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Design and Development of Dynamic Prosthetic Leg

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ABSTRACT

This paper centers on planning and Development of Dynamic Prosthetic Leg for beneath amputees. A power framework can possibly lessen the limits in scope of movement and positive work yield of aloof strolling and running feet. Amputee walk in different day by day life circumstances utilizing aloof, semi-dynamic and controlled prostheses is analyzed. Regions for upgrades are examined. It could be required for assortment of reasons including illnesses, mishaps and intrinsic deformities. The general objective of prosthetics is to help standardize amputees. Essential intention of the task is to be equipped for change between standing, strolling and running with speed transformation.

Keywords**:** *Prosthesis, Amputee, Dynamic, Design*

1. INTRODUCTION

Present status of the craftsmanship lower appendage prosthetic innovation permits amputees to dominate most everyday life assignments. Nonetheless, contrasted with non-amputees the metabolic energy utilization and subsequently the development exertion is expanded. Investigating the amputee stride kinematics and energy, contrasts in joint points and forces can be distinguished. For the counterfeit leg, inadequacies can be followed back to a missing force source, yet additionally by limits to the scope of movement.

To conquer the two constraints, fueled prostheses like the Power Knee, Sparky or the Power Foot were created during the last. Every one of them utilizes an engine to give outside energy to joint incitation like the human muscle strands. Close to the engine the Power Foot and Sparky use springs that are streamlined to help the engine to lessen top force necessity and energy utilization. The springs are utilized to imitate the versatile capacity of the Achilles ligament. Simply by including the flexibility conceivable to fabricate minimal controlled lower legs can impersonate the human lower leg joint conduct for day by day exercises like strolling with current engine innovation. While breaking down human lower leg joint biomechanics for higher strolling paces and running, requesting necessities for the joint speed, the force and the speed increase can be distinguished. No off-the-rack engine can coordinate with the necessary determinations. In this manner, a technique to beat the restrictions of the current engine innovation is required.

As recommended by past ages of prosthetic feet it very well may be conceivable that springs can help the walk, to lessen the engine necessities. Such a course of action of engines with springs was at that point used to activate a fueled lower leg orthotics.

2. METHODOLOGY

The proposed arrangement comprises of the Dynamic Prosthetic below Knee. The prosthetic attachment is the gadget that joins your remaining appendage (stump) to the prosthesis. The attachment is made only for you, as per the condition and state of the leftover appendage. An attachment can without much of a stretch be changed (adjusted) to suit your shape, wear ability and solace whenever required. Its basic plan which uses pins to as a holding system empowers producer to deliver these quantitative connectors rapidly, effectively and reasonably. The presentation of such gadget in prosthesis won't just profit the prosthetic patient yet additionally bring another degree of logical quantization to a field that is obliged by subjectivity. Arch is the interfacing bar between the attachment and foot framework. The

principle component of the venture is the foot framework which gives ongoing control the assistance of which the amputee can accomplish a superior control on his/her every day exercises.

Fig-2.1: Proposed Setup

3. COMPONENTS

3.1 Socket

The principle target picking this attachment was to advance burden move between lingering appendage and mechanical appendage proficiently. Prosthetic attachments are planned by catching the remaining appendages shape and applying a progression of mathematical alterations called rectifications .The High-Fidelity Interface Socket is alluded to as the Hi-Fi Socket, and is a progressive new attachment plan that prompts greater steadiness of the lingering appendage for the transfemoral patient. The Hi-Fi Interface draws nearer to the femur bone by utilizing a patent-forthcoming substituting pressure and delivery plan. Longitudinal swaggers apply pressure to choose spaces of the lingering appendage, and interestingly planned windows between the swaggers help deal with the progressive arrival of uprooted delicate tissue, which empowers leftover appendage volume to securely get away. This is for any amputee that needs to run, bounce, climb or do anything with expanded portability and solace.

Fig-3.1: Socket

Table-3.1: Specification of Socket

Type	Below Knee
Material	Polypropylene
Height	0.22m
Width	0.12m
Operating Temperature	-20º-80º C

3.2 Pylon

The inward edge, or skeleton, of a prosthetic appendage is known as the arch. It has customarily been shaped of metal bars, as it should offer underlying help. An arch is the part which gives the association between the remaining appendage (leg stump) and the prosthetic foot. Hybrid strands contain at least two kinds of various filaments materials. Which give the composite materials an incredible exhibition in mechanical like effect, pliable, and inflexibility or different properties, for example, electrical or warm conductivity needed for application. Mixture strands are mixes of half Carbon filaments and half Glass filaments. Carbon filaments have properties higher than Glass strands; however have greater expense from Glass filaments. In this way, the mix between two filaments in woven gave great outcomes by adjusting between the expense and mechanical properties in prosthetic pylon.

Fig-3.2: Pylon

Table-3.2: Specification of Pylon

Material	Hybrid Fiber (Carbon Fiber + Glass)
Height	100mm
Width	20 mm
Elastic Modulus	151 GPA
Tensile Strength	3625 MPa
Elongation Percentage	2.8
Poisson's Ratio	0.235
Operating Temperature	-50 to 250°C

3.3 Foot

The prosthesis comprises of 4 significant parts. The carbon foot, the foot connector, the primary lodging, and the engine gear mounting. The foot connector incorporates the front spring connection. The principle lodging has the lower leg joint at the distal end and the association with the engine and stuff mounting at the back proximal end. A little three-sided linkage associates the spring with the nut. This linkage is directed by a third connection point that is in line (yet no unbending association) with the lower leg joint. At the point when the roller screw pivots the nut will go up or down to cause a joint force at the lower leg joint. In flight stage the development of the nut will straightforwardly cause lower leg plantar flexion or dorsiflexion. During position stage the nut course characterizes if the spring will be stacked or dumped to adjust wanted lower leg force point profiles. There is a tremendous potential for springs to help engines to copy the human lower appendage joint kinematics and energy during walk. The outcomes on the decreases of engine top force prerequisites and energy utilization help to see how human muscles might be utilized effective to profit however much as could be expected from the flexible ligament work. The noticed bits of knowledge on the effective collaboration can be utilized to improve the plan and the control of fueled lower appendage prostheses. As opposed to latent prostheses, development execution and subsequently amputee assistance and personal satisfaction may improve.

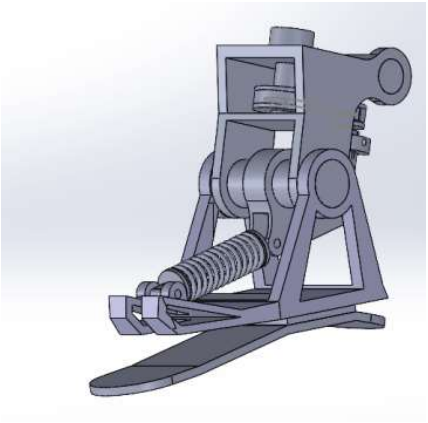

Fig-3.3: Foot System

Table-3.3: Specification of Foot

Material	Carbon Fiber
Width	0.16 m
Height	0.17 m
Speed	1.6 m/s – 4 m/s
Motor	200 W DC
Battery	4400 mAh 25.9 V
Weight	1.9 kg

3.4 Arduino

The Arduino Uno is one sort of microcontroller board dependent on ATmega328, and Uno is an Italian expression which implies one. Arduino Uno is named for denoting the impending arrival of microcontroller board specifically Arduino Uno Board 1.0. This board incorporates advanced I/O pins-14, a force jack, simple I/ps-6, clay resonator-A16 MHz, a USB association, a RST button, and an ICSP header. Every one of these can uphold the microcontroller for additional activity by associating this board to the PC. The force supply of this board should be possible with the assistance of an AC to DC connector, a USB link, in any case a battery. Arduino code is written in C++ with an expansion of exceptional strategies and capacities, which we'll make reference to later on. C++ is a comprehensible programming language.

Fig-3.4: Arduino ATMega 328

Table-3.4: Specification of Arduino ATMega 328

Microcontroller	ATmega328
Operating Range	5V
Input Voltage(limits)	6-20 V
Digital I/O Pins	14
Analog Input Pins	6
DC current per I/O Pin	40mA
DC Current for 3.3V Pins	50mA
Flash Memory	32KB

3.5 Accelerometer

An accelerometer is an apparatus that actions appropriate speed increase. Legitimate speed increase is the speed increase of a body in its own immediate rest outline; this is not quite the same as facilitate speed increase, which is speed increase in a fixed organize framework. The proportion of progress in speed increase (contribution) to change in the yield signal. This characterizes the best, straight-line connection among speed increase and output.

Fig-3.5: Accelerometer Sensor

Table-3.5: Specification of Accelerometer

Model Number	ADXL 335
Interface	3V3/5V Microcontroller
Voltage Requirement	3-6V DC
Output Format	Analog Output
Measuring Range	+/- 3g
Measuring Values(-3 to +3)	X (-274 to +325) Y (-275 to +330) Z (-275 to +310)

3.6 Gyroscope

Gyrator sensor is a gadget that can gauge and keep up the direction and rakish speed of an item. These are further developed than accelerometers. These can gauge the slant and sidelong direction of the article though accelerometer can just quantify the straight motion. Gyroscope sensors are likewise called as Angular Rate Sensor or Angular Velocity Sensors. These sensors are introduced in the applications where the direction of the article is hard to detect by people.

Fig-3,6: gyroscope Sensor

Table-3.6: Specification of Gyroscope Sensor

Model	ENC-3R
Number if axis	1
Range	+/- 300 deg./.sec
Sensitivity	0.67 mV/deg./sec.
Non-Linearity	+/- 5%
Size	4.0 x 8.0 x 2.0 mm

2.7 200 W Brushless DC Motor

A brushless DC motor consists of a rotor in the form of a permanent magnet and stator in the form of poly phase armature windings. It differs from the conventional dc motor in such that it doesn't contain brushes and the commutation is done using electrically, using an electronic drive to feed the stator windings. This is used to rotate belt drive.

Fig-3.7: Brushless DC Motor

Table-3.7: Specification of DC Motor

Motor	Brushless DC Motor
Power	200 W
Torque	0.64 Nm
RPM	3000
Volt	24 V

3.8 25.9 Volt Battery

Orange 2200mAh 2S 30C/60C Lithium polymer battery Pack (Li-Po) batteries are outfitted with substantial release prompts limit opposition and support high current burdens. Orange batteries confront the rebuffing limits of aerobatic flight and RC vehicles. Each pack is outfitted with gold plated connectors and JST-XH style balance connectors. All Orange Lithium Polymer batteries packs are collected utilizing IR coordinated with cells.

Fig-3.8: Battery

Tabel-3.8: Specification of Battery

Model No.	2200/2S-30C
Weight	115.0g
Voltage	7.4V
Maximum Continuous Discharge	30C(66.0A)
Maximum Burst Discharge	60C(132.0A)

3.9 Belt Drive

Belt drive, in hardware, a couple of pulleys joined to generally resemble screws and associated by a surrounding adaptable belt (band) that can serve to communicate and change revolving movement from one shaft to the other. The Motor pivots the driving pulley and the determined pulley is connected to the reticulating ball screw.

Fig-3.9 Belt Drive

3.10 Re-Circulating Ball Screw(Ankle)

A recycling ball screw comprises a screw, a nut and a progression of balls. Since moving rubbing is exceptionally not exactly sliding erosion recycling ball screw has extremely high productivity of force move. The strings of screw and nut in recycling ball screw are half circle so they can oblige moving balls. This is utilized to lower and higher the foot and goes about as a lower leg.

Fig-3.10: Re-Circulating Ball Screw Mechanism

3.11 Spring

Pressure helical springs are energy proficient capacity gadgets, which are otherwise called open-loop helical springs. These springs are intended to offer opposition against the direct packing power applied along their pivot. Pressure helical spring gets packed on the use of burden. This Spring acts as a damper in the foot.

Fig-3.11 Helical Compression Spring

4. EXPIRIMENTAL VALIDATION

4.1 Socket

The vast majority of the pressure is oppressed towards the arch joining connector as the heaviness of the body is concentrated towards it. Immaterial pressure is created on the dividers of the attachment as the amputee utilizes it to simply to excrement and push the leg forward. The outcomes which were gotten from the examination were protected.

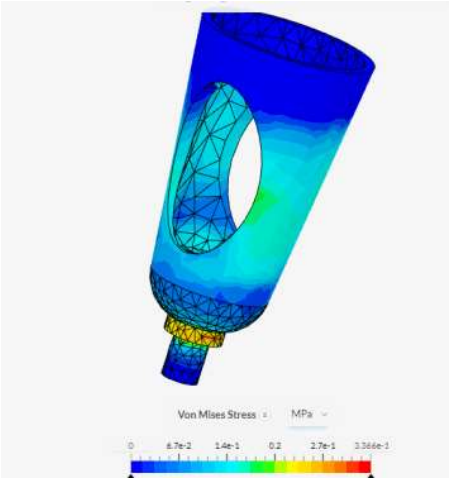

Fig-4.1: Analysis of Socket

4.2 Pylon

Arch which interfaces the Socket to Foot has been broke down. The majority of the pressure is oppressed towards the progression development of the arch. Additionally, the element of connector is finished by the arch as the plan is streamlined so that the connector and arch are made all together pieces. The outcomes which we got from testing of this part were protected and along these lines we could proceed with this plan.

Fig-4.2: Analysis of Pylon

4.3 Foot Frame

The principle some portion of the prosthetic leg is the unique foot. The greater part of the components, for example, engine, helical pressure spring, cylinder chamber course of action and the foot plate is connected to this foot outline. Therefore, the principle rationale as to make the edge structure protected and fit for lifting weight of the previously mentioned segments. As from the investigation it is seen that the plan is protected so the segments can be effectively collected to the foot outline.

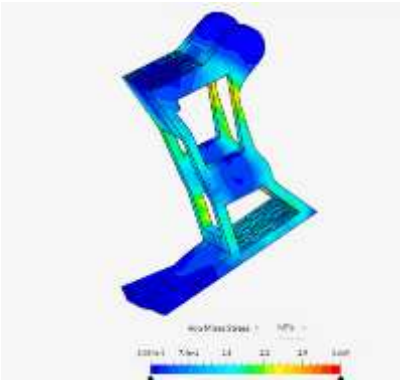

Fig-4.23: Analysis of Foot Frame

5. CONCLUSIONS

1. A functioning mechanical prosthesis might actually empower individuals with an above knee removal to perform various sorts of movements that require power in lower appendage joints.
2. Created wearable sensor network executes the proposed control in the model plan, making it a brilliant prosthesis and offers an ongoing control.
3. It is feasible to copy human reference lower leg joint conduct for strolling and approaching a speed of 2.6 m/s.
4. The dynamic foot can defeat limits in ROM and in creating positive work contrasted with aloof prosthetic strolling and running feet.

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