SYNTHORGANIC

"Creating balance between the synthetic and organic worlds."

PROJECT CHARTER

ABSTRACT

Synthorganic is an innovative initiative dedicated to revolutionizing prosthetic leg functionality by integrating artificial intelligence (AI) for continuous learning and adaptation to diverse terrains. This transformative project involves the development of a generational learning model that utilizes advanced sensors to interpret user movements, incorporating recurrent neural networks and reinforcement learning. Seamlessly integrated with physical prosthetic leg hardware, the model emphasizes continuous learning through online techniques and user feedback. Synthorganic's mission is to significantly enhance user mobility, accessibility, and comfort, contributing to the forefront of assistive technology and establishing a new standard for AI-integrated prosthetic devices.

AUTHOR

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2 PROJECT SUMMARY

The goal of the Synthorganic initiative is to revolutionize the functionality of prosthetic legs by incorporating artificial intelligence (AI) to enable continuous learning and adaptation to various terrains. This project aims to enhance user mobility, accessibility, and comfort for individuals with prosthetic limbs. Unlike existing systems, Synthorganic utilizes advanced sensors and AI algorithms to create a generational learning model that evolves over time, providing a personalized and adaptable experience. By seamlessly integrating with physical prosthetic leg hardware, Synthorganic sets out to establish a new standard in assistive technology, significantly improving the quality of life for users and contributing to advancements in the field.

3 TEAM

NAME	ROLE (TEAM LEADER, PROGRAMMER, DESIGNER, ETC)
Mohammed Asad	Team Leader, Programmer, Hardware Integration
Harkiran Bhullar	Programmer, AI Development and Testing
Lorenzo Alderiso	Programmer, AI Development and Visualization

4 SCOPE

The scope of the Synthorganic project involves the development of an adaptive AI system utilizing TensorFlow, an open-source machine learning platform. This learning model will be visualized using Blender, an open-source 3D computer graphics software tool. The project encompasses the entire lifecycle, including model development, testing, and visualization. Following these phases, the AI will be seamlessly integrated into robotic legs for real-time testing in physical environments. This comprehensive approach ensures the successful creation, visualization, and real-world implementation of the adaptive AI, leveraging open-source technologies for robust and accessible prosthetic leg optimization.

4.1 GOALS AND OBJECTIVES

- *Create an outline of how the AI will be designed in TensorFlow.*
- *Build AI in 3 stages: walking on flat surface, walking on incline/decline surface, walking on varying terrain.*
- *Design software to test integration of TensorFlow AI into hardware.*
- *Create a functional skeleton structure of robotic legs to begin integration testing.*
- *Test and optimize hardware.*

4.2 DELIVERABLES

Phase 1: Designing AI in TensorFlow

- *AI Design Outline:*
  - *Documented outline of the AI design in TensorFlow, detailing the neural network architecture, input parameters, and anticipated output for prosthetic leg optimization.*
- *TensorFlow Prototype:*

- *Developed prototype of the AI model for walking on a flat surface in TensorFlow, showcasing initial design and functionality.*
- *Includes codebase, model architecture documentation, and a brief demonstration.*

- *Platform and Framework:*
  - *TensorFlow framework for AI model development.*
- *Blender 3D Model Prototype*
  - *Design a 3D model using Blender of the prototype that can be integrated with the AI for training.*

Phase 2: Building AI in Three Phases

- *Phase 1 Implementation: Walking on Flat Surface:*
  - *Completed AI model for walking on a flat surface with documented code and model performance metrics.*
  - *Testing dataset for flat surface walking scenarios.*
- *Phase 2 Implementation: Walking on Incline/Decline Surface:*
  - *Expanded AI model to accommodate walking on incline/decline surfaces, with associated code, model documentation, and testing dataset.*
- *Phase 3 Implementation: Walking on Varying Terrain:*
  - *Further enhanced AI model for walking on varying terrains, including documentation, code, and a diverse testing dataset.*

Phase 3: Software for Integration Testing

- *Integration Testing Software:*
  - *Developed software tool to assess the seamless integration of the TensorFlow AI into robotic leg hardware.*
  - *Testing scenarios for flat surfaces, inclines/declines, and varying terrains.*
- *Platform and Framework:*
  - *Custom software application built using Python with TensorFlow integration.*

Phase 4: Robotic Legs Integration

- *Functional Skeleton Structure:*
  - *Constructed a functional skeleton structure of robotic legs suitable for integration testing, including mechanical specifications and design documentation.*
- *Integration Testing Results:*
  - *Results documentation from the integration testing phase, outlining the performance and interaction between the AI and robotic legs.*

Phase 5: Hardware Testing and Optimization

- *Hardware Test Reports:*
  - *Comprehensive reports on the real-time testing of robotic legs with integrated AI, detailing performance, user experience, and any observed challenges.*
- *Optimization Recommendations:*
  - *Recommendations and documentation on optimizing the hardware based on testing results.*
- *Platform and Framework:*
  - *Utilization of robotic leg hardware and sensors, integrated with the custom software developed in earlier phases.*

General Deliverables:

- *Project Documentation:*
    - *Detailed project documentation covering design choices, methodologies, and rationale for AI and hardware implementation.*
- *Training Materials:*
    - *Materials for training end-users and technical staff on the use and maintenance of the AI-enhanced prosthetic legs.*
- *Platform and Framework Overview:*
    - *Summary document providing an overview of platforms (TensorFlow, Blender, etc.) and frameworks used throughout the project.*

4.3 Stakeholders

Role	**Interest/Impact**
DeSales University Computer Science	Stakeholder has invested resources such as money and hardware into the development and success of this project
Biotechnology Industry	Upon the successful completion of this project, the findings can be presented to interested biotechnology companies for potential scalability and development of Synthorganic technology.

4.4 Out - of - Scope

- *Due to the limited budget, the prosthetic will not be designed to be able to jump. However, this is a future goal.*
- *This project will not include clinical testing.*
- *To reduce costs, proprietary computer hardware will not be designed and built. Instead, pre-exiting tools such as the raspberry pi single-board computer and Lego Mindstorms sets will be used for initial testing.*
- *In this project, no user interface will be developed for the prosthetics user to interact with the software, however, this is a future goal.*

4.5 Risks, Constraints, Assumptions

Risk/Constraint/Assumption Title	**Explanation**
Programming Language	The AI will be made using the python programming language due to its extensive libraries and packages that support machine learning.
Cost Restrictions	Due to budget limitations, the team will be using open-source tools, and hardware will be build using resources that are readily available.
Software Integrity Concerns	Due to the open-source nature of the tools that are being used, the software integrity could be compromised, and could introduce security risks to the users. Thus, the software and hardware will be tested in controlled settings to ensure safety.

5 SUCCESS MEASUREMENTS

AI Model Performance:

- *Accuracy: Achieve a high level of accuracy in prosthetic leg movement predictions across different terrains.*
- *Robustness: Demonstrate the model's resilience to variations in user walking styles and environmental conditions.*

Phased Development:

- *Timely Completion: Adhere to the project timeline for each phase of AI development and hardware integration.*
- *Progressive Improvement: Observe measurable enhancements in AI performance through each phase (flat surface, incline/decline, varying terrain).*

Integration Testing:

- *Seamless Integration: Successfully integrate the TensorFlow AI into the robotic legs without compromising stability or safety.*
- *Real-time Responsiveness: Achieve minimal latency in the communication between the AI and hardware during real-world testing.*

User Accessibility:

- *Improved Mobility: Measure the increase in user mobility across different terrains compared to traditional prosthetic legs.*
- *Accessibility: Ensure the AI-enhanced prosthetic legs are user-friendly and accessible to individuals with varying levels of technical expertise.*

Cost-Efficiency:

- *Cost-Benefit Analysis: Conduct a cost-benefit analysis to ensure the project's economic feasibility and potential for wider adoption.*

6 SIGNATURES

Customer:		
Name	**Signature**	**Date**
Dr. Pranshu Gupta		
Project Manager:		
Name	**Signature**	**Date**
Mohammed Asad		**01/28/2024**
Team Members:		
Name	**Signature**	**Date**
Harkiran Bhullar		**01/28/2024**
Lorenzo Alderiso		**01/28/2024**

7 APPENDIX A – GLOSSARY

<u>Stakeholder</u>: DeSales University Computer Science Department

<u>Customers</u>: Hospitals, Biotechnology companies, patients requiring accessible prosthetics.

*The **Project Leadership** comprises those who will guide and coordinate the execution of the project.*

<u>Project Champion</u>: Mohammed Asad

<u>Project Sponsor</u>: DeSales University Computer Science Department

<u>Functional Project Owner</u>: Dr. Pranshu Gupta

<u>Project Manager</u>: Mohammed Asad

*The **Project Team** comprises those who will do the work of the project, producing the end product(s)*

<u>Developers:</u> Lorenzo Alderiso, Harkiran Bhullar, Mohammed Asad

<u>Testers:</u> Lorenzo Alderiso, Harkiran Bhullar, Mohammed Asad

<u>Subject Management Experts:</u> Lorenzo Alderiso, Harkiran Bhullar, Mohammed Asad