Mini Project

On

PROSTHETIC ROBOTIC LEG FOR PHYSICALLY IMPAIRED DOGS

Bachelor of Technology

3rd Year

In

COMPUTER SCIENCE AND ENGINEERING - ARTIFICIAL INTELLIGENCE

Submitted by

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Under the guidance of

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DEPARTMENT OF CSE- ARTIFICIAL INTELLIGENCE

KKR & KSR INSTITUTE OF TECHNOLOGY AND SCIENCES

Approved by A.I.C.T.E New Delhi || Permanently Affiliated to JNTUK, Kakinada) || Accredited with 'A' Grade by NAAC || NBA Accreditation status for 5 B.Tech Programmes (Civil.CSE, ECE, EEE & Mech)

Vinjanampadu (Vil), Vatticherukuru (Md), Guntur (DT), A.P-

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CERTIFICATE

This is to certify that this Mini project titled ***"PROSTHETIC ROBOTIC LEG FOR PHYSICALLY IMPAIRED DOGS"*** is doneby **Ms.N.Madhupriya (21JR1A4396), G.Sanavya(22JR5A4305), K.Anjali(21JR1A4378)** in the duration of January to April 2024, who carried out the work under my supervision and submitted in the partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in Computer Science & Engineering-Artificial Intelligence from **JNTU-Kakinada.**

HEAD OF THE DEPARTMENT PROJECT GUIDE

DEPARTMENT OF CSE-ARTIFICIAL INTELLIGENCE

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DECLARATION

We hereby inform that this mini project titled "***PROSTHETIC ROBOTIC LEG FOR PHYSICALLY IMPAIRED DOG"*** is has been carried out by myself in the duration of January to April 2024 and submitted in partial fulfillment for the award to the degree of **Bachelor of Technology in Computer Science and Engineering-Artificial Intelligence** to **Jawaharlal Nehru Technological University Kakinada** under the guidance of Mrs PADMAVATHI, ASSISTANT PROFESSOR, Dept. of Computer Science and Engineering- Artificial Intelligence.

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Institute Vision and Mission

INSTITUTION VISION

To produce eminent and ethical Engineers and Managers for society byimparting quality professional education with emphasis on human values and holistic excellence.

INSTITUTION MISSION

- To incorporate benchmarked teaching and learning pedagogies in curriculum.
- To ensure all round development of students through judicious blend ofcurricular, co- curricular and extra-curricular activities.
- To support cross-cultural exchange of knowledge between industry andacademy.
- To provide higher/continued education and researched opportunities to theemployees of the institution.

Department Vision and Mission

Department VISION

To be a renowned department for education in Artificial Intelligence and empowering students into professional engineers with human values and holistic excellence.

Department MISSION

- Impart rigorous training to acquire knowledge through the state-of-the-art concepts and technologies in Artificial Intelligence.
- Train students to be technically competent through innovation and leadership.
- Inculcate values of professional ethics, social concerns, life-long learning and environment protection.
- Establish centers of excellence in leading areas of computing and artificial intelligence.

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ABSTRACT

This project aims to design and develop prosthetic legs tailored specifically for dogs to enhance their mobility and quality of life. Canine amputees face numerous challenges in performing daily activities, including walking, running, and engaging in playful behaviors. The absence of a limb not only affects their physical abilities but also impacts their psychological well-being.

Prosthetic legs offer a promising solution to address these challenges by restoring mobility and functionality.The research focuses on understanding the biomechanics of canine locomotion and the unique anatomical features of dogs that influence prosthetic design. By employing advanced engineering techniques and materials, such as lightweight yet durable alloys and 3D printing technologies, customizable prosthetic solutions will be developed to suit individual dog breeds and sizes.The project incorporates rigorous testing methodologies to evaluate the performance, comfort, and adaptability of the prosthetic legs. This includes biomechanical analysis, gait assessment, and feedback from veterinary experts and dog owners. Iterative design improvements will be implemented based on the collected data to optimize the prosthetic's functionality and ensure a seamless integration with the dog's body.In addition to technical aspects, the project considers the emotional bond between dogs and their owners. Education and training programs will be developed to assist owners in facilitating the rehabilitation process and promoting the acceptance and use of prosthetic limbs by their canine companions.

UNIT-1

INTRODUCTION

1.1 INTRODUCTION OF THE PROJECT:

In recent years, advancements in robotics and prosthetics have significantly improved the quality of life for humans with disabilities. However, a group that often gets overlooked in this progress is our canine companions. Dogs, like humans, can face mobility challenges due to injury, illness, or congenital conditions. To address this gap, the development of prosthetic robotic legs for dogs has emerged as an innovative solution. This project aims to design, develop, and refine a prosthetic robotic leg specifically tailored to meet the unique needs of dogs, providing them with improved mobility, comfort, and functionality. By leveraging cutting-edge technologies in robotics, materials science, and veterinary medicine, this project seeks to enhance the lives of countless canine companions and their human caregivers, fostering a deeper bond between humans and their furry friends while advancing the field of animal prosthetics.

1.2 EXISTING SYSTEM:

The existing system for prosthetic solutions for dogs primarily revolves around traditional prosthetic devices and surgical interventions. Currently, when a dog loses a limb or experiences mobility issues, veterinarians often resort to fitting them with passive prosthetics or performing surgeries such as amputations or joint fusion. These solutions, while helpful to some extent, may not fully restore the dog's mobility or natural gait and can be associated with challenges such as discomfort, limited durability, and restricted adaptability to the dog's changing needs.

Although some innovative prosthetic designs for dogs exist, they typically lack the integration of robotics and advanced materials, limiting their effectiveness in providing dynamic and adaptable mobility solutions. Consequently, there remains a gap in the market for prosthetic solutions that offer enhanced functionality, comfort, and longevity, tailored specifically to the unique biomechanics and lifestyle of dogs.

The need for an improved prosthetic system for dogs is evident, necessitating the development of prosthetic robotic legs that can provide greater mobility, stability, and versatility to canine patients. By leveraging advancements in robotics, materials engineering, and veterinary medicine, the transition from the existing passive prosthetic systems to dynamic, robotic-assisted solutions holds the potential to revolutionize canine rehabilitation and enhance the quality of life for dogs with mobility impairments.

1.2 PROBLEMS OF THE EXISTING SYSTEMS:

Certainly, here are the concise problems of existing systems for prosthetic solutions for dogs:

1. Limited Mobility: Current solutions often fail to fully restore a dog's natural mobility and functionality, leading to awkward gaits and restricted movement.
2. Comfort Issues: Poor fit and inadequate padding in traditional prosthetics can cause discomfort and pressure sores, making dogs reluctant to wear them.
3. Lack of Adaptability: Existing prosthetics lack adjustability, making them unsuitable for a dog's changing needs over time.
4. Durability and Maintenance: Passive prosthetics may not withstand everyday use, requiring frequent repairs or replacements.
5. Technology Integration: Current solutions lack advanced technology integration, hindering the development of responsive prosthetic systems.
6. Cost Constraints: The high cost of traditional prosthetics limits access to effective solutions for many pet owners.

1.3 PROPOSED SYSTEM:

The proposed system for prosthetic legs for dogs integrates affordability, customization, comfort optimization, durability, adaptive functionality, comprehensive rehabilitation support, user-friendly maintenance, and continuous improvement strategies. By prioritizing cost-effectiveness without compromising quality, modular customization, and comfort-focused design, the system ensures prosthetic legs are tailored to individual dogs' needs while remaining accessible to a broader range of pet owners. Enhanced durability through advanced materials and construction techniques minimizes the need for frequent repairs, while adaptive features and comprehensive rehabilitation support facilitate dogs' adaptation to prosthetic limbs. User-friendly maintenance protocols and a continuous improvement feedback loop with veterinary professionals and pet owners ensure ongoing refinement and optimization of prosthetic designs, ultimately enhancing dogs' mobility, comfort, and overall quality of life.

1.4 BENEFITS OF THE PROPOSED SYSTEM:

The proposed system for prosthetic legs for dogs offers several key benefits:

1. Dynamic Mobility: Prosthetic robotic legs will provide dogs with a more natural and functional gait, enabling them to move with greater ease and confidence across various terrains.
2. Customization and Comfort: The prosthetics will be custom-designed to ensure a perfect fit for each dog, minimizing discomfort and pressure sores. Advanced padding materials will enhance comfort during prolonged wear.
3. Adaptability: The prosthetic robotic legs will be adjustable to accommodate the dog's changing needs over time, reducing the need for frequent replacements and adjustments.
4. Durability and Maintenance: Utilizing high-quality materials and robust construction techniques, the prosthetics will offer increased durability and require minimal maintenance, ensuring long-term reliability and performance.
5. Technology Integration: Advanced sensors and actuators will be integrated into the prosthetic design, allowing for real-time adjustments to the dog's movements and terrain. This technology will enhance stability, responsiveness, and overall functionality.
6. Affordability: The development process will prioritize cost-effectiveness to ensure that the prosthetic robotic legs are accessible to a wide range of pet owners.

UNIT -II

ANALYSIS

User Requirements:

1. Mobility Enhancement: Enable natural movement patterns and stability across different terrains.
2. Tailored Comfort: Provide personalized fit and cushioning to alleviate discomfort and pressure points.
3. Adaptive Design: Accommodate changes in size and condition, ensuring long-term usability.
4. Robust Durability: Utilize resilient materials for minimal maintenance and prolonged lifespan.
5. Integrated Technology: Incorporate sensors and actuators for responsive adjustments and improved performance.
6. Economic Accessibility: Offer cost-effective solutions to ensure widespread availability and affordability.

Non-Functional Requirements for Prosthetic Robotic Leg System for Dogs

1. **Reliability**: Ensure consistent performance and durability.
2. **Safety**: Prioritize features to minimize risk during use.
3. **Scalability**: Accommodate various dog breeds and sizes.
4. **Usability**: Design intuitive controls and fitting procedures.
5. **Compatibility**: Integrate seamlessly with existing veterinary practices.
6. **Regulatory Compliance**: Adhere to relevant standards and certifications.

System Requirements for Prosthetic Robotic Leg System for Dogs

1. **Biomechanical Compatibility**: Ensure alignment with a dog's natural limb movement.
2. **Customization and Adaptability**: Tailor the prosthetic to each dog's unique anatomy and adjust for changes over time.
3. **Material Durability and Comfort**: Use durable yet comfortable materials for prolonged wear.

4. **Battery Life and Power Management**: Optimize battery life for sustained functionality.

5. **Integration with Rehabilitation Programs**: Seamlessly integrate into existing veterinary rehabilitation protocols.

Modules Description :

Biomechanical Interface: Ensures compatibility with natural limb movement.

Adaptation and Customization: Tailors the prosthetic to individual dogs' needs.

Materials Engineering: Selecting durable and comfortable materials.

Power Management: Optimizes battery life for sustained use.

Data Acquisition and Analysis: Collects usage data for continuous improvement.

Integration and Compatibility: Seamlessly integrates with veterinary practices.

Technical feasibility

Our project's technical feasibility rests on a foundation of cutting-edge technology and collaborative expertise. Leveraging advancements in robotics, materials science, and sensor technology, we aim todevelop a prosthetic system tailored to canine biomechanics.

1. Interdisciplinary collaboration among robotics engineers, veterinarians, biomechanics specialists, and materials scientists ensures comprehensive design and development. This synergy enables us toaddress multifaceted challenges in canine prosthetics effectively.

2. Prototyping and testing iterations will validate design concepts and functionality. By closely monitoring and refining prototypes, we mitigate technical risks and optimize performance before implementation.

3. Adequate resource allocation, including funding and access to specialized equipment and facilities, supports our research and development efforts. Securing necessary resources is pivotal for achievingproject milestones and delivering a robust prosthetic solution.

Operational Feasibility of Prosthetic Robotic Leg System for Dogs

1. **Usability**: Designing intuitive interfaces for both veterinarians and pet owners to ensure ease of use.
2. **Scalability**: Ensuring the system can accommodate various dog breeds and sizes to address diverse needs.
3. **Cost-effectiveness**: Conducting thorough cost-benefit analyses to optimize resource utilization and affordability.
4. **Stakeholder Engagement**: Actively involving veterinarians, pet owners, and animal welfare organizations to foster acceptance and support.
5. **Regulatory Compliance**: Proactively addressing regulatory requirements to ensure legal and ethical integrity throughout the project.

Behavioral Feasibility of Prosthetic Robotic Leg System for Dogs

1. Acceptance by Dogs: Understanding how dogs adapt to and interact with the prosthetic system is essential. Behavioral studies and observation sessions will provide insights into acceptance levels, comfort, and ease of mobility.

2. Ease of Integration into Daily: Examining how seamlessly the prosthetic integrates into a dog's daily activities, such as walking, running, and playing, is key. Observational studies and userfeedback will help identify any challenges or adjustments needed for smooth integration.
3. Owner Compliance and Caregiver **:** Assessing the willingness of pet owners to adhere to maintenance protocols and provide necessary care is vital. Surveys and interviews with pet owners will shed light on their attitudes, perceptions, and experiences with the prosthetic system.
4. Veterinary Adoption and : Evaluating the readiness of veterinary professionals to incorporate the prosthetic system into their practice is essential. Training sessions and consultations with veterinarians will gauge their comfort level, knowledge, and support for the technology.

Process model

The process model used for developing the prosthetic robotic leg system for dogs is the IterativeDevelopment Model. This model emphasizes cyclic development, where the project progressesthrough repeated cycles of planning, designing, implementing, and testing. Each iteration allows forincremental improvements based on feedback and lessons learned from the previous cycle. Thisapproach enables flexibility in accommodating evolving requirements and technical challenges whileensuring a high degree of stakeholder involvement throughout the

Development process.Additionally, it facilitates early identification and mitigation of risks, ultimately leading to thecreation of a robust and user-centric prosthetic system for canine mobility enhancement.

Hardware and Software Requirements :

Hardware Requirements:

1. **Prosthetic Components**: Custom-designed prosthetic components including sockets, actuators, sensors, and structural materials tailored to canine anatomy and biomechanics.
2. **Embedded Systems**: Microcontrollers or embedded systems to control the prosthetic movements and integrate sensor feedback for real-time adjustments.
3. **Power Supply**: Lightweight and durable batteries or power sources to provide energy for theprosthetic system, ensuring sustained operation throughout the day.
4. **Sensors**: Various sensors such as gyroscopes, accelerometers, and force sensors to monitor the dog's movements, weight distribution, and environmental conditions.
5. **Communication Modules**: Wireless communication modules (e.g., Bluetooth, Wi-Fi) for data transmission between the prosthetic system and external devices such as smartphones or computers.
6. **Testing Equipment**: Equipment for biomechanical testing, including motion capture systems,force plates, and gait analysis tools to evaluate prosthetic performance and fit.
7. **Manufacturing Tools**: Tools for fabrication and assembly of prosthetic components, including 3D printers, CNC machines, and hand tools.

Software Requirements:

1. **Embedded Software**: Firmware or embedded software to control the operation of the prosthetic system, including motor control algorithms, sensor fusion, and communication protocols.
2. **User Interface (UI)**: User-friendly software interface for configuring prosthetic settings, monitoring sensor data, and providing feedback to veterinarians and pet owners.
3. **Data Analysis Software**: Software for analyzing sensor data collected during prosthetic usage, enabling insights into the dog's movement patterns, performance, and comfort.
4. **Simulation Tools**: Simulation software for virtual prototyping and testing of prosthetic designs, allowing for iterative refinement before physical implementation.
5. **Programming Languages**: Proficiency in programming languages such as C/C++, Python, or MATLAB for developing embedded software, user interfaces, and data analysis algorithms.
6. **CAD Software**: Computer-aided design (CAD) software for designing and modeling prosthetic components, ensuring accuracy and compatibility with canine anatomy.
7. **Version Control**: Version control software (e.g., Git) for managing code repositories and facilitating collaboration among team members working on different aspects of the project

Software Requirements Specification (SRS) for Prosthetic Robotic Leg System for Dogs:

1. Introduction

1.1 Purpose The purpose of this Software Requirements Specification (SRS) document is to define the functional and non-functional requirements for the development of a prosthetic robotic leg system tailored for dogs. This document serves as a guideline for the design, implementation, and testing of the system.

1.2 Scope The prosthetic robotic leg system aims to enhance the mobility and quality of life for dogs with limb impairments. It includes hardware components such as actuators, sensors, and control systems, as well as associated software for controlling prosthetic movements and monitoring dog's activities.

1.3 Definitions, Acronyms, and Abbreviations

- SRS: Software Requirements Specification
- UI: User Interface
- API: Application Programming Interface

- CAD: Computer-Aided Design

2. System Overview

2.1 System Description The prosthetic robotic leg system comprises a custom-designed prosthetic limb, embedded control systems, user interface software, and associated testing and calibration tools.

2.2 System Features

- Real-time monitoring and control of prosthetic movements
- Customizable settings for adapting to individual dog's needs
- Integration with external devices for data visualization and analysis

3. Functional Requirements

3.1 Prosthetic Control 3.1.1 The system shall enable precise control of prosthetic movements, including flexion, extension, and rotation. 3.1.2 The system shall adjust prosthetic parameters based on real-time feedback from sensors, ensuring stability and comfort for the dog.

3.2 User Interface 3.2.1 The system shall provide a graphical user interface (GUI) for configuring prosthetic settings and monitoring dog's activities. 3.2.2 The GUI shall display real-time sensor data, including joint angles, force distribution, and battery status.

4. Non-functional Requirements

4.1 Performance. 4.1.2 The system shall be capable of operating continuously for a minimum of 8 hours on a single battery charge.

4.2 Reliability 4.2.1 The system shall demonstrate robustness and reliability in various environmental conditions, including temperature, humidity, and terrain.

4.3 Usability 4.3.1 The user interface shall be intuitive and user-friendly, requiring minimal training for veterinarians and pet owners. 4.3.2 The system shall provide clear feedback and error messages to assist users in troubleshooting and maintenance.

5. System Constraints

5.1 Hardware Limitations 5.1.1 The system shall be compatible with standard prosthetic components and materials suitable for canine use. 5.1.2 The system shall adhere to size and weight constraints to ensure comfort and mobility for the dog.

6. External Interface Requirements

6.1 User Interfaces 6.1.2 The user interfaces shall communicate with the prosthetic control system via a wireless connection (e.g., Bluetooth).

6.2 API Interfaces 6.2.1 The system shall provide APIs for integrating with external devices, allowing for data exchange and synchronization.

7.Glossary

- Prosthetic: A device designed to replace or augment a missing or impaired body part.
- Robotic: Relating to or involving robots or automation.
- Embedded: Refers to a system or device that is built into a larger system.
- GUI: Graphical User Interface, a visual way of interacting with a computer program.

UNIT III
DESIGN PHASE

3.1 Design Phase:

Designing prosthetic leg for dogs involves considering various factors such as dog’s size, weight, breed ,activity level.

3.2 Design Constraints:

Designing prosthetic legs for dogs involves various considerations to ensure they are effective, safe,and comfortable for the animals.

1. Adaptability: Dogs may need time to adjust to wearing a prosthetic limb. The design should
2. allow for easy adjustments and modifications to accommodate changes in the dog's

Condition or lifestyle.

3. Water Resistance: Dogs are often active outdoors and may encounter water, mud, or other environmental conditions. The prosthetic should be water-resistant or waterproof to prevent damage and maintain functionality.
4. Ease of Maintenance: The design should facilitate easy cleaning and maintenance to ensure hygiene and longevity. Components should be easily replaceable if damaged or worn out.
5. Cost Considerations: While quality and functionality are paramount, the cost of the prosthetic.

3.3 Conceptual Design

Designing prosthetic legs for dogs involves considering several factors such as the size and weight of the dog, their activity level, the condition being addressed (e.g., amputation), and the materials used.

Assessment and Measurement: Before designing the prosthetic legs, thorough assessment and measurement of the dog's remaining limb(s) and overall health are crucial. This helps in creating a custom-fit prosthetic that ensures comfort and functionality.

Material Selection: Lightweight, durable, and non-toxic materials are preferred for prosthetic legsCommon materials include carbon fiber, thermoplastics, titanium, and medical-grade silicones. These materials offer strength while being lightweight to ensure ease of movement for the dog.

UNIT IV
CODING AND OUTPUT SCREENS

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    <geometry>
      <mesh filename="package://kuka_kr210_arm/meshes/visual/tube_engagement_-4_degree-_right.dae"
scale="0.01 0.01 0.01"/>
       </geometry>
     <material name="black">
  <color rgba="0 0 0 1"/>
</material>
  </visual>
  <collision>
    <origin rpy="6.23 0 1.57" xyz="-0.35 -0.015 0.709"/>
    <geometry>
      <mesh filename="package://kuka_kr210_arm/meshes/collision/Tube_Engagement_-4_degree-_right.stl"
scale="0.005 0.005 0.005"/>/>
```

```
    </geometry>
  </collision>
</link>
 <link name="lefttube">
  <visual>
    <origin rpy="0.1 0 0" xyz="0 0 1.1"/>
    <geometry>
      <cylinder length="1" radius="0.032"/>
    </geometry>
    <material name="grey">
      <color rgba="0.75294 0.75294 0.75294 1"/>
    </material>
  </visual>
  <collision>
    <origin rpy="1.57 0 0" xyz="-0.93 0.16 0.708"/>
    <geometry>
     <cylinder length="1" radius="0.032"/>
    </geometry>
  </collision>
</link>
 <link name="dog">
  <visual>
    <origin rpy="1.57 0 0" xyz="1.25 0.42 0.2"/>
    <geometry>
      <mesh filename="package://kuka_kr210_arm/meshes/visual/dog_v2.dae" scale="0.07 0.07 0.07"/>
    </geometry>
    <material name="beige">
      <color rgba="  0.830 0.656 0.31 1"/>
    </material>
  </visual>
  <collision>
    <origin rpy="0 0 0" xyz="-0.53 0.1 -0.3"/>
    <geometry>
```

```
      <mesh filename="package://kuka_kr210_arm/meshes/collision/dog_v2.stl" scale="0.07 0.07 0.07"/>
    </geometry>
  </collision>
</link>
   <link name="holder2">
  <visual>
    <origin rpy="1.57 1.57 0" xyz="1.25 0.42 0.2"/>
    <geometry>
      <mesh filename="package://kuka_kr210_arm/meshes/visual/rope2.dae" scale="0.008 0.04 0.014"/>
    </geometry>
    <material name="black">
      <color rgba="0 0 0 1"/>
    </material>
  </visual>
  <collision>
    <origin rpy="5.12 0  1.59" xyz="-0.03 0.45 0.2"/>
    <geometry>
      <mesh filename="package://kuka_kr210_arm/meshes/collision/rope2.stl" scale="0.008 0.04 0.014"/>
    </geometry>
  </collision>
</link>
<link name="lefth">
  <visual>
    <origin rpy="0.1 0 0" xyz="0 0 1.1"/>
    <geometry>
      <box size="0.1 0.2 0.4"/>
    </geometry>
    <material name="black">
      <color rgba="0 0 1"/>
    </material>
  </visual>
  <collision>
    <origin rpy="0 0.37 0" xyz="-1 0.52 0.508"/>
```

```
    <geometry>
     <box size="0.06 0.23 0.33"/>
    </geometry>
  </collision>
</link>
<link name="righth">
  <visual>
    <origin rpy="0 -0.37 0" xyz="0 0.52 0.51"/>
    <geometry>
      <box size="0.06 0.23 0.4"/>
    </geometry>
    <material name="black">
      <color rgba="0 0 1"/>
    </material>
  </visual>
  <collision>
    <origin rpy="0 -0.37 0" xyz="-0.01 0.52 0.51"/>
    <geometry>
     <box size="0.06 0.23 0.4"/>
    </geometry>
  </collision>
</link>
<joint name="wheel1_to_support1" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="wheel1"/>
<child link="wheel_support1"/>
<axis xyz="0 1 0"/>
</joint>
  <joint name="support1_supportjoint1" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="wheel_support1"/>
<child link="wheel_support_joint1"/>
<axis xyz="0 1 0"/>
```

```
</joint>
 <joint name="supportjoint1_rearsupport1" type="fixed">
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</joint>
<joint name="rearsupport1tobacktube" type="fixed">
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<child link="backtube"/>
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</joint>
 <joint name="supportjoint1torighttube" type="fixed">
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<parent link="wheel_support_joint1"/>
<child link="righttube"/>
<axis xyz="0 1 0"/>
</joint>
<joint name="supportjoint1_frontclip1" type="fixed">
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<child link="frontclip1"/>
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</joint>
 <joint name="rearsupport1torearsupport2" type="fixed">
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<parent link="rearsupport1"/>
<child link="rearsupport2"/>
<axis xyz="0 1 0"/>
</joint>
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<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
```

```
<parent link="rearsupport2"/>
<child link="wheel_support2"/>
<axis xyz="0 1 0"/>
</joint>
<joint name="support2_wheel2" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="wheel_support2"/>
<child link="wheel2"/>
<axis xyz="0 1 0"/>
</joint>
<joint name="support2_supportjoint2" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="wheel_support2"/>
<child link="wheel_support_joint2"/>
<axis xyz="0 1 0"/>
</joint>
<joint name="supportjoint2_lefttube" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
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<child link="lefttube"/>
<axis xyz="0 1 0"/>
</joint>
 <joint name="supportjoint2_frontclip2" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="wheel_support_joint2"/>
<child link="frontclip2"/>
<axis xyz="0 1 0"/>
</joint>
  <joint name="supportjoint2_dog" type="fixed">
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<parent link="wheel_support_joint2"/>
<child link="dog"/>
<axis xyz="0 1 0"/>
```

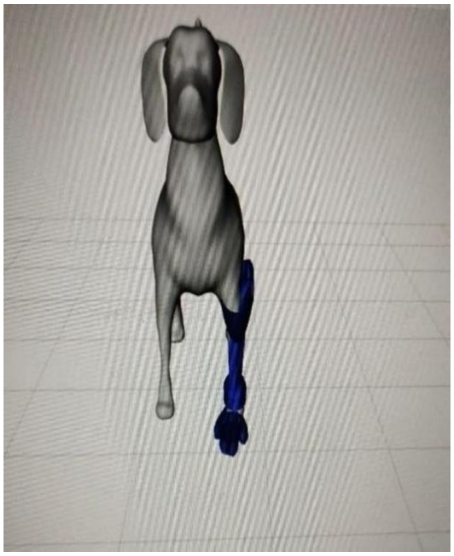
```
</joint>
  <joint name="dog_holder2" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="dog"/>
<child link="holder2"/>
<axis xyz="0 1 0"/>
</joint>
    <joint name="holder2_lefth" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="holder2"/>
<child link="lefth"/>
<axis xyz="0 1 0"/>
</joint>
    <joint name="holder2_righth" type="fixed">
<origin rpy="0 0 0" xyz="0 -0.1 0.04"/>
<parent link="holder2"/>
<child link="righth"/>
<axis xyz="0 1 0"/>
</joint>
</robot>
```

ARDUINO CODE FOR SERVOMOTORS:

```
#include <Servo.h>
Servo servos1;
Servo servos2;
int servosPin1 = 9;
int servosPin1 = 10;
void setup() {
servo1.attach(servoPin1);
servo2.attach(servoPin2);
}
void loop() {
for (int angle = 0; angle <= 180; angle += 1)
  {servo1.write(angle);
```

```
  delay(15);
 }
 for (int angle = 180; angle >= 0; angle -= 1)
  {servo2.write(angle);
  delay(15);
 }
  for (int angle = 180; angle >= 0; angle -= 1)
  {servo1.write(angle);
  delay(15);
 }
 for (int angle = 0; angle <= 180; angle += 1)
  {servo2.write(angle);
  delay(15
 }
}
```

RVIZ MODEL:



UNIT-V

TESTING

5.1 Introduction to Testing

Testing plays a crucial role in ensuring the safety, functionality, and effectiveness of prosthetic legs designed for dogs. The objective of testing in this project is to validate the design, materials, and functionality of the prosthetic limbs, ultimately aiming to enhance the mobility and well-being of canine users. The testing process encompasses various stages, each focusing on specific aspects of the prosthetic legs' performance and suitability for the intended use.

5.2 Types of Testing

Various types of testing will be conducted to validate the robustness and accuracy of the system. Thisincludes:

1. **Unit Testing**: Verifies individual components of the prosthetic legs, ensuring functionalities like material strength and joint mobility meet specifications.
2. **Integration Testing**: Validates interactions between prosthetic leg components, confirming seamless operation and compatibility.
3. **System Testing**: Evaluates the entire prosthetic leg system, including fit, comfort, and functionality, under simulated real-world conditions.
4. **Acceptance Testing**: Involves dog wearers and owners assessing the prosthetic legs in actual usage scenarios to ensure they meet expectations and requirements.

5.3 Test Cases and Test Reports

Test cases are meticulously designed to cover various scenarios, including material durability, fit, and functional performance of the prosthetic legs. Each test case outlines specific steps, expected outcomes, and acceptance criteria. Test reports document the results of these tests, highlighting any deviations from expected behavior and providing insights for further refinement. These reports serve as vital records of the testing process, informing decisions regarding the readiness

UNIT-VI

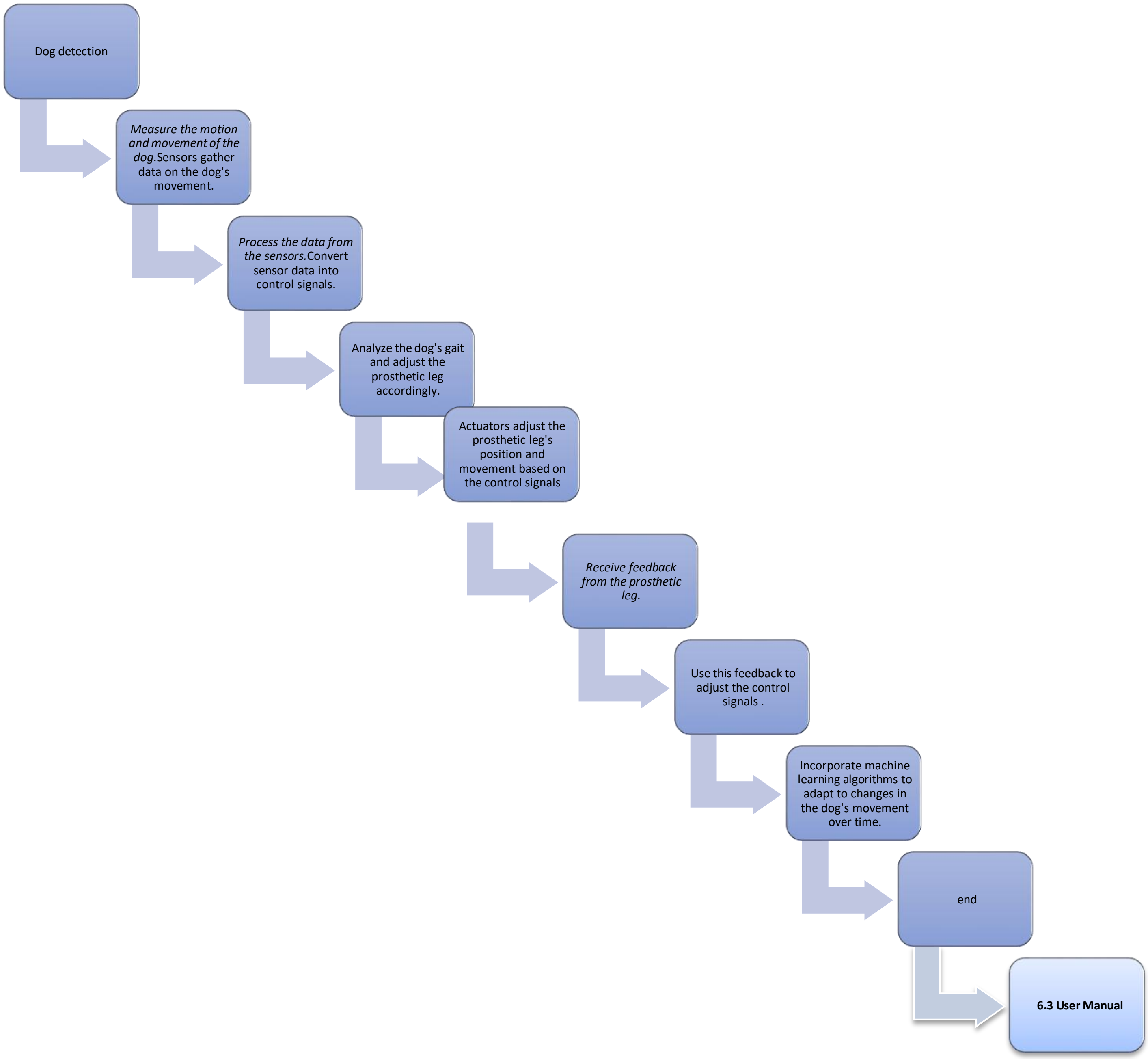
IMPLEMENTATION

6.1 Implementation Process

The implementation process of a prosthetic leg for dogs typically begins with a thorough assessment by a veterinary specialist to evaluate the dog's condition and suitability for a prosthetic device. This assessment involves considering factors such as the dog's size, weight, age, health status, and the specific requirements of the amputation site. Once the assessment is complete and the decision to proceed with a prosthetic leg is made, the next step involves creating a custom-fitted prosthetic device tailored to the dog's anatomy and needs. This process often involves taking precise measurements, designing the prosthetic using advanced CAD/CAM technology, and selecting appropriate materials to ensure durability and comfort for the dog. Finally, the prosthetic leg is carefully fitted and adjusted to ensure proper alignment and functionality, followed by a period of rehabilitation and training to help the dog adapt to its new mobility aid. Throughout the entire process, close collaboration between the veterinary team, prosthetist, and dog owner is essential to achieve the best possible outcome for the dog's mobility and quality of life.

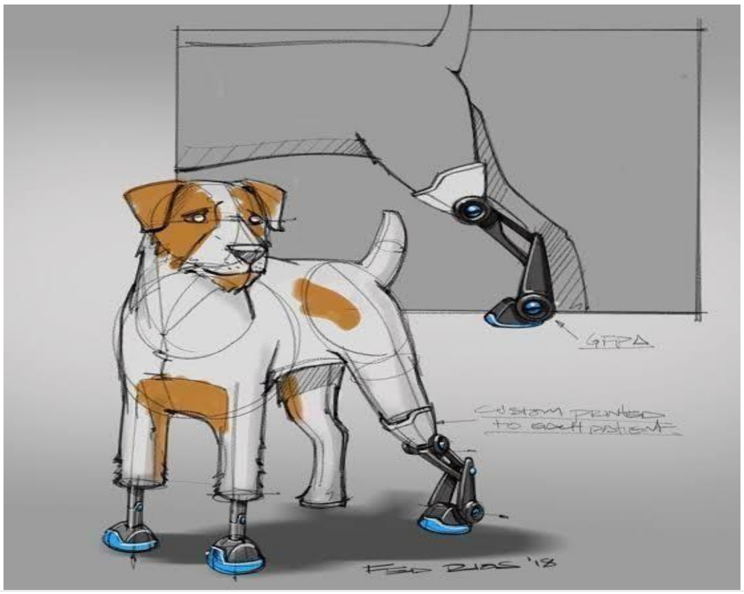
6.2 Implementation Steps

1. Assessment: A thorough evaluation by a veterinary specialist to determine the dog's suitability for a prosthetic leg, considering factors such as size, health, and amputation site.
2. Customization: Precise measurements are taken, and the prosthetic is designed using CAD/CAM technology, ensuring a custom fit and appropriate materials for durability and comfort.
3. Fabrication: The prosthetic leg is carefully crafted according to the design specifications, incorporating any necessary adjustments to accommodate the dog's unique anatomy.
4. Fitting: The prosthetic is expertly fitted to the dog, ensuring proper alignment and functionality, with adjustments made as needed to optimize comfort and mobility.
5. Rehabilitation: A period of rehabilitation and training follows, aimed at helping the dog adapt to its new prosthetic leg and regain mobility, typically involving exercises and gradual reintroduction to activities.
6. Follow-up: Ongoing monitoring and support are provided to address any issues that may arise, ensuring the prosthetic continues to meet the dog's needs for mobility and quality of life.


Dog detection
*Measure the motion and movement of the dog.*Sensors gather data on the dog's movement.
*Process the data from the sensors.*Convert sensor data into control signals.
Analyze the dog's gait and adjust the prosthetic leg accordingly.
Actuators adjust the prosthetic leg's position and movement based on the control signals
Receive feedback from the prosthetic leg.
Use this feedback to adjust the control signals .
Incorporate machine learning algorithms to adapt to changes in the dog's movement over time.
end
6.3 User Manual

6.3 User Manual

The user manual for the prosthetic leg outlines essential information for the caregiver or owner to ensure the optimal use and maintenance of the device. It begins with an introduction providing an overview of the prosthetic leg and its intended purpose, followed by detailed instructions on how to properly fit the device onto the dog, ensuring correct alignment and comfort. Safety precautions are emphasized, including guidelines for monitoring the dog's skin condition and detecting any signs of discomfort or irritation. The manual also includes information on the rehabilitation process, outliningrecommended exercises and activities to help the dog adapt to the prosthetic leg and regain mobility effectively. Maintenance instructions cover cleaning and care routines to keep the prosthetic leg in good condition, including recommendations for regular inspections and adjustments as needed. Troubleshooting tips are provided to address common issues that may arise during use, along with guidance on when to seek professional assistance from a veterinary specialist or prosthetist. Additionally, the manual may include resources for further support and assistance, such as contact information for customer service or additional educational materials. Overall, the user manual serves as a comprehensive guide to ensure the safe and effective use of the prosthetic leg, promoting the well-being and mobility of the dog.



UNIT- VII

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 CONCLUSION:

The development and utilization of prosthetic legs for dogs signify a remarkable advancement in veterinary medicine, enhancing the quality of life for canines facing limb loss or mobility challenges. These prosthetics offer dogs newfound mobility, allowing them to engage in activities they once enjoyed and facilitating their integration into daily life alongside their human companions. The innovation in materials and manufacturing techniques has led to prosthetic legs that are lightweight, durable, and tailored to individual dog's needs. Moreover, the compassionate care provided by veterinarians and prosthetic specialists ensures proper fitting and ongoing support for the dog throughout its journey with the prosthetic. Beyond physical rehabilitation, prosthetic legs for dogs often bring emotional benefits, restoring their confidence and sense of independence.

However, challenges such as cost and maintenance persist, highlighting the importance of continued research and accessibility initiatives to ensure that all dogs in need can benefit from this life-changing technology. Overall, prosthetic legs for dogs represent a heartening fusion of science, compassion, and innovation, demonstrating the profound bond between humans and their canine companions.

7.2 Future Enhancements

In the future, advancements in prosthetic legs for dogs are likely to focus on enhancing comfort, mobility, and functionality for canine amputees. Miniaturization of components and advancements in materials science may lead to lighter and more durable prosthetics, reducing strain on the dog's body. Integration of smart technology, such as sensors and actuators, could enable prosthetic legs to adapt in real-time to the dog's movements and terrain, providing a more natural gait and reducing the risk of injury. Incorporating 3D printing technology may allow for customizable and cost-effective prosthetics tailored to each dog's unique anatomy and needs. Furthermore, research into regenerative medicine and tissue engineering could pave the way for prosthetic limbs that integrate with the dog's own tissues, offering improved biocompatibility and long-term integration. Collaboration between veterinarians, engineers, and designers will be crucial in driving these advancements and ensuring that prosthetic legs continue to improve the quality of life for dogs with limb loss.

Additionally, advancements in data analytics and artificial intelligence could enable predictive maintenance, early detection of potential issues, and continuous improvement in prosthetic design through iterative learning from user feedback. Embracing interdisciplinary approaches and ethical considerations will be paramount in ensuring that future enhancements in prosthetic legs for dogs prioritize safety, efficacy, and the preservation of the human-animal bond.