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# Design and Fabrication of Customized Prosthetic Leg for Fully Amputed Using TPU and PLA

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**ABSTRACT:**

This study explores the customization of prosthetic legs for dogs through the integration of Thermoplastic Polyurethane (TPU) and Polylactic Acid (PLA) materials. The objective is to design prosthetic limbs that offer both flexibility and durability, tailored to the unique needs of individual canine users. Utilizing 3D printing technology, the prosthetic legs are designed to mimic natural limb movement while providing structural support. By combining TPU for flexibility and PLA for stability, these prosthetic legs aim to enhance the mobility and comfort of dogs with limb disabilities. This abstract highlights the potential of additive manufacturing and material selection in advancing prosthetic solutions for canine patients.

**KEYWORDS:** 3D printing, thermoplastic polyurethane (TPU), Polylactic acid (PLA), tinker card.

## INTRODUCTION:

Introducing 3D printing in prosthetic leg manufacturing revolutionizes accessibility and customization. By harnessing advanced technology, these prosthetics are tailored to individuals' needs, offering improved comfort, functionality, and aesthetics. Let's delve into how this innovation is shaping the future of prosthetic limbs. Thermoplastic polyurethane (TPU) is prized for its remarkable combination of flexibility and durability, making it an ideal choice for crafting prosthetic components. Its elastomeric properties allow for comfortable and natural movement, mimicking the flexibility of human tissue. Additionally, TPU exhibits excellent resistance to abrasion and impact, ensuring longevity and reliability in everyday use. Polylactic acid (PLA), derived from renewable resources such as corn starch or sugarcane, offers an environmentally friendly alternative in prosthetic limb fabrication. Despite its biodegradable nature, PLA boasts sufficient rigidity to support structural components of prosthetic limbs, providing stability and support where needed

## LITERATURE SURVEY:

**Comparative Analysis of Ankle Prosthesis connector Adapters in 3D printed using PLA and PETG:**

**AUTHOR NAME:** A Silva, D Guilhon-XXVI Brazilian Congress on Biomedical Engineering…, 2019-Springer

The high price of adapters of lower limb prostheses and the difficulty for the purchase of this product encouraged us to develop a low-cost version using 3D printing. For printing was chosen two types of filaments: polylactic acid (PLA) and polyethylene terephthalate glycol (PETG)[1][2]. 3D Printing producing is a progressive innovation for various applications, specifically on account of its capacity to customize. From bioprinting to the making of clinical items, for example, inserts, prostheses, or orthoses, it is having a significant effect. Given that there are many energizing activities and organizations in every one of these territories today we will present to you a positioning of the best 3D printed orthoses. Dissimilar to prostheses that supplant a non-existent piece of the body, orthoses are clinical gadgets that are made to settle, soothe, immobilize, control, or right a piece of the body. Since every patient is unique, 3D printing is especially appropriate for these kinds of items and gadget[5][7]s. Requiring an orthotic or prosthetic item likely methods a work concentrated, tedious, and chaotic procedure. For makers, creating great fitting orthotic and prosthetic gadgets is costly and requires profoundly gifted staff. Patients can anticipate that to a lesser degree a hold up should get their gadget, fewer fittings, and improved sturdiness. Developing a comfortable, properly fitting prosthesis is not just a science, it is also an art[2].

## EXISTING SYSTEM:

The high price of adapters of lower limb prostheses and the difficulty for the purchase of this product encouraged us to develop a low-cost version using 3D printing. For printing was chosen two types of filaments: polylactic acid (PLA) and polyethylene terephthalate glycol (PETG). This work had as main objective to evaluate, through simulations and mechanical compression tests, the adapter prototypes' maximum deformations and to identify the best material regarding mechanical resistance. The results obtained through simulations were compared with those obtained from compression tests according to Taguchi orthogonal distribution.

## DIAGRAM

## PROPOSED SYSTEM

### THERMOPLACTIC POLYURETHANE:

Thermoplastic polyurethane (TPU) is prized for its remarkable combination of flexibility and durability, making it an ideal choice for crafting prosthetic components. Its elastomeric properties allow for comfortable and natural movement, mimicking the flexibility of human tissue. Additionally, TPU exhibits excellent resistance to abrasion and impact, ensuring longevity and reliability in everyday use. TPUs are designed to offer high performance for deep learning tasks, including both training and inference.TPUs excel at parallel processing, enabling them to handle large-scale computations efficiently. 3D printing enables the production of personalized prosthetic components tailored to the specific needs and preferences of individual users. TPU's flexibility allows for the creation of intricate geometries and designs that optimize fit and function, leading to better comfort and performance .

### POLYLACTIC ACID

PLA is relatively inexpensive compared to some other 3D printing materials, making it a cost-effective option for prototyping and manufacturing prosthetic components. This affordability can help reduce the overall cost of prosthetic devices, improving accessibility for individuals in need of prosthetic care.

PLA offers a compelling option for 3D printing prosthetic components, combining sustainability, ease of printing, lightweight design, and cost-effectiveness. While it may not be suitable for every application within a prosthetic leg, PLA can play a valuable role in certain components and designs, contributing to improved functionality and accessibility for prosthetic users. PLA is a polymer made from renewable resources such as corn starch, sugarcane, or other biomass sources

## ADVANTAGES:

- TPU is a flexible material that can provide the necessary elasticity and shock absorption needed in prosthetic devices
- . PLA, while more rigid, can be used for structural components. Combining both materials allows for a balance between flexibility and strength, resulting in a prosthetic that can withstand everyday use and movement.
- 3D printing enables highly customized designs tailored to individual needs. By using TPU and PLA together, prosthetic legs can be designed with specific features such as varying levels of flexibility in different parts of the leg, adjustable joints, and personalized fit.
- Compared to traditional manufacturing methods, 3D printing prosthetic legs using TPU and PLA can be more cost-effective, especially for producing custom designs in small quantities. This affordability is crucial for ensuring accessibility to prosthetic devices.
- **MEASUREMENT OF DOG LEG**

| | |
|---|---|
| Leg full length | 32cm |
| Upper leg | 14cm |
| Lower leg | 23cm |

| | |
|---|---|
| Straight length | 45cm |
| Diameter | 7cm |
| Fingers | 3 to 5cm |

## PROCEDURE

**Design Creation:**

CAD (Computer-Aided Design) software to create a 3D model of the prosthetic leg. Design considerations should include the socket, structural components, and any necessary features for attachment and support.

**Material Selection:**

3D printing. TPU is selected for its flexibility and elasticity, while PLA is used for its strength and rigidity.

Ensure that the selected filaments are compatible with your 3D printer's specifications, including temperature settings and filament diameter

**Slicing and Preparation**:

Import the 3D model into slicing software (e.g., Cura, Simplify3D) to prepare it for printing.

Configure slicing settings, including layer height, infill density, and support structures based on the properties of TPU and PLA.

**Dual Extrusion (Optional):**

If using a dual-extrusion 3D printer, set up the printer to simultaneously print with both TPU and PLA filaments. This allows for the creation of complex structures with varying material properties in a single print job.

**Printing:**

Load the TPU and PLA filaments into the 3D printer.

Start the printing process according to the sliced model and printer settings.

Monitor the printing progress to ensure proper adhesion and layer alignment, especially when printing with TPU which can be more challenging due to its flexible nature.

**Post-Processing:**

Once printing is complete, allow the prosthetic leg components to cool down on the print bed. Carefully remove any support structures and clean up the printed parts. Inspect the printed components for quality and structural integrity.

**Customization:**

Make any necessary adjustments or modifications based on user feedback and testing results.

## MATERIALS REQUIRED:

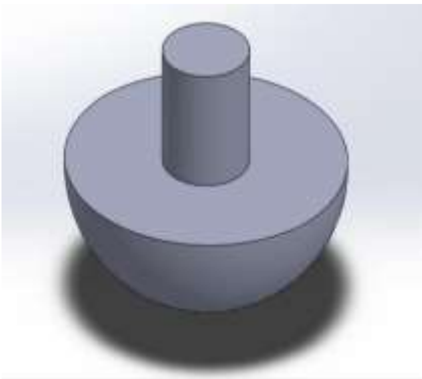
- PLA(Polylactic Acid).
- 3D printer machine.
- 3D designing software(Tinkercad).
- TPU(Thermoplastic Polyurethane)

**STEPS:**

- Design in Tinkercad.
- Export Models.
- Import into Prosthetics leg
- Adjust mashroom shape
- Export and Share.


## RESULT AND DISCUSSION:

This project Explore the Combination Could result in a prosthetic with both strength and flexibility, ideal for mimicking a dog leg movement



## CONCLUSION:

The purpose of this project was to create a utilizing TPU and PLA in the customization of prosthetic legs provides a promising avenue for improving comfort, functionality, and individualization. However, it requires careful consideration of material properties, design, and fabrication techniques to achieve optimal performance and user satisfaction.

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