Afghan Hound, and Alaskan Malamute, are vulnerable to heat. If you own one of these breeds, you may notice that your dog is less active in hot weather and less inclined to play and engage in other activities

Insect bites

Ticks and other insects are normal routines for all wild animals. It's because wild animals easily get ticks and other cold-blooded insects from their precinct. Due to that, they carry those insects with them everywhere they go. And also, these insect bites don't give them any diseases especially. Due to being bitten by insects in a daily basis, these wild animals have been adopted to their consequences and abnormal disease which domestic pet gets.

On the other hand, domestic pets usually tend to get fever frequently due to being bitten by these insects. Due to being raised in a comfortable precinct, domestic animals are uncomfortable with insects such as ticks. Therefore, pet owners need to pay extra attention to their pets daily and need to be very careful when it comes to going for walks on paths filled with grass and sand.

Foods and liquids

Often wild animals' digestive systems are bulletproof for any kind of food that they consume. Due to not having regular meals by a master, they usually dump and consume almost anything edible. Hence wild animals rarely get infections from foods. But on the other hand, domestic animals need to be carefully tracked on what they consume by keeping an eye on the foods that they consume. It's because by being raised in the domestic environment they have sensitive digestive systems most of the time. Therefore, we need to have a proper diet routine for domestic pets at least for a certain amount of period in their life cycle.

If we ignore these truths, it can lead to serious health problems for any type of pet. Depending on the environment in which they develop, they will be distinct and acceptable. A stray dog reared on the streets may have a robust immune system, but a domestic dog kept exclusively within a house may have a poor immune system. Because of these factors, dog owners must have some level of education to own a dog. However, not every pet owner can afford to be well-versed in every topic before purchasing a pet.

Raising an animal is a step-by-step process that provides valuable knowledge to the person involved. Every puppy owner provides more attention throughout the puppy stage. However, as the dog ages, this procedure becomes increasingly ignored. A puppy should be taken to the veterinarian weekly and monthly until it is a year old, as is the typical procedure for a newborn dog. Vaccinations and other treatments for growth and

health are given to the puppy at this time. Treatments are gradually decreased to long periods after the first year (during the first year, every month).

After the first year, every six months, and so on, as directed by the doctor). Even though the vital treatment periods are gradually reduced, pet owners should be concerned as usual about their dog's health. But most of the time this factor gets neglect among the community. This neglect can be caused by,

A busy schedule of the pet owner

It has been a common fact that people tend to adopt dogs and neglect them after a while. Mostly when the pet is only one year or two years, they take care of the puppy. But most of the pet owners neglect the puppy after two years. The most dangerous side is neglecting the medical routines of domestic dogs. When dogs raise domestically, owners need to have a solid medical routine to take care of their dogs.

Lack of knowledge about the dog's health

Pet owners need to have some sort of knowledge when it comes to taking responsibility for a dog. Like taking care of a human baby, puppies also need to have special care in the early stages. Especially as aforementioned, puppies need to have diets and medical routines in their early stages. Since we are separating it from its parents, we need to provide the right nutrition which it gets from the mother puppy as milk.

Thought of giving healthy foods would be just enough

Giving healthy foods would not be the only factor when it comes to the health of a dog. Dogs need to be trained and exercised regularly to keep a good cardiovascular system. Unlike wild animals, domestic dogs tend to have fewer active levels daily. But if pet owners feed them more than they required as daily calories, they need to look for cardiovascular issues as well. Domestic dogs tend to get more cardiovascular-related issues due to neglecting exercises and walk frequently .

Dogs tend to do activities on their own

Domestic dogs tend to have at least two meals a day. In south Asian countries, the main meal always consists of heavy carbohydrates. And also, domestic pets eat what most of the families consume daily. Therefore, pets consume more calories in a day. So, these domestic pets need to take out for long walks to burn those excessive calories.

Otherwise, pet owners need to provide them with a proper diet with fewer carbohydrates and more proteins. One of the myths that run around in the society is that when dogs walk here and they're in the home precinct would be enough to calculate their activeness in a day. Dogs need to have space to run and walk, but it shouldn't be few minutes like domestic pets do daily.

Not seeing any signs of illness from outside

Pet owners cannot identify each issue of their pets by looking at them externally. It's because not all the symptoms come outside as a side effect to identify the diseases or particular issue. Therefore, pet owners need to be concerned about all the temperature/pulse and heart rate changes of the dogs as well. For that pet owner needs to be educated about the dogs to some extent. This has been a massive issue in society as of now. Pet owners normally care about dogs when they see any symptoms. Otherwise, they won't put much attention to the dog as they normally should. Due to that, there's a possibility to miss some dangerous issues which pets are suffering day today

Most of the time these neglections get ended up giving long-term health issues to dogs. With the correct use of technology, these problem gaps can be answered efficiently. Unfortunately, the solutions that have been released to the market hasn't brought up to the point where it can give proper guidance and knowledge to the pet owners. As I mentioned earlier, a device that just measures (temperature, heart rate, and footsteps) does not educate or inform pet owners to take actions which requires for their pet dogs.

Domestic dogs should be paid more attention to carefully. With the current schedules and life patterns of people, it is something difficult to afford. But every problem has its way of solving. Therefore, my research will bring up a solution that can measure a track the internal health of dogs. Especially system will recognize unusual behaviors of the sensor information. And by using that information, the system will provide predictions and suggestions for relevant areas which the service requires. This solution's primary objective is to prevent dogs from diseases and laying a path to a healthy strong life.

Dogs are sensitive, intelligent, social, and loyal animals to their human companions. When someone acquires a dog as a pet it does not come with a manual 'how to adopt it'? It is all up to the owner to figure it out. If a dog owner is less experienced how to tell whether the dog is happy, hungry, sad, or bored? and what to do about it? In such a situation dog owners may find it difficult to adopt some breeds. These animals love to communicate with their owners. They use different methods to communicate with their owners and get their owner's attention towards them. Also, dog owners are willing to understand what their dog is trying to communicate to them.

When it comes to dog owners according to the above survey results, we can determine that there are mainly two types of dog owners

1. Less experienced dog owners

Even though there is no proper definition for ‘experienced’ dog owners these types of dog owners have vast experience and knowledge about dog behavior traits. They have acquired this knowledge by exposing themselves for a long time to their pet dog breed or multiple dog breeds at once. These owners usually can understand canine language, dog’s body language unique gestures, unique vocalizations patterns, accurately identify them. These types of dog owners know the basic principles of dog behavior, why dogs do what they do—including reading meta signals, avoidance behaviors, and displacement behaviors. These owners usually have no issues understanding their dogs accurately.

2. More experienced dog owners

These types of owners are less experienced dog owners. These less experienced dog owners have very little knowledge of dog behavior traits, gestures, body language, and barking vocalization patterns. According to the survey, we can see that most of these owners are being around their pet dog for less than one year or so. Unlike experienced dog owners, less experienced dog owners don't have a good idea or partially understand what their dog is trying to communicate to them. What if the dog is in pain or the dog needs any special attention, and it snarls in discomfort, but the less experienced dog owner does not understand what the dog is trying to say or knows what to do and just ignores the dog? The dog might face some uncomfortable situations and if it is a critical condition the dog might even face threats to its life. As an example, Beauceron is a breed with high intelligence and hyperactivity. If the owner is not active enough the dog might not be happy. These kinds of dogs will signal its owner that it needs to walk or do activities but if the owner is not experienced enough or knowledgeable enough the owner might not understand the dog’s need. Eventually, it will make the dog unhappy and stressed .

If the owner could understand or some experienced dog owner could assist the inexperienced dog owner in understanding their pet dog’s wants and needs, they will attend to their pet dog without any hesitation. If someone can understand vital and subtle signs to avoid conflicts with other canines. This is a vital factor as this might involve recognizing behaviors that are prey-driven, defensive, or compulsive. We can identify this by looking at the survey results (figure 1.4). It shows that most owners are willing to give special attention to their dog and they do care a lot about their pet dog. Always seeking help from an experienced dog owner to attend to your dog’s wants and needs can be disturbing to both parties. What if a software solution could assist inexperienced dog owners to understand their dog and provide guidance to what kind of steps they need to follow?

If we look at the market for alternative solutions, there are only very few cases where machine-learning techniques have been used in behavioral research on dogs. With a machine learning approach can a dog's acoustic barking patterns be analyzed and assessed to understand the dog better? Can the dog barking pattern translate and be displayed to a smartphone device in real-time?

Compared to human language dog language is less complicated. To translate and interpret canine vocalization patterns such as barks, groans, cries, howls, and whimpers into a language that can be understood by humans, using machine learning and deep learning approaches has not been completed yet. Even though there is some research on dog acoustic bark pattern identification [9] practical implementations of these research conclusions are not available.

With the ever-increasing applications of machine learning and deep learning can it be applied to translation and for vocalization patterns identification? If a dog's acoustic barking patterns are analyzed and assessed most owners will understand exactly what the dog needs. Also, with a help of a pre-trained machine learning model can it be identified? To answer these questions a classifier must be created. To train the model data will be needed to classify on a behavioral approach. Behavioral approaches mostly will be on feasible solutions more than optimal solutions due to their nature of behavior can sometimes be unpredicted. This project involves research into investigating the most efficient, effective way of translating pet dogs' vocal patterns to a smartphone to understand what the dog is communicating and the mental state of the dog such as happy, sad, need to be loved, feared, needs attention.

Dogs are sensitive, knowledgeable, social, and loyal companions to humans. When it comes to dog owners, we can also see that there are mainly two groups of dog owners, based on the survey data. They are experienced dog owners who have kept pets for a long time and inexperienced dog owners who are unfamiliar with newborn dogs, medical recommendations, and food recommendations. Inexperience dog owners does not like experience dog owners. Because they are very interesting to know all the information about newborn pet and how to care him. Without having knowledge about above problems people give them to food and medicine which used for peoples. Because of those things they have to face very bad situations. Sometimes they might be the death.

The other thing is both experience and inexperience pet owners want to find a proper partner for their pet. Base on the survey data we can see most of them find a mate to breed their dog from doctor and through word of mouth. Most people are busy with their day to activities. But when they are doing those things, they

have to wait more time to contact them. Before contact, the other owner they do not have and clear idea about the other dog and mainly they do not know the health detail, history of that dog and some other important thinks.

There are not applications with machine-learning techniques have been used to find the result of newborn pet. With a machine learning approach can identify the pattern of newborn pet after analyzing the information. Find the solution for above problems using artificial intelligence and machine learning approaches has not been successfully completed yet.

Withing the current schedule and life pattern of people, they have become accustomed to do their things quickly. They try do their works by own. However, each problem has its own way of solving it. Therefor my research will bring up a solution for 'find the result of newborn pet', 'recommending food and medical routings for newborn pet', 'help to find a perfect partner for your dog' and create a platform like social media to share their information among registered pet owners.

The development of health care has grown reliant on information technology and computer science. People are attempting to examine deeper into the many sectors of the health domain using computers and information technology to discover answers. On average, we are living in a golden age of medical research. People are always eager to get involved in this area, and they come up with new ideas to innovate human life. A thorough history, physical examination, and appropriate diagnostic tests are required to diagnose the causes of a pet dogs' skin condition accurately .

Many skin diseases have identical symptoms, making an immediate diagnosis difficult. A veterinarian may prescribe various laboratory tests based on the pet dog's history and physical examination. Diagnostic tests include skin scrapings and hair microscopic analysis, hair or skin swab cultures, specialized skin testing, blood, and urine tests, and even biopsies . The results of the laboratory tests may take several days to arrive. A proper diagnosis typically requires more than one visit. One of the research study's main problems is targeting to identifying common skin diseases in canines. Usually, the dog's skin diseases can be caused by environmental factors, food, insect bites, or various dog activities. Most people lack the proper knowledge about the skin diseases of dogs. Most of the time, these skin diseases can be easily treated with over-the-counter medication []. Often, canines develop skin diseases that need immediate relief.

The data received from the first survey is presented in the following figure 2.1. If you look closely, you will notice that most pet dog owners cannot understand if their

pet dog has an illness. When we get it as a percentage, it was 84% of survey respondents. Figure 2.2 shows the extent to which a pet owner can understand a dog's illness. Most of the respondents cannot properly understand the dogs' illness. The main reason for those two problems is that they do not have proper knowledge about their pet dogs or pay attention properly to their pet dogs.

RESEARCH OBJECTIVES

Main Objective

The main goal of the project represents the overall idea of this research project. Therefore, we have designed our main goal to address solutions to dog-related problems dog owners face from an overall perspective.

We have set out the main goal to be as create an efficient, effective, and easily accessible software solution for dogs' well-being. This software solution should allow dog owners to easily access a wide variety of services for their pet dogs in one place. The proposed solution should make the dog owner's and their dogs' lives much more comfortable. Also, this solution will focus on dogs' health and well-being as major concerns as for many owners this is the most important factor for them.

Sub Objective

This project has four different components. Each component has its sub-objectives to archive.

- **Smart Health Analyzer**

1. Heart rate sensor which helps to identify unusual patterns and predicts health

This is one component of the main IoT device (Smart Health Tracker). This component will mainly focus on tracking the heartbeat rate of the dog []. The primary target is to gather the heartbeat rate of the dog daily to identify any patterns that can cause harm to the dog and to prevent it by taking necessary actions. By using the functionalities of this module, the pet owner (user) can get an overall idea about past week's information's on the dog's heart rate. This module will help users to identify,

- Weekly or monthly heart rate patterns as a diagnosis report along with other sensor information's which can be shared with doctors and drug stores
- Low and high heart rate levels will be informed to the user.
- And also, information's will be shared through the app as suggestions on what users can do about those high and low heart rate levels
- Information's on risky heart rate levels. And especially reasons why it can cause.
- Exercise suggestions to main a good health

2. Body temperature sensor which helps to identify and track normal and irregular temperatures.

This is the second component of the main IoT device (Smart Health Tracker). This component will mainly focus on watching the dog's body temperature daily. This device will be able to identify the high and low temperatures of the dog. The normal body temperature range of dogs is 101 to 102.5 degrees Fahrenheit. but this can be slightly changed according to the environment. Therefore, solution will gather data daily to distinguish normal body temperatures from abnormal temperatures which the pet owner should be concerned about. This module will help users to identify,

- Weekly or monthly Body Temperature patterns as a diagnosis report along with other sensor information's which can be shared with doctors and drug stores
- High and Low body temperatures.
- And also, information will be shared through the app as suggestions on what users can do about those high and low Body temperature levels.
- Information's about remedies for fever

3. Footstep tracker which helps to track the activity level of the dog and suggest exercises to the dog

This is the third component of the main IoT device (Smart Health Tracker). This component will primarily focus on tracking the daily activity levels of the dog. Therefore, this device will be able to identify how many steps dogs have taken within the day. Depending on that, the device can decide whether the dog is active and healthy. If the dog hasn't taken any steps which a normal healthy dog would take, the device will suggest and inform the pet owner through the app to take the dog out for a walk. This module will help users to identify,

- Daily and weekly steps which the dog has taken.
- If a dog has taken fewer steps, the app will inform to take the dog out for a walk
- The app will suggest exercises
- Weekly step targets for a dog depending on the weight levels.

- **Smart Translator**

To create an efficient and effective solution that could analyze and translate dog acoustic barking patterns and canine language to human-understandable language with the help of modern technology such as smartphones, machine learning, and deep learning

approaches. The device should be able to give the dog owner a better understanding of the pet dog's canine language, unique gestures, unique vocalizations patterns, accurately identify them such as sad, pain, happiness, needs special attention, etc. This should help the dog owner to understand the dog better so the owner could attend to the dog's wants and needs properly without going through any conflicts. The translator should be able to make the dog and the owner more intimate.

- **Breed your pet**

1. Breed your pet component which help you to identify what kind of pet will born for your dog.

This is the main component we are going to focusing on this application. It is mainly focusing to generate the result of newborn pet. Firstly, all users have to register the application before they use this component. When they are registering to this application, they have to enter all necessary information about their dogs. Because application is analyzing that information using machine learning algorithms with pre train data in the database. From that we can get the clear idea about their newborn pet. It is the primary target of this component. But additionally, in this component this application generates the recommendations for food and medical treatments for that newborn pet. Because of that thing people who have lack of knowledge about pet, can take care their dog and their newborn pet by own.

2. Find a partner for your pet.

This is the second component of this application. This component is mainly working such as social media platform. Because of that using this component user can find the proper partner for their pet. As I mention earlier when user is going to register the application, they have to enter all necessary information about their dogs. From that information application automatically shows the same breed dogs who registered in the application. Also, if you want to find some specific breed user can search and find the proper partner for their pet. When they are finding the partner, they can see all information about dog and of user want to contact that pet owner they can also get the contact details.

Because of this component user can find a proper partner without wasting time and the can get a clear idea about dog which they are going to breed their dog.

- **Pet Skin care**

The component's main purpose is to introduce a technology-based mobile-first approach to dog owners to identify different skin diseases in pet dogs. This

component will use preprocess images from reliable resources to compare device upload images to predict skin-related disease accurately. Therefore, only the mobile camera should be used to detect skin issues, and this component is useful for users. Based on image observations, the app will determine whether skin-related diseases are minor or severe. Therefore, dog owners can get to the best conclusion about their dog's skin diseases

METHODOLOGY

System Diagram

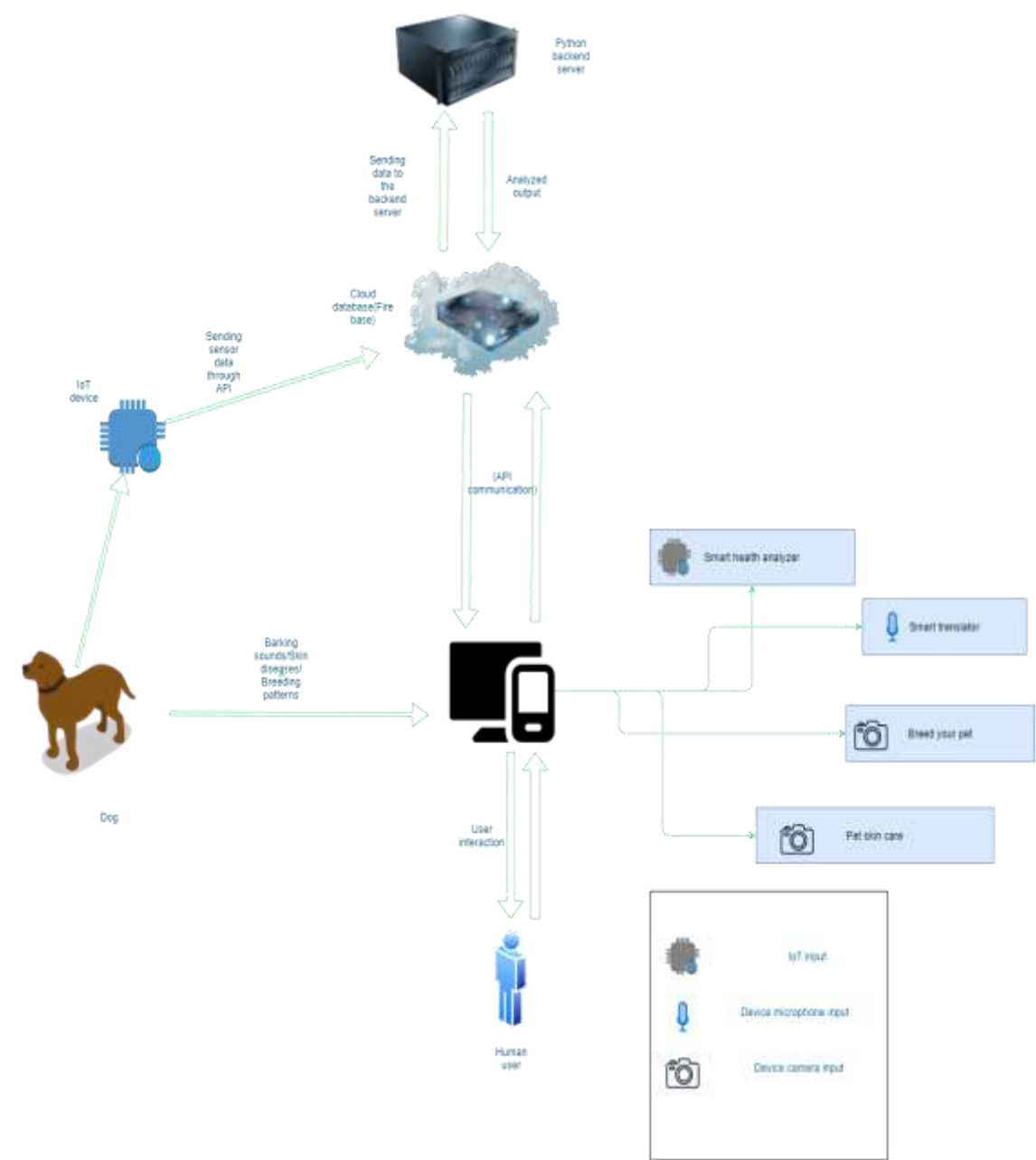
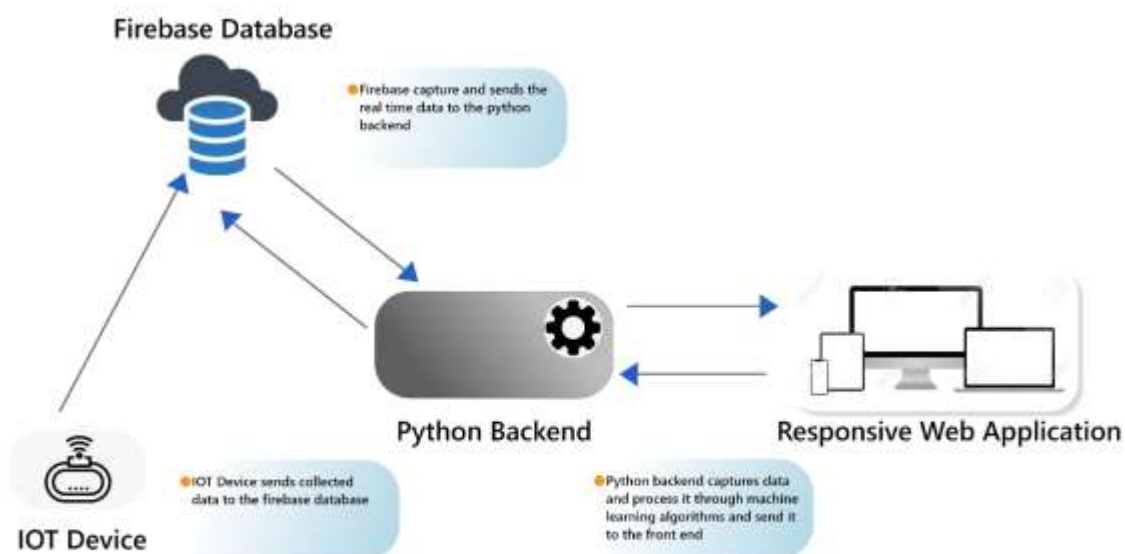


Figure 0:1:Overall system diagram

The proposed system will mainly cover the relevant areas that are supposed to be covered to full fill the pet owners' expectations by providing the necessary services (Such as Internal Health (what are the issues and what actions should be taken), Voice Recognition and translations, external issues such as skin diseases, and breeding patterns and breeding outcomes). Team priority is to emphasize necessary services that should be included in the mobile application and provide fluid services with fewer interruptions. And also, a service that has been never issued perfectly and solely to the Dog owners in a one go. Finally, this service will provide both IoT devices and a supportive eye-catching mobile app to the market.

The app works as a personal assistant, especially for new dog owners. The mobile has four main components. Each component assesses four different areas that dog owners might face when having a pet dog.

1. Smart Health Analyzer



Studies have shown, majority of the animal-related health issues have been caused by either due to lack of exercise or proper nutrition. Commonly, domestically bred animals face heart-related issues due to a lack of movements in their daily routines. And also, due to being neglected or undiscovered symptoms, these dogs' health can be at stake. This research mainly focused on tackling down these symptoms at early stages to provide necessary remedies and eradicate symptoms that can cause

major health issues in the long run. Research shows that if dog owners can track down the body temperature and heart rate of a dog, it can help the owner to get a high-level view of the health status of the dog. As per this research, the expectation is to provide an all-in-one IoT-based solution that can be used to identify body temperature, heart rate, and the footsteps of a dog at any given time. The solution will be provided as an IOT device where it can be attached to the leash.

The device will be located under the left leg of the dog. The given solution will be synced up with a uniquely created fully responsive mobile app. Hence all the information which gets derived from the IoT device will be shown in a manner in the mobile device for the dog owners' perusal. Given solutions' main expectation is to provide calculated and measured ideas about the current Heart rate, body temperature, and footsteps of the dog. And also, what exactly can be done using that information that can make a change in dog's health.

Research has mainly focused on eradicating small identifiable issues in the early stages to take precautions that can be taken by the owners. In the research, the system provides three main solutions which can be taken as measures to identify noticeable issues of dogs by their owners.

- a) Heart rate tracker
- b) Body temperature tracker
- c) Foots steps tracker

These solutions have been already provided in the market as single solutions by various inventors and researchers. Even though the services have been catered already to the market, expectations of the pet owners from the solutions haven't been sufficient or rather promising. According to the research and the relevant studies, the solution should not just calculate the live data and visualize it in the smartphone.

As an example, capturing the heart rate of a dog and visualizing the number in the mobile app through an API. All the solutions which have been made in the market do similar work as in the example above. Therefore, the mechanism of live data capturing and visualizing using an IoT device would not make any subtle changes in the health of a dog from the device.

This research will offer a unique solution where the pet owners get their hands in an IoT device that can capture data from all the three sensor components (Heart rate, temperature, foot's steps) and use the captured information to get an idea about the health status of a dog in a given time. These live captured data will be carefully analyzed using machine learning algorithms to educate the dog owners about their dogs in a much efficient way.

This research has tackled down and studied the risky health statuses of dogs and how they can be identified through heartbeats and body temperature. Hence the

data which gets captured from the IoT device will get fed to the machine learning algorithms to identify any abnormal behaviors of the given data. All the predictions and precaution methods have been implemented with the guidance of specialized doctors in the relevant field.

- **Information extraction and results**

For the reader's simplicity, the following information has been broken down into four separate sections. Therefore, the following sections will elaborate on the mechanism process accordingly to the research. Sections consecutively,

- a) Data gathering
- b) Training and testing data
- c) Data preprocessing
- d) Feature extraction

- **Data gathering**

This research will mainly have relied on the IoT device data attached to the dog leash. The device will gather data according to the manipulation which occurs from the software side. Once the owner isolates any of the sensors and captures the data, it will get stored in the database.

And also, the captured data will be analyzed accordingly using the machine learning algorithms to generate conclusions. During the training phase, the device capturing data would not be sufficient to predict any conclusions. Therefore, research has been fed with the massive amount of data that has been captured from IoT device sensors (Heart rate, temperature, footsteps) which are collected from various resources from the internet.

Gathered data segregated into two separate sections, where 60% can be used for testing and 40% can be used for training purposes to measure the accuracy.

- **Training and Testing data**

As mentioned, to increase the accuracy, given collected chunk of data sets mainly segregated into two separate sections. Since there are three main components in the research, data has to be collected for all the components separately. Mainly data has to be collected for the heart rate and temperature components,

Footstep's component calculates the footsteps of a given day and measures the activity level of the dog. Hence the necessity of a data set didn't get crucial.

For the heart rate and temperature components, data has to be collected in a manner to identify the relevant sizes of the dog. As per the research, dogs can be identified into three different categories such as,

- I. Small size breed (ex: Shih Tzu)
- II. Medium size breed (ex: Ridgeback)
- III. Large size breed (ex: Greatdane)

These categories can have slightly different ranges of heartbeats and temperature patterns. Therefore, to make the solution much more accurate, the data sets have been collected separately with the guidance of local special veterinary doctors. And the collected data set has been divided into the ratio of 60:40 for training and testing purposes.

- **Data Prepossessing**

The data collected from the various resources had to be categorized and organized in a manner to make the best use out of it. Therefore, all the data had to be pre-processed before using it. As per the preprocessing method, the researchers used the following techniques to organize the data,

- I. Data cleaning
- II. Data transformation
- III. Data reduction

When in the process of gathering the data, data has to be structure in a manner to be fed to the algorithms. Especially some gathered data were in long decimal points since IoT devices deliver accurate numbers. Hence, there was extra work to normalize and cleanse data to get the best use out of it.

- **Feature Extraction and IoT device**

when it comes to Heartbeats and temperature measurements, people tend to focus on rare occurrences of the normal pattern to identify abnormal health-related issues. As an example, if a human shows 38°C and above, it indicates that the particular human suffers from fever. Likewise, a study shows that the best way to identify any issues which regard to heartbeat and temperature is to keep an eye on rare occurrences of the normal pattern. Hence as per the machine learning studies, the best and suitable algorithm or rather the mechanism is to follow the anomaly detection process.

The anomaly detection process allows you to step in data mining that identifies data points, events, and/or observations that deviate from a dataset's normal behavior. Anomalous data can indicate critical incidents, such as a technical glitch, or potential opportunities, for instance, a change in consumer behavior.



Figure 5 Diagram Picture Four

Since the research mainly focuses on breeds and their respective heartbeat and temperature ranges, the anomaly detection process was able to identify rare occurrences which IoT device records according to the given normal ranges.

As an example, medium-size dog breeds have a body temperature range which lies in between 101.0 to 102.5°F. hence the recorded temperature exceeds 102, it will be recorded as anomaly detection. Or else studies can call it an outlier. Therefore, all the information that gets recorded from the IoT device will be carefully processed with anomaly detection algorithms to identify any rare occurrences.

The research will apply the same above-mentioned concept to the heartbeat component as well. All the healthy ranges and unhealthy ranges have been recorded with the guidance of local specialized doctors in the field.

Additionally, that research will provide extra unique solutions to the pet owners where they can get a proper understanding of the given information in the mobile application. The basic solution will cover the following areas consecutively.

- a) Identifying rare occurrences in the body temperature and predicting the issues with the probable causes
- b) Identifying rare occurrences in the heartbeat and predicting the issue with regards to the activity level of the dogs.

- c) Footstep's calculator will give an idea about how much a dog is active on a given day.

Upon basic features, the solution will provide the following for the easiness of the pet owner.

- I. Temporary remedies that can be taken if there's a high fever notified in the system.
- II. Activity suggestions for less active dogs.
- III. Diet suggestions for dogs who have slower heartbeats.
- IV. Exercise routines for dogs who have high cholesterol and bodyweight levels. (Note that the above suggested exercises and diet plans have been created with the guidance of specialized doctors. And these system-generated diet plans and exercise routines have been tested and well prepared for the specific dog breed sizes.)

- **Support Vector Model-SVM**

support vector machine is a supervised machine learning algorithm that can be used for both classification and regression requirements. In the Smart health analyzer project, we can identify two components that capture dog heart rate and pulse rate levels. In this case, what we are mainly targeting is to identify fluctuations in the range of heart rate and give temperature levels. Therefore, classification can be used to optimize the project objectives.

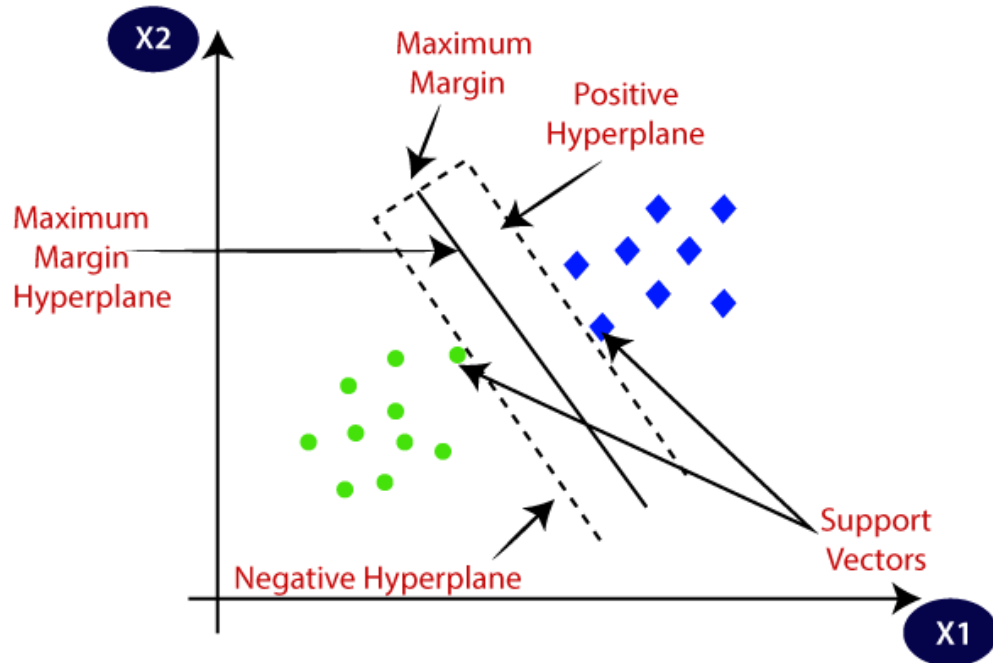


Figure 6 Support Vector Algorithm

○ Support Vector Machine Algorithm

$$\text{if } w^T x + b = 1 \quad y +$$

$$\text{if } w^T x + b = -1 \quad y -$$

$$(w^T x + b)y_+ = (1)y_+$$

$$(w^T x + b)y_- = (-1)y_-$$

$$y_+ = 1, y_- = -1$$

$$(w^T x + b)y_+ = (1)(1)$$

$$(w^T x + b)y_- = (-1)(-1)$$

$$y_i (w^T x + b) = 1$$

$$y_i = \{y_+, y_-\}$$

In order to give a brief explanation to the above equation, if all points we have checked in the condition,

If a point(x) $y_i \cdot (w \cdot x + b) = 1$

Point=support vector

Classified correctly save parameters

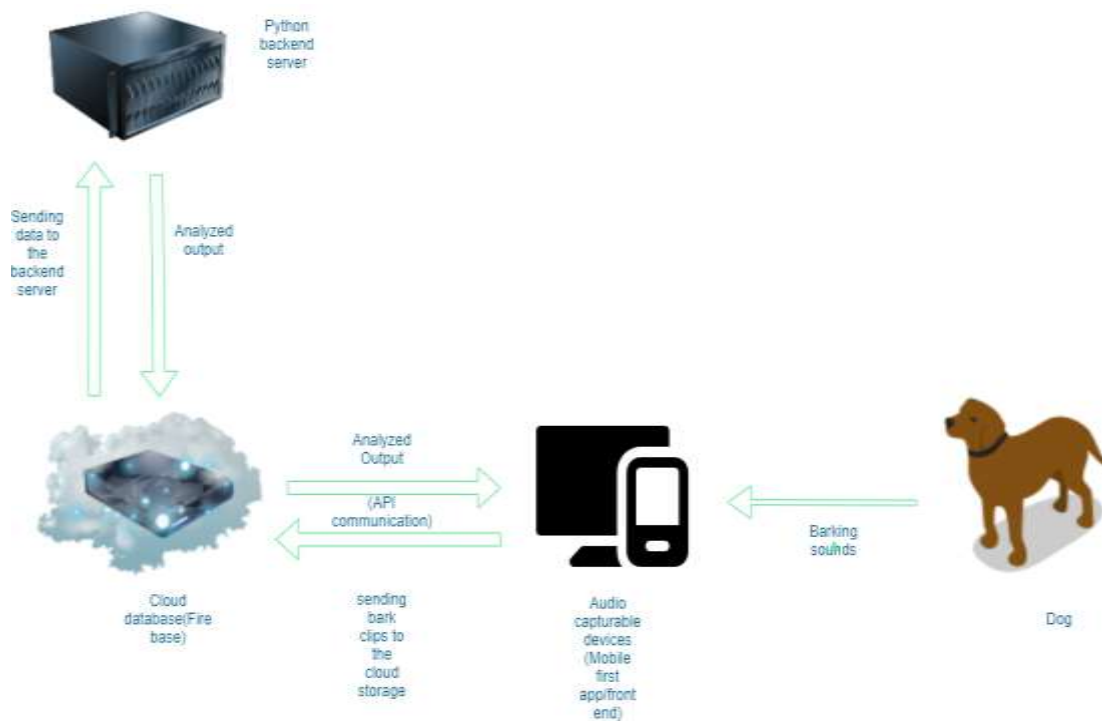
else if > 1 :

Classified correctly save parameters

else:

classified incorrectly adjust parameters

2. Smart Translator



Now in modern days, information communication technology has been applied to solve modern issues. What if to solve the pet dog communicating problem modern information technology concepts like machine learning, artificial intelligence, and Smartphones can be applied

The smart translator is a compound that will help the owner better understand the dog and what the dog is trying to communicate. Using a modern machine-learning algorithm, the possible context-specific and individual-specific roles of dog barks were studied. The function of the algorithm was to understand the acoustic characteristics of the barks, collected in various contexts and from different individuals, and then it will help to identify the barking pattern which will output what the dog is trying to communicate. The software will perform this activity by evaluating barks emitted by identified dogs in previously identified contexts. humans can categorize various barks and associate them with appropriate emotional content by merely listening to them. Humans with different dog experience levels showed similar trends in the categorization of the possible inner state of the given barking dog. According to a study, we have shown that human perception of the motivational state in dogs is influenced by acoustic parameters in the barks.

- **Data gathering**

Barks of several dog breeds have been used here that belong to 10 different dog breeds. However, the recorded data set has not considered the male to female sex ratio as a parameter. Age range 3- 4 years. The total sample size of barks analyzed is 500 bark clips. All bark clips have been recorded in 4 different behavioral contexts. Those are Stranger, Angry, Sad, and Pain. All this voice clip data has been extracted from the google audio set which already has been classified.

Stranger(N=111) - The principal way of communication of dogs. All sound clip consists of 10 seconds of barking. In this scenario, a stranger appears front of the dog, and it starts responding to the stranger with a casual bark.

Angry (N=100)- An aggressive threatening behavior performed by dogs. This is a low guttural vocalization.

Sad (N=120)- This is a long plaintive cry performed by a dog.

Pain (N=101)- This is a muted vocalization indicated by a dog. Indicates submission or pain.

Background – 100 clips

- **Preparation of Sound Material**

Sound clips were made and trimmed using Wave pad sound editor. To reduce the noise in the sound clip and normalize the Wave pad normalization option was utilized the bit rate of sound clips has been set to 1536kbps.

As each recording contained up to three or four barks, individual bark sounds were manually segmented and extracted. The final process of this resulted in individual 400 acoustic dog clips. These clips only contain single bark

- **Exploratory Data Analysis**

Sound consists of two types of audio waves. mono waves and stereo waves. Mono wave consists only one wave and stereo waves consist of two waves. A sound clip can be displayed in a spectrogram. Here when it comes to the model training model compares the input voice sound clip. Each class has its mono and stereo audio form.

- **Feature extraction**

samples will be used in this case. The MFCC summarizes the frequency distribution throughout the window size, allowing analysis of both the frequency and situational variables of the sound. We will be able to determine parameters for classifications using these audio representations.

In sound processing, MFCC performs the following steps to process a sound clip and uniquely identify it. First, it takes the signal and Fourier transforms it. Then the signal is mapped according to the powers of the spectrogram obtained onto the Mel scale. This is done using triangular overlapping windows or cosine overlapping windows. Then it takes the each of Mel frequencies respective to the log value. As it was a signal it takes the discrete cosine transform of the list of Mel log powers. The resulting spectrum is the MFCC aptitudes. The algorithm can be shown below,

$$F(\omega) = f(w) = \int_{-\infty}^{\infty} f(x)e^{-i\omega f(x)}e^{-i\omega x} dx$$

- **Artificial Neural Network (ANN)**

Artificial neural networks also called neural networks are based on animal brain neural network patterns. These neural networks are computing systems that are similar to biological neural networks. This is a base model of the loosely coupled biological brain. These neural networks consist of multiple layers of neurons.

First Layer

First, concerning the no of features, the `input_shape` has been set to five (5). The first layer of neurons has a density of 100 neurons. The activation function has been set to 'relu.' Then we can set the dropout to 0.5. Setting the dropout layer is important as it will prevent overfitting. During the training time, the drop-out layer randomly sets input units to 0 with a frequency of rate at each step. This only drops in the training time and no drop-out is done during inference.

Second Layer

The first layer of neurons has a density of 200 neurons. The activation function will be the same as the first layer. Then we can set the dropout to 0.5. Setting the dropout layer is important as it will prevent overfitting similar to the first layer.

Third Layer

Similar to the second layer but the third layer has a density of 100 neurons. Other characteristics are all similar to the second layer.

Final Layer

This is the output layer of the artificial neural network. Here the 'num_labels' is equal to the number of features. The activation function will be 'softmax' as this is a multiclass classification problem.

- **Creating and Training the Model**

To create an ANN model we will be using the following libraries from 'TensorFlow and 'SK-learn'.Also, we will be adam optimizer for optimization purposes.

Once these parameters are set we can train the model

From the TensorFlow Keras library, I have imported 'ModelCheckpoint' to save the model for future use. Since this is not a large dataset the number of epochs for this training session will be 30. For a small data set, it is better to set the number

of epochs between 25-30. If it is a large data set we can set our no of epochs to a large number. If the data set is large and the number of epochs is more than 30 it may lead to overfitting of the model. Since relatively the data set is not that large we can set the batch size to 15. If we increase the batch size we can see the model will overfit and cause accuracy problems.

Then we can declare the checkpoint using the libraries we imported previously. Using this checkpoint function we can save this model hd5 format for future use.

```
In [182]: test_accuracy=model.evaluate(X_test,y_test,verbose=0)
          print(test_accuracy[1])

0.8002289533615112
```

3. Breed Your Pet

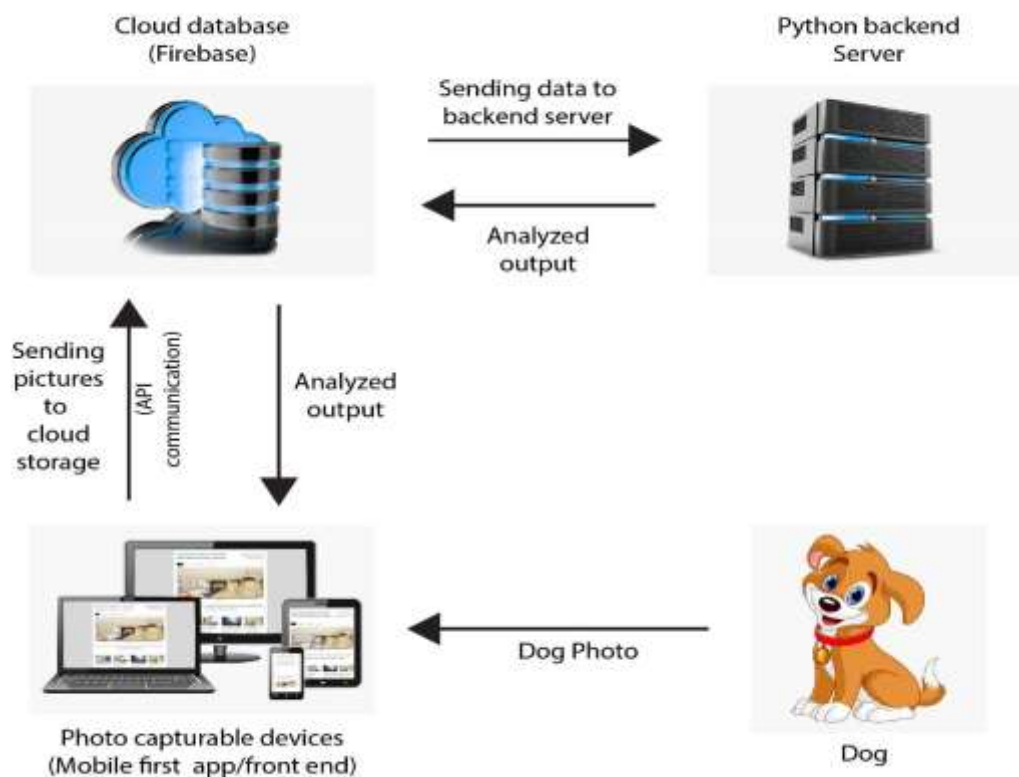


Figure 0:4:Breed your pet

Here we will create a fully responsive mobile application that answers all these questions. This software allows pet owners to enter the required data and retrieve the information they need. This mobile application gives the pet owner all the updated basic knowledge which they need.

Research has mainly focused on eliminating the problems that pet owners face in their daily lives. In this research, the system provides four main solutions which pet owners have to face.

- a) Result of mixed-breed
- b) Food routings for a newborn pet.
- c) Medical treatment recommendation for a newborn pet.
- d) Find a mate to breed their dogs.

Similar solutions to these problems have already been proposed by inventors and testers, but pet owners have not been able to get the answers they hope for. According to the research and relevant studies, pet owners can get answer all their problems with a single mobile application.

For example, to identify your dog's type, you can insert a photo into a mobile application and get answers. But this application is designed to be able to see what a puppy is born after crossing their dog and another dog, using this application. Here you can learn about the pure breed as well as newborn pets born by mix-breed dog's cross. For this, the user entered data carefully analyzed using machine learning algorithms to understand what kind of pet will be born to their dog.

In addition, although apps for food and medical recommendation have been created for puppies, they are often difficult for pet owners to understand. Because those apps are so complicated. For example, dogs can be divided

into three main categories (small size breed, medium-sized breed, large size breed). In most cases, small animals are given liquid food and vitamins, while medium-sized puppies are given nuts and protein. Large size dog breeds should be given heavy foods and vitamins and this app visualizes all food and medical recommendation so that they can be easily identified and understood by the user.

And very few people use the internet to find a partner for your puppy. The reason for this is that there is no proper app or website for these activities. In this way, you can spend less time finding a suitable partner for your dog, learn about the puppies that come from crossing the dogs, and all the information about the food and medical routing that should be given to those puppies. All these predictions have been implemented under the guidance of specialize doctors in the field.

- **Information extraction and results**

For the readers' simplicity, the following information has been broken down into four separate sections. Therefore, the following sections will elaborate on the mechanism process accordingly to the research. Sections consecutively,

- a) Data gathering
- b) Data preprocessing
- c) Feature extraction
- d) Feature mapping
- e) Categorization

- **Data Gathering**

This research mainly is relied on the dogs' photos. And data that are related to the dog's food and medical recommendation. These captured data will be analyzed accordingly using the machine learning algorithms to generate conclusions. To obtain a sufficient amount of data, a large amount of data from various resources on the Internet has been provided for this test.

The data thus collected were divided into two main parts. 70% of the data collected was used for training and the remaining 30% was used for data testing purposes to verify accuracy.

- **Data Gathering**

must be properly categorized and organized for maximum effective use. Because of that, all the data had to be preprocessed before using it. For the preprocessing method, the following techniques of this research have been used to organize the data.

- I. Data cleaning
- II. Data transformation
- III. Data reduction

In addition, to reduce the complexity and size of the pictures, it has been decided to reduce the scale of the photos to 225*225 during the preprocessing stage.

- **Feature extraction**

Feature extraction is mainly expected to reduce the number of features of the dataset by creating new features from the existing ones. This latter identifies important features or attribute in data

This research mainly uses machine learning techniques to find out what a puppy is born with after two dogs cross. We mainly use photos here. Here we can use Color Histograms to represent the distribution of the composition of colors in the image. It makes it easy for us to see different types of colors appeared and the number of pixels in each type of color appeared.

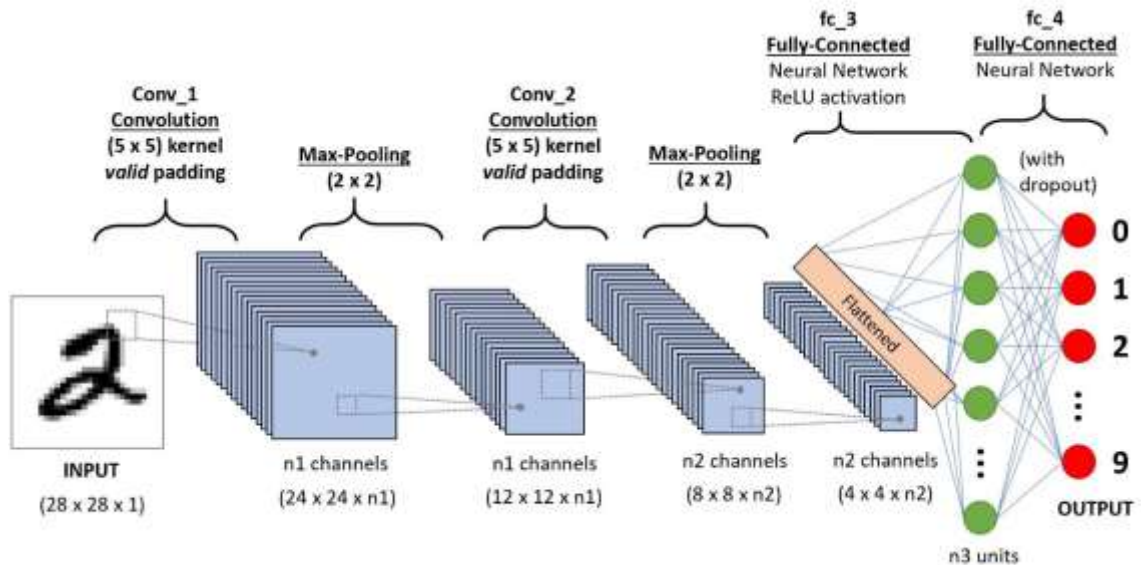
In addition, Haar Wavelet compressions are used to compare lossless and lossy images. To generate a sparse or nearly sparse matrix, it uses averaging and differencing values in an image matrix. A sparse matrix may be efficiently stored, resulting in reduced file sizes.

Also, we are using the Canny edge detection algorithm to detect the wide range of edges in images. The OpenCV method `cv2.Canny()` accepts our input picture as the first parameter and its aperture size (min and max value) as the second and third arguments.

In addition, dogs can be grouped into small breeds, medium breeds, and large breeds. Here, for example, the data entered by the pet owner identify the category in which the puppy is born. Then the general food and medical recommendation for that category are given. This food and medical recommendation will be given for six months.

(Noted that all of the above-suggested food and medical recommendations and related prescriptions are designed under the guidance of specialized doctors.)

Convolutional neural network



An input layer, hidden layers, and an output layer make up a convolutional neural network. Any intermediary layers in a feed-forward neural network are referred to be hidden since the activation function and final convolution hide their inputs and outputs

4. Pet Skin Care

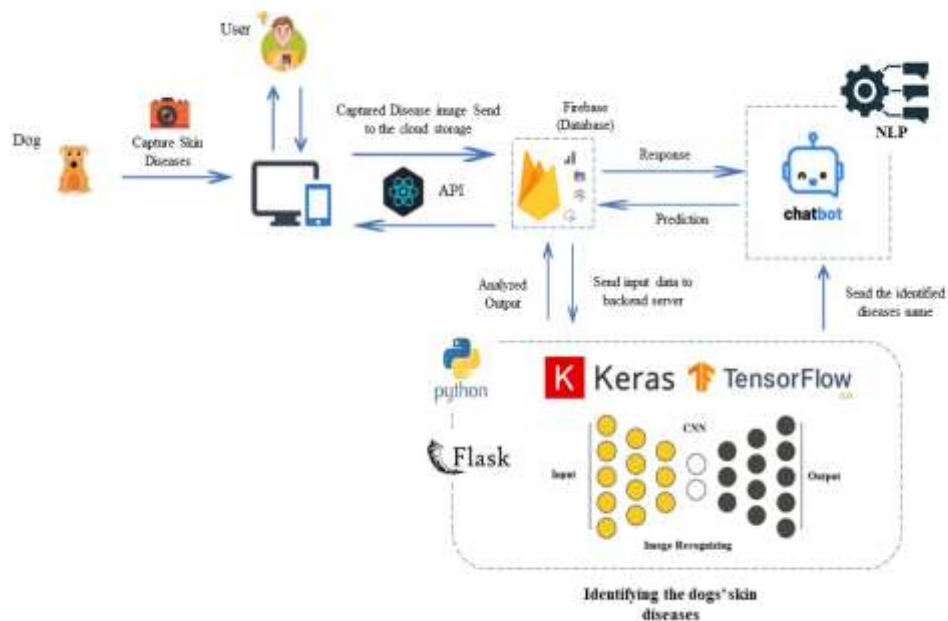


Figure 0:5 - System Overview of the Pet Skincare Component

Efficient methods developed with deep learning have provided impartiality and high accuracy in identifying skin diseases in the past years. This research gives dog owners a

system developed using Android to detect a dog's skin diseases such as Tick, Redness, Shedding and Hair Loss, Rashes, Dry or flaky skin, Mange (Mites), Fleas, Swelling, Lumps, Hot spot, and wounds using an image processing algorithm. As well as promote accurate, cost-effective, and timely treatment using a chatbot. In addition, the component offers diagnoses and treatment without the need to contact veterinaries, which is particularly desired when the illness is infectious, or the dogs have another contagious disease. On the other aspect, it is not feasible to proceed with deep networks on resource-constrained devices (E.g., mobile phones). Therefore, lightweight network designs have been proposed in the literature. However, only a few mobile applications have been developed to identify dogs' skin diseases using colored images using lightweight networks.

Moreover, only a few skin diseases have been treated in those applications. Furthermore, they do not perform as well as deep network models, particularly when it comes to pattern identification. Therefore, in this study, a novel model has been created using a mobile-based application. The proposed K-means algorithm, Canny Edge Detection technique, Deep Convolutional Neural Network, Morphological image processing technique using Non- Linear Regression, and mobile-based app chatbot to enhance the user experience for identifying skin diseases of pet dogs. The study aims to propose and develop an intelligent expert system for classifying skin diseases in dogs. In earlier research, we explored skin diseases identification using a conventional machine learning algorithm. By conventional machine learning method, we meant a computational approach for skin diseases classification that includes various stages, and classification is done using manually derived characteristics. In this study, we have studied the classification accuracy of the convolutional neural network, a part of the deep neural network.

The proposed approach is a useful tool for determining pet dog's skin diseases and predicting skin disease. A hybrid architecture comprising image processing, machine learning, and deep learning techniques are utilized in this proposed system to identify disease types with potential accuracy quickly. Preprocessing, segmentation, and feature extraction are all stages in the image processing phase. Processing, training, and detection are the three stages in the machine learning phase. Color, texture, and shape characteristics are retrieved from the dog's skin disease input images using the proposed system's HSL/HSV conversion

techniques, Morphological image processing, and Thresholding technique Canny edge detection algorithm for feature extraction. The correlation values of the input skin disease image are compared.

In image segmentation, clustering is a powerful technique that has been developed. An image data collection is segmented into distinct groups or clusters using cluster analysis. The color space conversion algorithm may be used to complete the conversion process. The suggested approach uses a convolutional neural network for categorization (CNN). The proposed system also identifies the drug-related to the skin problem through a chatbot and provides general knowledge about dogs.

Ticks, Redness, Shedding and Hair Loss, Rashes, Dry or flaky skin, Mange (Mites), Fleas, Swelling, Lumps, Hot spots, and wounds are among the frequent skin diseases detected by the classifier model. The use of a neural network for integration produces accurate results. This proposed system analyzes many types of dog skin diseases, saving the user time and cost. For the experimental results of this proposed system, deploy a PyCharm-based Python script. The entire experimental approach for detecting dog skin diseases utilizing image processing, Machine Learning, and Deep Learning techniques.

- **Data Gathering**

Each category has a varied number of images. This study utilized a total of 2 639 images. The number of images in each category is split into training and testing sets. There are 1 924 images for training and 715 images for test dog skin diseases.

- **Data Preprocessing**

For image classification by randomly shifting or horizontally flipping images. As a result, we will provide a quick rundown of the methods below. There are two stages of the suggested intelligent expert system, E.g., the training, and testing phases. The pictures are pre-processed and scaled to 225x225 in the training phase.

Hue Saturation Lightness Value/ Hue Saturation Luminance (HSL/HSV) color space a non-linear conversion of the RGB color space is used in this color space model. It is helpful in image processing since the luminance data is separated from the chrominance data. It is also very intuitive, non-linear, and machine-dependent. It is applied in the field of color visualization. The HSV and HSL models are widely applied in computer vision and image processing for element identification

or image segmentation. Most color spaces are defined and simulated using MATLAB and realized in real-time utilizing a GPU processor with Google Collaboratory.

- **Image Enhancement**

Image enhancement involves areas that include intensity and contrast manipulation reduction, background removal, edge sharpening, filtering, and more in image processing. Using an image enhancement technique in this study is to improve the contrast between the clusters and the background.

Mathematical Morphology techniques, such as the Top-Hat morphological transform, were used to accomplish the purpose.

- a) **Canny Edge Detection**

A multi-stage edge detector is a Canny filter. The width of the Gaussian (the noisier the image, the greater the width), as well as the low and high thresholds for hysteresis thresholding, are all configurable in the Canny [19]. The following are some general criteria for edge detection:

Edge detection has a low error rate, implying that the detection should capture as many of the image's edges as feasible.

The edge point identified by the operator should be accurate in locating the edge's center.

Image noise should not generate spurious edges, and a particular edge in the image should only be marked once.

- b) **Mathematical Morphological Image Processing**

Mathematical morphology is a discipline in the field of image processing, which involves the analysis of structures. The geometrical structure of images is determined by locally comparing it with a predefined elementary set, called a structuring element. Image processing, using morphological transformations, is a process of information removal based on size and shape. In this process, irrelevant image content is eliminated selectively. Therefore, the essential image features can

be enhanced. Different results can be obtained in the output image by selecting the shape and size of the structuring element.

- **Image Segmentation**

Image analysis encompasses a wide range of tasks, including segmentation, classification, and interpretation. Image segmentation is an important task in image processing and computer vision, and it entails recognizing objects or areas in an image with similar features. Image categorization gives labels to individual pixels based on prior knowledge about the issue under consideration. Image interpretation is the process of extracting meaning from an image. About certain features of skin disease images, image segmentation aims to split an image into non-overlapping component areas that are homogenous. The extent to which the subdivision is carried out is determined by the point being made.

- **Image Segmentation by the clustering algorithm**

K-means clustering methods were utilized in this study. The essential initiation phase in image processing is digital image segmentation, which extracts the semantic meaning of the pixels. To segment skin diseases images, the clustering algorithm seeks groupings of pixels with comparable gray-level intensity or homogenous groups. The similarity is calculated using the distance between pixels and objects or

area prototypes and each pixel is allocated to the group with the closest or most similar prototype.

K-means Algorithm

One of the most important unsupervised learning algorithms is k-Means. The technique uses a basic and straightforward method to categorize the dog's skin diseases data set as Z in a d -dimensional space using a predetermined number of clusters (assuming k clusters). The central concept is to create k prototypes, one for each cluster. The next step is to link each of Z 's points with the cluster that has the closest prototype. The first step is accomplished, and an early group is finished when no points are outstanding. For the k prototypes to remain the most representative element of each cluster, we must recalculate their new values at this point. After then, a new binding between the same data-set points and the closest prototypes must be completed. It has been created through an iterative process. Consequently, it may observe that the k prototypes gradually shift their office until

there are no more modifications. The next objective function, a squared error function, is minimized using this method. The following is the objective function.

- **Image Classification**

The architectures for the models we develop for image categorization are shown in this section. CNN's have two different kinds of neural network layers [22]. A convolutional layer is the first. This layer runs a sliding window across the images, convolving the sub-image with filters at each step, resulting in a new volume with increasing depth. By a given factor, a pooling layer downsamples the volume along the spatial dimensions. Lowers number of parameters and the size of the representation, making the model more efficient.

The learned classifier is the result of the training phase. The images in the testing dataset are also pre-processed and scaled to $225 \times 225 \times 3$ during the testing phase. Following that, the features from the images are retrieved and stored in the feature vector. The extracted feature vector is sent to the learned classifier, and the image is classified as healthy, Tick, Redness, Shedding and Hair Loss, Rashes, Dry or flaky skin, Mange (Mites), Fleas, Swelling, Lumps, Hot spot, or wounds.

However, depending on the size of the data collection, we may have many choices for fine-tuning; for example, if the target data set is small, we may be able to overfit the network. Because we have a large data set, we decided to freeze the upper layers except for the final four. Set the batch size to 16, utilize data augmentation (a method that allows researchers to significantly increase the diversity of data for training models without actively acquiring additional data), and begin with a learning rate of 0.005.

Neural Networks

Layers will be created initially in order to build the network. Adding an input layer is the first step. Then there will be hidden layers added. There are many hidden layers in a deep neural network. A neural network with more hidden layers may be more effective. The output layers are now being added. The neural network must be built and fitted to the dogs' skin diseases training data after adding layers. Assume that the input matrix's reading starts at the top left corner of the image. The algorithm chooses a filter, which is

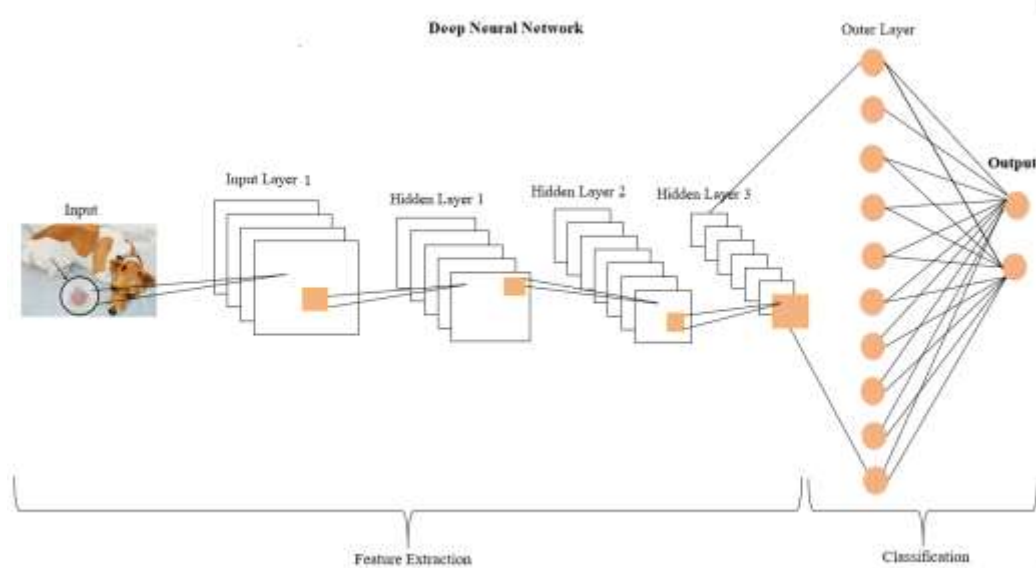


Figure 0.6 - Proposed System for CNN Architecture

a smaller matrix. The purpose of the filter is to multiply values with the original pixel values. All of these multiplications are added together.

Finally, only one number is acquired. Because the filter has only read the image in the top left corner, it moves 1 unit to the right, repeating the same process. A matrix is produced after running the filter across all positions. The pooling layer works with the image's width and height. In the previous convolution process, certain features had already been identified. When a detailed image is no longer required for processing, it is compressed into smaller images. As a result, the volume of the image is reduced. By changing these weights, the network's accuracy may be improved. The neural network's accuracy may be improved by repeating this process several times [].

Implementation of chatbot

To build a chatbot from scratch, we must choose an NLP/ML framework and develop a neural network. NLP.js is a feasible option for this task since it focuses on Node with React implementation of chatbots. Furthermore, NPM is the most convenient platform for hosting and running a React application's web server. First, We must build a corpus, which is a collection of question-and-answer entries and all of the necessary elements. Figure show the corpus in the quizQuestion.js.

```
var quizQuestions = [
  {
```

question: "Select your pet dog's Breed ",
answers: [

```
{
  type: "0",
  content: "Labrador"
},
{
  type: "1",
  content: "German Shepherds"
},
{
  type: "2",
  content: "Golden Retrievers"
},
{
  type: "3",
  content: "Bulldog"
},
{
  type: "4",
  content: "Ridgeback"
},
{
  type: "5",
  content: "Rottweiler"
},
{
  type: "6",
  content: "Dalmatian"
},
{
  type: "7",
  content: "Beagle"
},
{
  type: "8",
  content: "Doberman"
},
{
  type: "9",
  content: "Pomeranian"
},
},
```

```
{
  type: "10",
  content: "Boxer"
}
],
{
  question: "How old is your pet dog?",
  answers: [
    {
      type: "a",
      content: "Less than 1 month"
    },
    {
      type: "b",
      content: "1 month to 5 months"
    },
    {
      type: "c",
      content: "5 months to 1 year"
    },
    {
      type: "d",
      content: "Over 1 year"
    }
  ]
},
{
  question: "Severity of signs?",
  answers: [
    {
      type: "g",
      content: "Minor"
    },
    {
      type: "h",
      content: "Severe"
    }
  ]
},
{
  question: "How long have your pet dog had these symptoms for?",
```

```

    answers: [
      {
        type: "e",
        content: "Less than 5 days"
      },
      {
        type: "f",
        content: "Above 5 days including 5 days"
      }
    ]
  },
];

export default quizQuestions;

```

The intents and their corresponding phrases that the chatbot will use to train itself can be found below. When the chatbot recognizes an intent, it will choose one of the available responses at random. It will also create a number or character for the potential responses to the chatbot's predictions. Because certain intents are complicated, they do not have matching responses. In addition, we must handle them using a callback function. The remaining code defines the unnamed function, the main loop, where all training and message exchange occurs. The diagram of **figure** illustrates the chatbot responses structure's possibilities.

Commercialization of the Product

Target audience

This product will be mainly targeted toward the less experienced dog owners but any dog owner can use purchase and use this product. The proposed solution comes as a package. The IoT device and the software solution. Even without the IoT device, the customer can still use some service of the software solution.

Benefits to end-users

- Less experienced dog owners can understand what the dog is trying to communicate
- The product will suggest dog owner what to do according to the dog's response
- This will help increase less experienced dog owner's knowledge about the dog

- Less experienced dog owners don't want to seek well-experienced dog owners help to understand the dogs
- The user can access the product's service at any time they want
- Without purchasing the IoT device the dog owner can still use the product.

Advertising and commercialization

- The app will mainly be marketed through social media such as Facebook, Instagram.
- On Facebook and Instagram, separate pages will be created and posted will be posted as advertisements.
- Also, Google advertisement services will be used if necessary to publish on google services.
- On youtube, a separate page will be created to market the product. The entire product and capabilities will be demonstrated via videos.
- The IoT device will be available to purchase through supermarkets, Kennel clubs in Sri Lanka, and dog products selling shops.
- A website will be created to publish the IoT and software solution product specifications.

Posters will be created and posted where the IoT device is available to purchase

TESTING & IMPLEMENTATION

Implementation Phase

Here we consider the what kind of technologies we used to develop the proposed system will be further described.

- **Technologies used,**

- 1. Python**

Python is well-known for its simple code length and simple syntax. Python is also a very flexible and well-designed programming language. Not only that, but Python is a platform-independent language, which means that Python-based software may run on a broad range of operating systems without the need for an interpreter. As a result, programmers may dedicate more of their time to addressing the more important problems of their development project rather than getting the code to execute or finding out how it works. Python's vast library of resources includes some web application frameworks. Flask is the framework we are utilizing here. It is a Python web framework that comes with a number of tools for building web applications. It is also a micro-framework, which means it does not rely on other libraries in any way. This framework is simple to understand, lightweight, and flexible.

- 2. React**

React.js is an open-source, declarative, flexible, and one of the latest JavaScript libraries for developing user interfaces. Especially for single-page applications and used for web developing and mobile development. Moreover, react permits to develop the reusable user interfaces (UI) components.

- 3. Fierbase**

Data can be securely stored on Google cloud servers and synchronized in real-time across all clients sharing the same database using the Firebase Realtime Database. The system's main goal is to provide a secure, reliable, and quick method to

synchronize data with minimum coding effort on the part of the developer. The database system is also developed to support millions of users.

- **Testing Phase**

The main objective of this phase is to evaluate the system whether it is running according to the client's requirements or to fix the bugs. In this phase, different kinds of testing levels facilitate checking behavior and performance for software. Unit Testing will test the individual components. Furthermore, Integration Testing will test the integrated components and check whether the data flow from one model to another. Therefore, in the System Testing test, the entire system will check whether the system meets the specifications. Moreover, lastly, Acceptance Testing will test the final system, and the user does it, or the client Debugging involves identifying and removing localized implementation errors or bugs from a program or system. It is also important to develop a strategy for maintaining a website periodically once it is up and running. Debugs the site for broken links and out-of-date information. It is also a good idea to keep a list of each page.

Test Case 1

Test Scenario ID	Login-01	Test Case ID	Login 1-A				
Test Case Description	Login -positive test case	Test Priority	High priority				
Pre-Requisite	The user should have a valid user account	Post-Requisite	N/A				
Test Execution Steps:							
S. No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Launch application	Cmd:npm start	Launch http://localhost:3000/	http://localhost:3000/	Google chrome	Pass	[Salman 4.29 P.M. 04/10/2021] Launch successful
2.	Enter user credentials and enter log in button	Email id: abc@gmail.com Password: 123	Dashboard view	Dashboard view	Google chrome	Pass	[Salman 4.30 P.M. 04/10/2021] Log in successful

Test Case 2

Test Scenario ID		Login-02		Test Case ID		Login 1-B	
Test Case Description		Login -Negative test case		Test Priority		High	
Pre-Requisite		N/A		Post-Requisite		N/A	
Test Execution Steps:							
S. No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Launch application	Cmd:npm start	Launch http://localhost:3000/	http://localhost:3000/	Google chrome	Pass	[Salman 4.35 P.M. 04/10/2021] Launch successful
2.	Enter valid mail and invalid password and enter log in button	Email id: abc@gmail.com Password:456	Incorrect user name or password	Incorrect user name or password	Google chrome	Pass	[Salman 4.39 P.M. 04/10/2021] Log in unsuccessful
3.	Enter invalid mail and valid password and enter log in button	Email id: abcd@gmail.com Password:123	Incorrect user name or password	Incorrect user name or password	Google chrome	Pass	[Salman 4.45 P.M. 04/10/2021] Log in unsuccessful

Test Case 3

Test Scenario ID	Voice input-03	Test Case ID	02-A
Test Case Description	Pulse rate	Test Priority	Medium
Pre-Requisite	1. The user should be logged in 2. IoT device should be connected 3. Pulse rate capture 4. Dog owner- sandagomi 5. Experience- 12 years	Post-Requisite	Great Dane breed

Test Execution Steps:

S.No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Select Smart Health Analyzer	N/A	Smart Health Analyzer	Smart Health Analyzer	Firefox	Pass	[Sandagomi 5.05 P.M. 04/10/2021] Navigation successful
2.	A device placed in the dog	N/A	Pulse Rate	Pulse rate	Firefox	Pass	[Sandagomi 5.10 P.M. 04/10/2021] Correct prediction]
3	Click 'log out'	N/A	Log in screen	Log in screen	Firefox	Pass	[sandagomi 5.10 P.M. 04/10/2021] Log out successful]

Test Case 4

Test Scenario ID	Voice input-04	Test Case ID	02-B
Test Case Description	Pulse rate	Test Priority	Medium
Pre-Requisite	1. The user should be logged in 2. IoT device should be connected 3. Pulse rate capture 4. Dog owner- sandagomi 5. Experience- 12 years	Post-Requisite	Log out from the system Ridgeback breed

Test Execution Steps:

S.No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Select Smart Health Analyzer	N/A	Smart Health Analyzer	Smart Health Analyzer	Firefox	Pass	[Sandagomi 5.15 P.M. 04/10/2021] Navigation successful
2.	A device placed in the dog	N/A	Pulse Rate	Pulse rate	Firefox	Pass	[Sandagomi 5.20 P.M. 04/10/2021] Correct prediction]
3	Click 'log out'	N/A	Log in screen	Log in screen	Firefox	Pass	[Sandagomi 5.25 P.M. 04/10/2021] Log out successful]

Test Case 5

Test Scenario ID	Voice input-05	Test Case ID	02-A				
Test Case Description	Voice input - positive test case	Test Priority	Medium				
Pre-Requisite	1. The user should be logged in 2. A voice clip of an angry dog 3. Breed- Labrador 4. Dog owner- Shashini Chethana 5. Experience- 12 years 6. Background noise- Quiet	Post-Requisite					
Test Execution Steps:							
S.No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Select ‘Smart translator and enter	N/A	Smart translator UI	Smart translator UI	Google chrome	Pass	[Shashini Chethana 5.05 P.M. 04/10/2021] Navigation successful
2.	Select ‘Choose file’	Angrily labeled Bark clip	Angry	Angry	Google chrome	Pass	[Shashini Chethana 5.10 P.M. 04/10/2021] Correct prediction]
3	Click ‘log out’	N/A	Log in screen	Log in screen	Google chrome	Pass	[Shashini Chethana 5.10 P.M. 04/10/2021] Log out successful]

Table 1 table 1

Test Scenario ID	Voice input-06	Test Case ID	02-B				
Test Case Description	Voice input - Negative test case	Test Priority	Medium				
Pre-Requisite	1. The user should be logged in 2. A voice clip of an angry dog 3. Breed- Labrador 4. Dog owner- Shashini Chethana 5. Experience- 12 years 6. Background noise- Loud	Post-Requisite					
Test Execution Steps:							
S.No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Select 'Smart translator and enter	N/A	Smart translator UI	Smart translator UI	Google chrome	Pass	[Shashini Chethana 5.15 P.M. 04/10/2021] Navigation successful
2.	Select 'Choose file'	Stranger labeled bark clip	Stranger	Stranger	Google chrome	Pass	[Shashini Chethana 5.20 P.M. 04/10/2021] Correct prediction]
3	Click the log out button	N/A	Log in screen	Log in screen	Google chrome	Pass	[Shashini Chethana 5.25 P.M. 04/10/2021] Log out successful]

Test Case 6

Table 2 table 2

Test Scenario ID	View skin diseases result - 07	Test Case ID	Login 1-A
Test Case Description	User view the results of skin diseases.	Test Priority	High priority
Pre-Requisite	User can view the result.	Post-Requisite	N/A

**Test Case
7**

Test Execution Steps:							
S. No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Browse the applicari on	Cmd:npm start	Launch http://localhost:3000/	http://localhost:3000/	Google chrome	Pass	[Shashini 5.20 P.M. 10/10/2021] Launch successful
2.	User click on the file upload button and select the image.	Image extentions : JPG/PNG/JPEG	User upload diseases image	User upload diseases image	Google chrome	Pass	[Shashini 5.20 P.M. 10/10/2021] successful
	Click on the the upload buton user can view the result.		User vew the result	User vew the result	Google chrome	Pass	Shashini 5.20 P.M. 10/10/2021] successful

Table 3 table 3

Test Scenario ID	View Treatments – 08	Test Case ID	Login 1-A				
Test Case Description	View skin diseases treatments via chatbot.	Test Priority	High priority				
Pre-Requisite	User can start a conversation with the chatbot	Post-Requisite	N/A				
Test Execution Steps:							
S. No	Action	Inputs	Expected Output	Actual Output	Test Browser	Test Result	Test Comments
1.	Browse the applicari on	Cmd:npm start	Launch http://localhost:3000/	http://localhost:3000/	Google chrome	Pass	[Shashini 5.20 P.M. 10/10/2021] Launch successful
2.	Start a conversation with chatbot click on the Questioner button.	Select the answers for the chatbot questions	Redirect to questions	View questions and user can response the questions	Google chrome	Pass	[Shashini 5.20 P.M. 10/10/2021] Launch successful

3	Select the minor skin diseases then it will redirect to the treatments page		View the skin diseases treatments	View the skin diseases treatments	Google chrome	Pas s	[Shashini 5.20 P.M. 10/10/2021] Launch successful
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RESULTS & DISCUSSION

Results & Research Findings

We have considered the results of all four components provided, so they are the result of the algorithm and the sensor's output.

The smart health analyzer, as expected, developed a less-weight device and was easier to carry for the dog, initially with the assumption that carrying such a device with the leash connected to the sensor and the breadboard weights would be problematic for the dogs. Furthermore, it is worth noting that this device was designed to replace sensors in the event of a failure. Not just for the sensors but also for the Node MCU mainboard, which may be changed if any problems arise in the future.



Here are some of the benefits of the device in research findings,

- Sensors are renewable and can be replaced with updated sensors without any issue.
- The mainboard of the device, which is called Node MCU, can be replaced. Therefore, the system will not get affected even if there is a shortage on the board.
- The device can be rechargeable at any time, and no need to replace the battery.
- The device will be covered with a hard plastic shell, and it will be waterproof.

This device can be used on dogs of any size. The device is getting an attached leash, and it can be attached to any dog, irrespective of the dog size. The MAX30100 sensor can also detect pulse rates on rough skin. We can easily monitor the pulse rate since the sensor includes two led bulbs that transmit infrared light to the skin. Initially, there is some question over whether the pulse rates can be monitored due to the fur density. It was simple to trace it down because of the sensor's technology. Furthermore, beneath the left arm, all of the dogs had less hair. As a result, putting the sensor under the arm makes it simple to collect the temperature and pulse rate.

We have mostly looked at how well the **dog bark classification** algorithm (ANN) performs in different environments, with different dog breeds, and on different devices. A summary of the following test case results can be seen in the table below. Ten test cases for each breed have been executed. The device output determines the test score often. One point is awarded for each accurate prediction.

Dog breed: Labrador

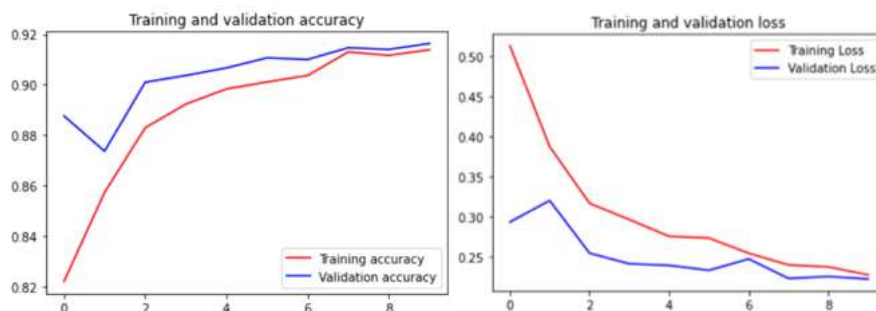
Condition	Stranger	Angry	Pain	Sad
Windy	9/10	8/10	9/10	9/10
High background noise	8/10	8/10	5/10	8/10
Low background noise	9/10	9/10	9/10	9/10

Dog breed: German Shepard

Condition	Stranger	Angry	Pain	Sad
Windy	9/10	9/10	9/10	9/10
High background noise	9/10	8/10	6/10	9/10
Low background noise	9/10	9/10	9/10	9/10

These experiments were carried out on Labrador and German Shepherd. According to the above test findings, a high windy situation may cause the microphone recording to be disrupted. This may lead to inaccurate predictions. The model accurately predicted 9/10 in a windy situation in our case. In addition, predictions have been evaluated in both low and high background situations. The model tends to perform as expected with high accuracy predictions in low background situations. High vocalizations barking patterns like Angry, Stranger, and Sad do not vary as much in high background situations as in low background situations. However, "pain" is a low vocalization bark pattern prediction with some drop in accuracy. The algorithm was able to predict accurately in low background noise for both breeds 9/10. Low vocalizations may have difficulty overcoming high background noise when there is a lot of it. As a result, the model was unable to identify the dog's vocalization properly.

This technique made it possible to **identify the dogs' skin diseases**. Traditional methods of detecting skin diseases have a number of flaws. This method can typically detect skin diseases in pets with a high degree of accuracy. Since this research seeks to limit the spread and detect the diseases, many skin images(both infected and healthy dogs) were used to build a model utilizing a machine learning and deep learning architecture. Furthermore, given a picture of a skin disease as input, the model would detect infected areas in any skin disease and increase its efficiency after the training.



The classification metrics are first produced by executing the model process `img.py` function in the TensorFlow framework, which runs through our trained model and stores the results in a saved model record file. The training and testing datasets are both reasonably accurate: 92.3% and 91%, respectively. This model is the final model due to a lack of time and hardware resources. As can be seen, moving the training loss values a

Discussion

When demonstrated the smart health analyzer, each dog responds differently to pulse rates, temperature rates, and motion detections. When dogs are categorized as small, medium, or large breeds, this is a common occurrence. Furthermore, when predicting and validating specific ranges, particularly at different scales, the support vector model performed well, as expected. We can use two machine learning algorithms to collect sensor data for this project.

1. Anomaly Detection algorithm
2. Support vector model

Although, the support vector model is the most effective in outlier detection in a wide range of data. As a result, the Support Vector Machine Learning model (SVM) is highly recommended even for future projects dealing with a wide range of numbers.

As the number of pulse rates and temperature rates in each class becomes increases, the model may be able to predict more accurately than it now does. We use normal data to train and identify normal levels and differentiate fever and other symptoms. If we can increase the number of dogs in the normal and healthy pulse rate and heart rate classes, we also must increase the number of dogs in the unhealthy pulse rate and temperature rate groups. We did not utilize machine learning for motion detection since it requires real-time data collection. Nevertheless, we provide some healthy dogs' daily activity levels to create a model against which each dog can be tracked with the help of their pet owners. As previously mentioned, below are some guidelines to follow while predicting and training a model,

- As much as we predict correct data, we also need to feed insufficient data to the model. For example, it is not enough to feed a healthy dog's pulse and temperature rates to the system to identify better predictions.
- Also, use the set of data as 60% to 40% percentages of chunks to train and test
- The data set need to be shuffled. And it can be done manually or automatically (Programmatically)
- Balancing the data set as much as possible is important.
- Also, the data set should be normalized for error-free predictions. Activations should be monitored. When normalizing, we can use batch normalization, layer normalization, zero centered normalization, or normally distributed.

- Finally, Gradient clipping can be done to control gradient explodes.

As we discussed the Smart translator, We found that the model will perform differently in different situations. We determined that background noise is a critical element for a microphone input-based device when making predictions. Background noise may interact with a pet dog's bark vocalization, and in some cases, it can completely drown out the dog's sound, resulting in inaccurate predictions. Even though we utilized approximately 500 sound clips for training the model, the model had difficulty accurately identifying the sound.

The model may be able to predict properly if the number of dog bark clips in each class is increased. To train the model, we utilized dog sound recordings with no background noise, although we did add some clips for background noise. We must increase the number of sound clips in the background class if we can increase the number of sound clips in the bark classes. We can utilize dog sound clips with some background noise instead of simply adding pure Sad, Angry, Stranger, and Pain clips to classes without any background noise so the model can differentiate properly. To improve accuracy, we must concentrate on the following aspects when training the model and preparing the data.

- We need to analyze the validation data for bad predictions(errors).
- Also, we need to focus on dead nodes on the artificial neural network. It is better if we could keep the dead node count noted.
- The data set needs to be shuffled, and it can be done manually or automatically (Programmatically)
- Balancing the data set as much as possible is important.
- Also, the data set should be normalized for error-free predictions. Activations should be monitored. When normalizing, we can use batch normalization, layer normalization, zero centered normalization, or normally distributed.
- Gradient clipping can be done to control gradient explodes.

When focused on the pet skincare component, used the K-means algorithm and the CNN for the next training phase. It was here using RGB, HSV, HSL, and canny morphological edge for feature extraction. Finally, when one of the parameters was modified, the graph's findings revealed some modifications. The model's size was changed to two distinct sizes, which had an impact on the systems. The vastness of the model became apparent, and the training session took a long time to finish. However, the accuracy rate of 92.3% is high compared to the huge size of the skin diseases dataset's training model.

When it comes to chatbots, the image of skin disorders is important. The pet owner may start a discussion with the chatbot after recognizing the illnesses. Consider the severity of the skin diseases, and the chatbot will provide remedies or alert the owner to find veterinarian help, with veterinary facilities appearing on Google Maps.

Summary of Each Student's Contribution

Student ID Number	Student Name	Contributions
IT18502466	Thilakarathne L.V.I.S	<ul style="list-style-type: none">• Pulse rates of the dogs of any size (small/Medium/large breed)• The temperature of the dogs of any size (small/Medium/large breed)• Activity levels of a dog. (This captures daily steps and activities that the dog does)• Analyze and predict the heart rates of the dog. (Whether it's in the normal ranger or needs to pay medical attention)• Analyze and predict the pulse rates of the dog. (Whether it's in the normal ranger or needs to pay medical attention)• Daily activity levels analyzer and informs about how active the dog is• Supplies diet routines for the dog depending on the size of the breed.• Supplies exercise routines for the dog depending on the activity levels of the dog.• Downloadable PDF format of diet routines.• Downloadable PDF format of the exercise routines.

IT18006858	Salay M.S	
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Wijethilaka M.G.R.		
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IT18001730	T.S. Chethana Fernando	<ul style="list-style-type: none"> • Implement the pet dogs' skin diseases identification system. • Implement the level of skin diseases and compare the other diseases with the accuracy of probability of the diseases. • Implementation of colour schema pattern for the uploaded skin diseases. • Implement a chatbot system. • Implementation of chatbot API • Implementation of pet dogs treatments for minor skin diseases. • Implement a suggestion for finding the veterinarians (For severe issues) via a chatbot system.
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CONCLUSIONS

According to the results, most pet owners cannot differentiate and identify minor symptoms that develop in their dogs' internal bodies without the help of a device. As is typical among pet owners, we always wait until the end of the month or until a particular day to see a veterinarian analyze our pets' behavior during specific times. On the other hand, this device allows pet owners to identify even small changes in temperature in their dog's internal body right away. Furthermore, dog owners may determine if their pets have or are suffering from cardiovascular problems by monitoring daily pulse rates. We have created a simple, straightforward solution that can be enabled with a small switch and utilized at any time of day. Furthermore, since this system is connected to a comfortable leash, the dogs may wear it without any difficulty or risk of harm. Sri Lankan data was used to train the device's professional Lead Veterinary Doctors in the Air Force. Because we were able to get accurate data from Air Force databases, we achieved higher levels of accuracy in the training model without difficulty.

Using machine learning and deep learning techniques, we discovered that dog vocalization patterns could be distinguished accurately. This comparable software experience provided by 'Dogodo Smart Translator' may be likened to a seasoned dog owner helping a novice dog owner incorrectly recognizing canine language and gestures. The suggested method is mainly based on canine communication. In addition, the system recommends a reaction to the dog owner in each canine response. Compared to human identification in 'Stranger' and 'Angry' scenarios, people could identify each class quicker than the algorithm. The computer surpassed human estimates in identifying 'Sad' and 'Pain.' In all situations, the algorithm could execute with an average of 80% accuracy. The variables obtained by the deep convolutional neural network for the multi-class classification issue were examined in the dog bark acoustic bark pattern recognition research. For the classification goal, a multi-Classifier was used to categorize the retrieved features. The multi-class classifier obtains an overall accuracy of 80.21% with a 19.79% error rate after 5-fold cross-validation.

```
In [182]: test_accuracy=model.evaluate(X_test,y_test,verbose=0)
          print(test_accuracy[1])
```

```
0.8002289533615112
```


As future work, this can be extended to understanding deeper contexts of canine communication. This research has only covered the fundamental aspects of canine communication and limited dog bark vocalizations. It can be extended to deeper dog communication with different dog sounds. For example, this research only covers the fundamental aspects of canine communication such as 'Stranger,' 'Pain,' 'Sad,' and 'Angry.' It could be extended to more complex identification such as 'Dog is in Pain due wound' or dog is sad due to lack of owner's attention. This system can also be further developed to identify mixed signals. For example, aggressive signals may come mixed with other signals like fear signals. For example, if a dog is communicating an aggressive signal towards the threat but the owner or stranger misread it as fear and approaches the dog, it may lead to a bite. Prevent this kind of situation, and the system can be developed and enhanced. We will need to train the model again with these kinds of mixed audio data signals, and the data set need to be larger and complex. We can do this by adding more sound clips and more classes to the dataset.

The study's goals were met since the created software can use the phone's rear camera to record localized skin diseases. According to the results, the proposed application allows for detecting and treating skin diseases at home. Consequently, the next step will be to utilize image processing techniques to detect various skin diseases in a single series. In this study, a total of 2 639 images were utilized. The test dataset contains 924 images for training and 715 images for skin diseases. The TensorFlow framework was also used to apply deep learning, which stimulated, trained, and categorized eight distinct kinds of skin diseases and healthy dogs with up to 92.3% accuracy. Python was eventually selected as the programming language for this research because it is compatible with the TensorFlow framework, allowing the whole back end of the proposed system to be developed in Python.

Additionally, the project's web application's mobile-first approach will be a helpful tool for pet dog owners, particularly those who reside in regions with inadequate infrastructure and veterinary facilities. The pet owners identify the illness, which reduces the dangers, and there is no need to see a veterinarian in mild instances. When it comes to severe skin disease problems, dog owners will utilize Google Maps to find a veterinary expert.

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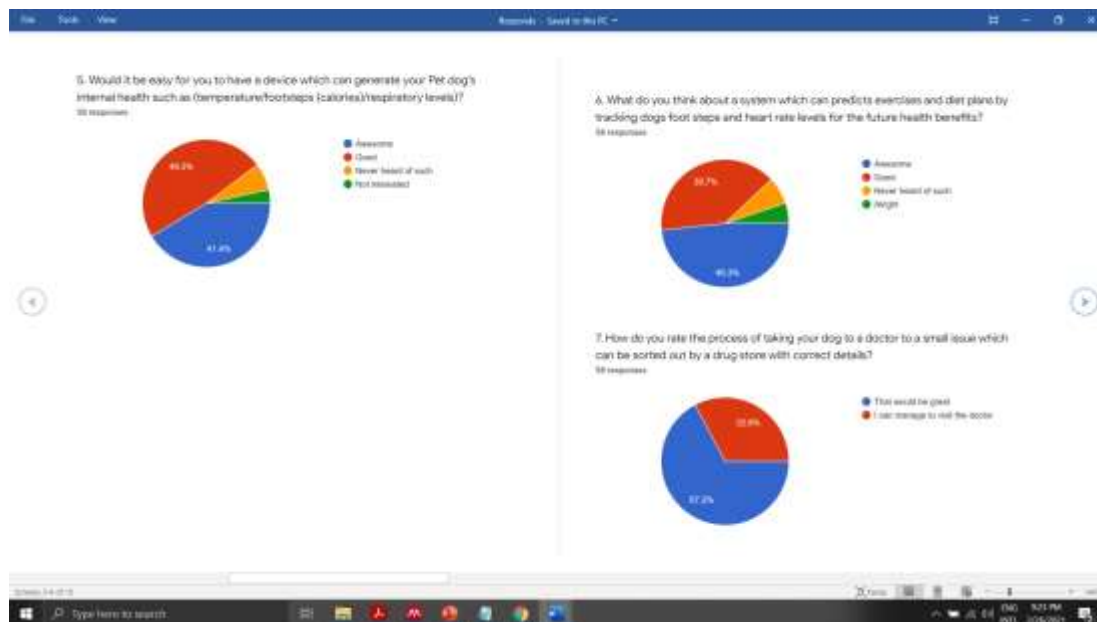
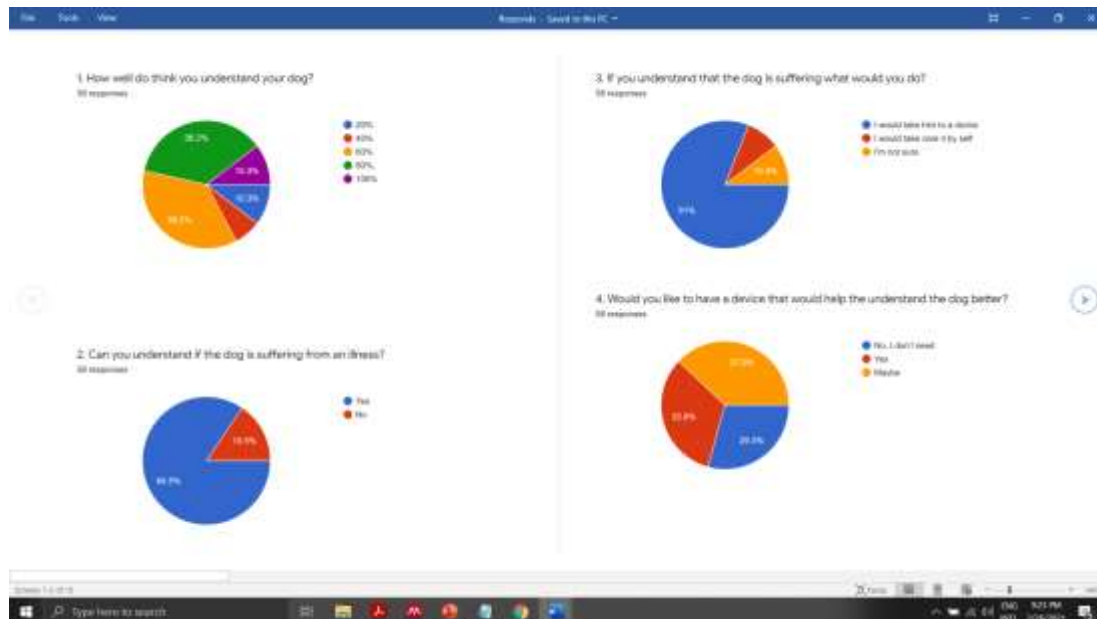
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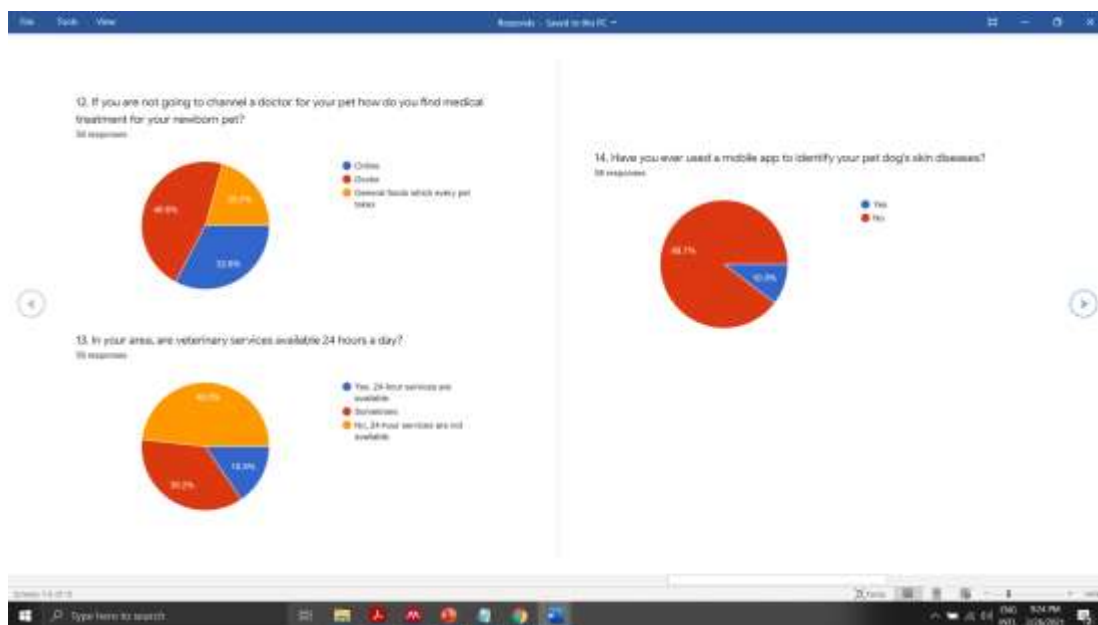
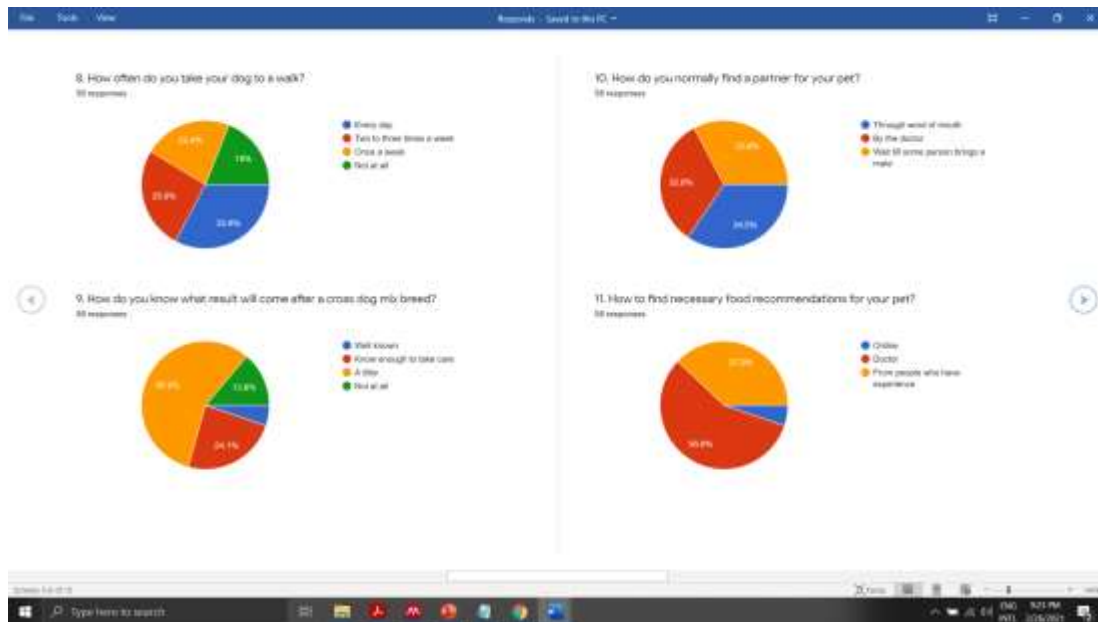
GLOSSARY

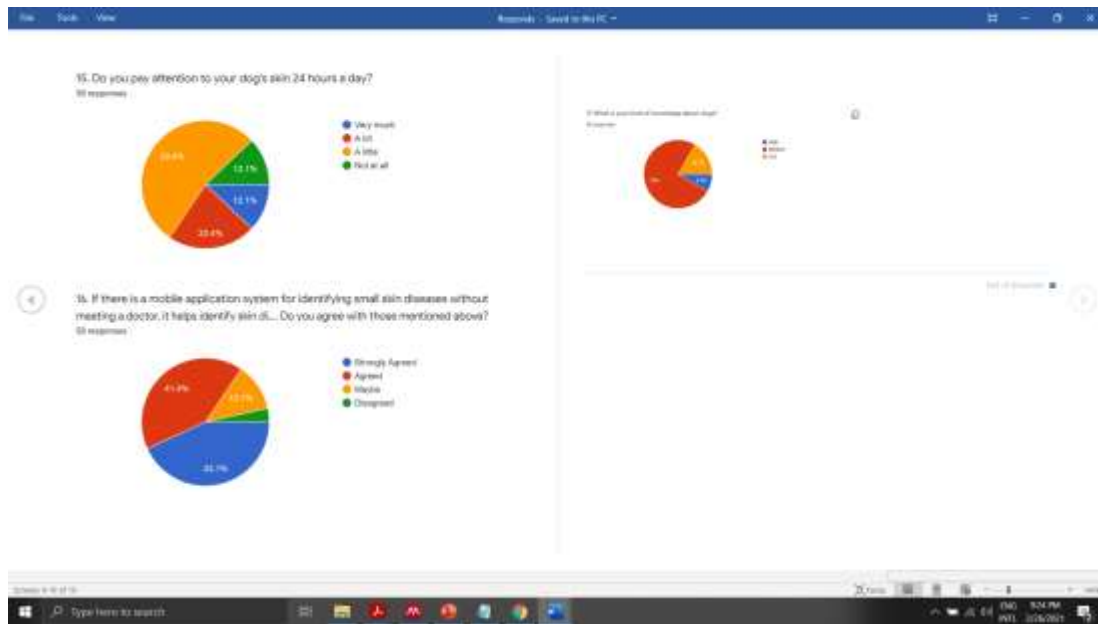
- Node MCU = Node Micro Controller Unit
- Canine - Relating to or resembling a dog or dogs
- Acoustic- The branch of physics concerned with the properties of sound.

APPENDICES

Appendix A: Complete questionnaire results







Appendix B: User Interfaces

