

**CST3990 Undergraduate Individual Project**

**VisionHealth Feeder(ViHF)**

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Contents

[1.Background of Study 3](#_Toc150687702)

[2. Problem Statement 3](#_Toc150687703)

[3. Description of Project 4](#_Toc150687704)

[3.1. Project Overview Aims Of Project 4](#_Toc150687705)

[3.2. Aim of the project 4](#_Toc150687706)

[3.3. Project Objectives 4](#_Toc150687707)

[3.4. Investigative work 5](#_Toc150687708)

[5. Project Plan 6](#_Toc150687709)

[6. Project Resources 8](#_Toc150687710)

[7. Bibliography 9](#_Toc150687711)

[8. References 9](#_Toc150687712)

Table of Figures

[Figure 1 Gantt Chart 7](#_Toc150686998)

[Figure 2 Component List (Joomun,2023) 8](#_Toc150686999)

1.Background of Study

Animal nutrition is a vital aspect of animal welfare, encompassing not only household pets but also animals in zoos and other care settings. Proper nutrition is crucial for maintaining the health and well-being of animals, and it involves understanding and providing a balanced diet that meets the specific needs of different species.

1. Balanced Ration: A balanced ration is a diet that contains all essential nutrients in the correct and adequate proportions. These nutrients include carbohydrates, proteins, fats and oils, minerals, vitamins, and water. The diet is formulated based on the animal's metabolic and physiological needs, which can vary greatly depending on factors like growth, lactation, reproduction, pregnancy maintenance, egg-laying, weaning, and fattening.
2. Imbalanced Ration: Conversely, an imbalanced ration is a diet that lacks essential nutrients or provides them in incorrect proportions. This can lead to a range of malnutritional diseases, each with specific causes, symptoms, and corrective measures.
3. Malnutritional Diseases: Five common malnutritional diseases in animals, along with their causes, symptoms, and corrections, include:

* Obesity: Caused by overfeeding or an imbalance of energy intake versus expenditure. Symptoms include excessive body fat and associated health risks. Correction involves diet management and increased exercise.
* Protein-Energy Malnutrition: This occurs due to inadequate protein intake. Symptoms include muscle wasting and weakened immunity. Correction involves providing a diet rich in quality protein.
* Vitamin Deficiencies: These can lead to various health issues like poor bone health, skin problems, or vision impairment. Each vitamin deficiency has specific symptoms and requires dietary adjustments or supplements for correction.
* Mineral Imbalances: Essential for bone health and other bodily functions, mineral deficiencies or excesses can cause various symptoms, corrected through diet adjustments.
* Fatty Acid Imbalances: Symptoms may include poor coat quality and skin issues, corrected by providing the right balance of essential fatty acids.

Given the diversity of animal species and their unique nutritional requirements, the field of animal nutrition is complex. For pet owners, zookeepers, and others responsible for animal care, understanding these dietary needs is crucial. This knowledge not only helps in preventing malnutrition and its associated diseases but also plays a significant role in enhancing the overall quality of life and longevity of the animals under their care.

With this our target animal shall be dog but can be expanded later to other animals as mentioned above the field of animal nutrition is complex.

* 1. Market Size

The market for solutions addressing animal malnutrition is significant and is a part of the broader animal nutrition market. This market is experiencing steady growth, indicating a strong demand for products and solutions in this area.

The global animal nutrition market was valued at USD 12.4 billion in 2022 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 6.2% from 2023 to 2029. This growth is driven by various factors, including the increasing demand for nutritious animal feed, the rise in awareness regarding animal health and nutrition, and the growing consumption of meat and other animal-based food products.

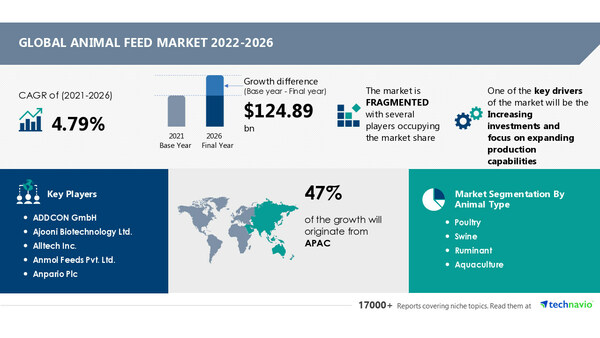


Figure 1 Market Research Report (Prnewswire,2021)

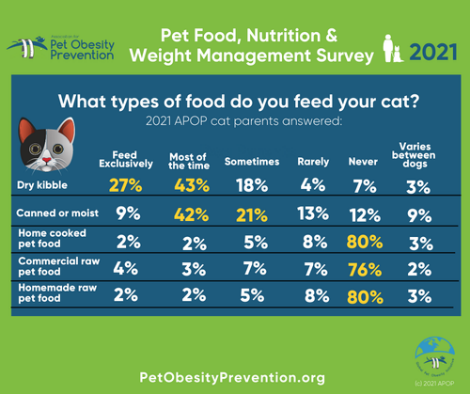
The market size for Animal Nutrition is ever-growing for both households and commercial use.

Figure 1 shows the Animal Feed Market Size to Grow by USD 124.89 billion with 47% of the market growth from APAC - 17,000. (Technavio, n.d.)

2. Problem Statement

Narrowing down from the main animal welfare the current automated pet feeders often fall short in addressing the unique health and nutritional needs of individual pets, leading to issues like overfeeding, underfeeding, and pet obesity.

1. **Pet Obesity Rates**: Research indicates that obesity affects about 60% of cats and 56% of dogs in the United States, as per the Association for Pet Obesity Prevention. This high prevalence underscores the need for precise feeding solutions.
2. **Impact of Improper Feeding**: Studies have shown that overfeeding or underfeeding can significantly impact a pet's health. For instance, even a few extra pounds can lead to conditions like diabetes, joint problems, and respiratory difficulties in pets.
3. **Individualized Nutrition** **Needs**: According to a survey, more than 70% of pet owners are interested in personalized pet diets, reflecting a growing awareness of the importance of tailored nutrition. This is especially relevant as dietary needs can vary greatly depending on the pet's age, breed, activity level, and health conditions.

Figure 2 Shows a survey one by petobesity prevention whereby dept analysis of animal welfare has been done for home animal.

Our approach seeks to ensure precise nutrition for each pet, addressing concerns of obesity and malnutrition, and significantly improving the standard of pet care for individual pet households.

Figure 2 Pet Food,Nutrition & Weight Management Survey (Association for Pet Obesity Prevention, n.d.)

1. Review of Existing Solution

The Petlibro automatic cat feeder is a Wi-Fi-enabled smart device. Same has been developed for animal food dispensing.

We shall critically analyse same feature wise with the pros and cons.

Figure 3 Shows the PETLIBRO

Figure 3 PETLIBRO Automatic Feeder (www.amazon.com, n.d.)

1. Features and Structural of system

## Smart APP Control

Petlibro automatic cat feeder with Camera & Wi-Fi is 5GHz and 2.4GHz WiFi-enabled, allowing you to program and monitor your pet's meals anywhere, anytime through the PETLIBRO App .You can set a feeding plan and schedule feeding time for two pets, up to 6 meals per day with 1-50 portions per meal. The feeding log can be used to check whether your pet is being fed according to the schedule you set. The feeder can be controlled by multiple family members'smartphones. (www.amazon.com, n.d.)

|  |  |
| --- | --- |
| **PROS** | **CONS** |
| Easy to Manage Pet Nutrition | Pet portions need to be set manually instead of using the camera to analyse and give portions accordingly |

1. 145 Camera

PETLIBRO smart pet feeder with camera uses a high definition video camera with 1080P high quality and 145° wide viewing angle for remote monitoring, allowing you to watch and hear how your beloved pet is eating while you're on the move. And the videos can be saved on an SD card (not included) with a capacity of up to 256GB. You may monitor your pet's eating habits by watching the video playback on the APP. The built-in camera has IR night vision, so you can see your dogs well in the dark.

|  |  |
| --- | --- |
| **PROS** | **CONS** |
| 24hr View of your pet | Camera Data are only used to see cat no analysis on Animal health done |
| Recorded video for your pet. | Camera Not Used to detect when the animal is in front of the pet feeder or not |
|  | Recorded video are stored on SD card could have stored on cloud since same is connected to Wifi |

Project Proposal

3.1. Project Overview Aims Of Project

The "VisionHealth Feeder" is an innovative pet feeding solution that employs cutting-edge machine vision technology. It features a dual-camera system for Depth Estimation using Stereo Vision. This sophisticated setup enables the feeder to accurately identify different pets, distinguishing them based on size, shape, and other unique characteristics. The system then adjusts the diet for each pet according to their specific health needs.

3.2. Aim of the project

The core purpose of the "ViHF" is to provide pet owners with an advanced and intelligent pet feeding system that goes beyond mere scheduling and portion control. This solution leverages machine vision technology to offer species-specific feeding and real-time nutritional adjustments, thereby addressing the challenges of pet obesity, dietary requirements, and multi-species households. The system aims to promote the health and well-being of pets by delivering tailored nutrition while offering convenience and peace of mind to pet owners.

3.3. Project Objectives

The primary aim of the "VisionHealth Feeder" project is to enhance the health and well-being of pets by providing a personalized and automated feeding experience. By utilizing advanced machine vision and depth estimation technologies, this project aims to:

1. **Accurately Identify Individual Pets:** Utilize the dual-camera stereo vision system to distinguish between different pets in a household, recognizing each one based on unique physical characteristics.
2. **Tailor Diets to Specific Health Needs:** Automatically adjust the quantity and type of food dispensed for each pet, based on their individual health requirements, dietary restrictions, or weight management needs.
3. **Promote Optimal Health and Nutrition:** Ensure that each pet receives a balanced diet that is appropriate for their age, breed, activity level, and any special health considerations, thus contributing to their overall health and longevity.
4. **Reduce Overfeeding and Waste:** Minimize the common problem of overfeeding pets, which can lead to obesity and health issues, and also reduce food waste by dispensing the precise amount needed for each pet.
5. **Enhance Convenience for Pet Owners:** Provide a convenient solution for pet owners, especially those with multiple pets, by automating the feeding process and ensuring that each pet is fed correctly even in their absence.

In summary, the aim is to integrate technological innovation into pet care, ensuring healthier, happier pets and more convenience for pet owners.

3.4. Investigative work

The "ViHF" project you're describing is a technology-driven solution that integrates various sophisticated technologies to create a comprehensive system for pet care. Here's a brief overview of the technology stack that could be leveraged for each of the components:

1. **Machine Vision- Stereo Vision:**

Cameras: High-definition, possibly multi-spectral cameras for capturing detailed images of pets.

Image Processing: Advanced software for analyzing images, which may include OpenCV or other computer vision libraries. Additional Python programming for Stereo vision and analysis to recreate a depth map for analysis of size of animal

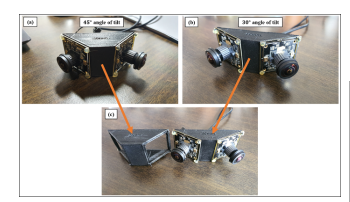
Algorithms: Machine learning algorithms, potentially deep learning models like convolutional neural networks (CNNs), trained on a large dataset of pet images to recognize different species and assess health indicators.

Figure 4 Dual Camera Set Up (IEEEXplore,n.d)

A CNN to be able to create the dept image of the environment.

The core notion of an angled stereo camera is based on previous works of traditional stereo cameras that use a pair of parallel optical axes. Two cameras are employed in traditional stereo camera technology to capture photos of a scene from slightly different perspectives. (ieeexplore.ieee.org, n.d.)

This occurs when both cameras are pointing in the same direction. The difference between the two photos is then compared to determine the distance between various spots within the captured overlapped scene. This method is comparable to how human eyes work, in that it detects disparities between images from both eyes instinctively. (ieeexplore.ieee.org, n.d.)

This enables us to perceive distance via vision. By minimizing the overlapping region, angled stereo cameras can capture a larger FOV.

1. **User Interface:**

Frontend Development: Utilizing frameworks such as React Native or Flutter for cross-platform mobile app development, ensuring that the user interface is responsive and intuitive.

Backend Integration: Node.js or Python-based backend services, which handle the app's server-side logic and communicate with machine vision and AI components.

APIs: RESTful APIs or GraphQL for smooth communication between the mobile application and the backend servers.

1. **Artificial Intelligence (AI):**

Data Processing: Big Data technologies for storing and processing large volumes of health data, possibly leveraging cloud platforms like AWS or Google Cloud for scalability.

Machine Learning Platforms: TensorFlow or PyTorch for designing and training AI models for real-time health assessment and nutritional optimization.

Analytics: AI-driven analytics for personalized insights, using tools such as Apache Spark for handling real-time data processing tasks.

By integrating these components, the ViHF project would be capable of providing a holistic pet care system. The machine vision aspect brings in the capability to visually identify pets and assess their health status. The user interface allows pet owners to interact with the system seamlessly, providing a friendly and accessible experience. Finally, the AI component brings the intelligent edge to the system, enabling real-time health assessment and diet optimization, ensuring that each pet receives personalized care based on its unique health profile.

5. Project Plan

For the proper running of the project, we shall be having multiple deliverables and milestones as below:

**Deliverables:**

1. D1-Project proposal document, following the selection and drafting of the proposal.
2. D2-Project scope and detailed plan, as part of the initial planning after the kick-off.
3. D3-Research findings on machine vision for species recognition.
4. D4-Initial health assessment algorithms from the development phase.
5. D5-Research findings on nutritional requirements and algorithm design for health-optimized nutritional dispensing.
6. D6-Initial prototype of the feeding system from the prototype development phase.
7. D9-Test results of the integrated system from comprehensive testing and validation.
8. D10-Finalized project adjustments completed for presentation.
9. D11-Project documentation and materials prepared for the final presentation.

**Milestones:**

1. M1-Approval of the project proposal during the supervisor meeting for proposal approval.
2. M2-Integration of vision system, health assessment, and other components marked as system integration.
3. M3-Final review and approval of the completed project in the last supervisor meeting.

These deliverables and milestones are the outcomes and checkpoints, respectively, that you would aim to achieve throughout the project timeline. Below is Gant chart for more information about planning .

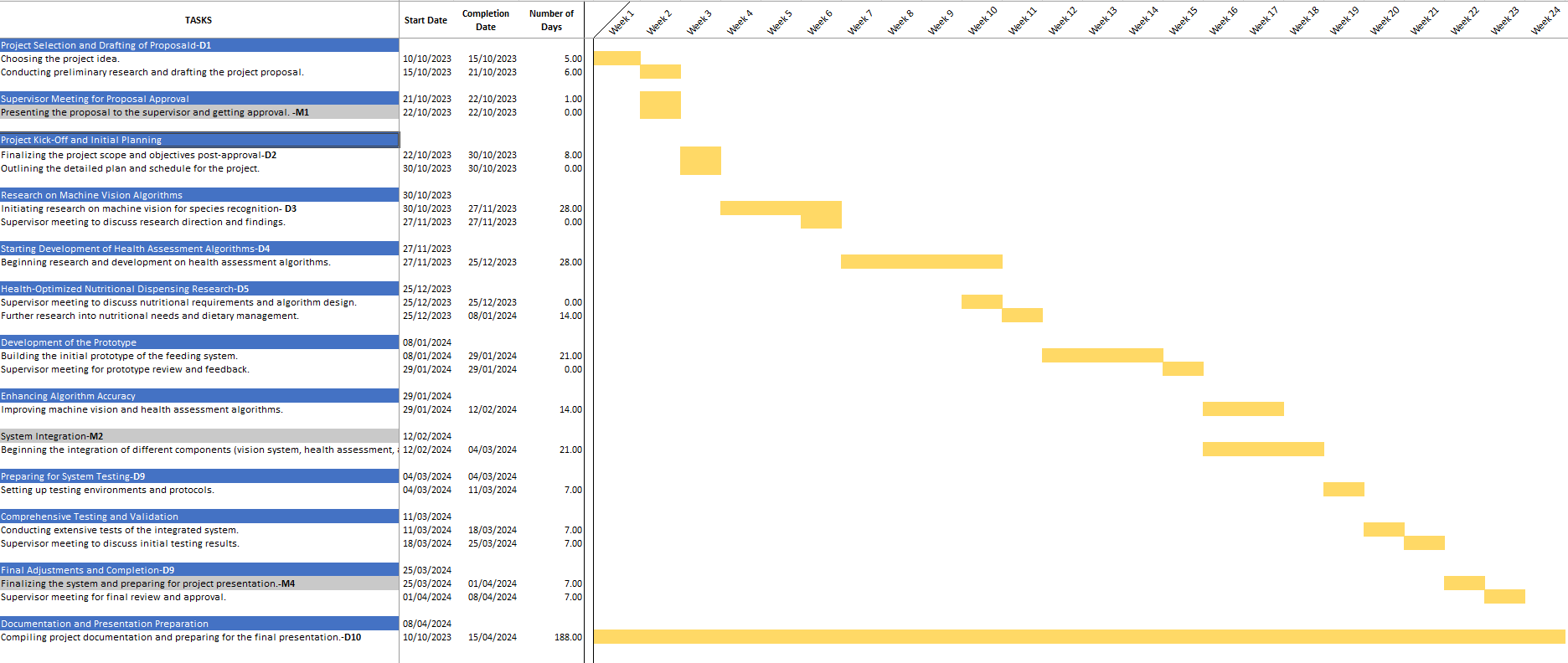


Figure 1 Gantt Chart

6. Project Resources

The project resources can be divided into 3 different sections which are:

1. Physical resources
2. Software resources
3. Other resources

Physical resources

For physical resources please see below table for expected component

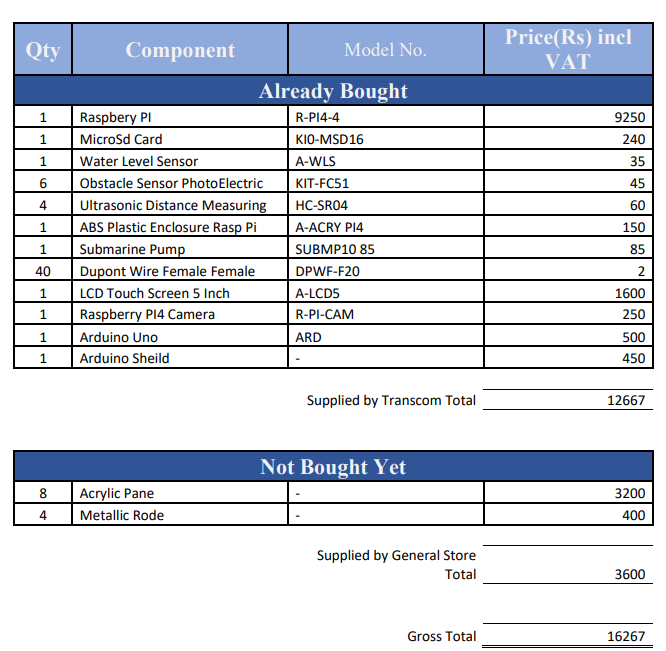


Figure 2 Component List (Joomun,2023)

Software resources

For development of the application for Machine vision python together with tensor flow. For development of Arduino Control C be used

Other resources

For the machine vision shall require a dataset. Same dataset shall be a custom dataset of Dog image of health dog and different species of dog.

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