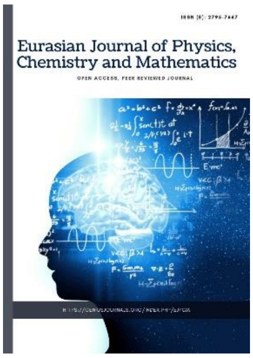

Application Of Hooke's Law In Prosthetics

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ABSTRACT

This paper examines methods for improving the production of prostheses by applying the laws of mechanics, in particular Hooke's laws.

Keywords: Hooke's law, prosthetics, nitinol, polyurethane elastomers, mathematical model.

In 2023, the number of amputations was still largely driven by conditions such as diabetes, peripheral arterial disease (PAD), and trauma. An estimated 1 million amputations occur globally each year. In the United States, about 185,000 amputations occur each year, and about 2 million people are living with limb loss.

The main reasons for amputation are the following factors:

1. **Traumatic incidents:**
- Military conflicts such as the war in Ukraine continue to cause significant injuries to military and civilians. There have been cases of limb loss as a result of combat, mine explosions and attacks.
- Automobile accidents and industrial injuries also remain among the leading causes of amputations.

2. **Diseases:**
- **Diabetes** is one of the leading causes of amputations in many countries. Diabetic foot, which can lead to gangrene, often requires surgery to remove the affected limbs.
- **Vascular diseases** such as atherosclerosis can reduce blood supply to the limbs, which can also lead to amputation if tissue begins to die.[1]

Prosthetics and technologies:

In 2024, prosthetic technologies are actively developing. Prostheses are becoming more and more functional, with the ability to connect to the nervous system and control through the brain. This gives many people the opportunity to regain lost functions and improve their quality of life.

There are several types of prosthesis manufacturing:

1. **Traditional casting and handcrafting methods**
- **Plaster casts:** This method involves making a plaster cast of the limb to accurately fit the

socket (the part of the prosthesis that comes into contact with the skin).

- **Lamination:** Once the prosthesis model is created, it is reinforced with fiberglass or carbon fiber to increase strength and lightness. This is a traditional method used to create rigid and durable prostheses.

2. 3D printing

- **Personalized Prosthetics:** 3D printing technology allows for the creation of highly accurate customized prosthetics based on three-dimensional models of the patient's limb. 3D printers use materials such as plastic or metal to print the prosthetic parts.
- **Accessibility and speed:** 3D printing significantly reduces the cost of producing prosthetics and speeds up the manufacturing process, making prosthetics accessible to more patients.

3. Microprocessor and bionic prostheses

- **Microprocessors**: Lower limb prostheses often have microprocessors built into them that control the movement of the knee joint, helping the user control their gait. These prostheses automatically adapt to different conditions, such as walking upstairs or running.
- **Myoelectric Prostheses:** These upper limb prostheses use muscle signals to activate movement. They allow the person to control the prosthesis through muscle contractions.

4. Bionic prostheses

- **Neuroprosthetics:** These devices are connected to the nervous system, allowing the user to control the movements of the prosthesis with the power of thought. This is a very advanced technology that requires careful fitting and adjustment.
- **Feedback:** The latest bionic prosthetics are equipped with sensory systems that transmit touch and pressure information back to the human nervous system, helping the user sense an object and control grip.

5. Modular prostheses

Universal designs: Modular prostheses are made up of replaceable components such as sockets, joints and feet. This allows parts of the prosthesis to be easily replaced if they wear out or if the patient's needs change.

Modern technologies for the production of prostheses make them increasingly adaptable, which improves the quality of life of patients and reduces the risks of complications associated with wearing such devices.

The production of prostheses faces a number of problems related to both technical aspects and issues of accessibility and individualization. Here are the main difficulties that arise at different stages of the creation and use of prostheses: [3]

1. Individual fit

- **Anatomical Complexity:** Each person has unique physical characteristics, so creating a prosthesis that fits perfectly is a complex task. Even with 3D scanning technology, fit issues often arise, especially if the shape of the residual limb changes over time.
- **Changes in stump size:** Over time, the stump may change due to swelling, weight loss or weight gain, which leads to the need for adaptation or complete replacement of the prosthesis.

2. Cost

- **High Cost:** Technologically advanced prosthetics such as bionic and microprocessor-based models are expensive. This makes them unaffordable for many people, especially in developing countries. Prosthetics can require significant investment, including the cost of the device, its maintenance, and replacement.
- **Limited insurance coverage:** In some countries, health insurance only covers basic prosthetic models, limiting access to more advanced and functional prosthetics.

3. Technical problems

- **Durability of materials:** The materials used to create prostheses must be lightweight, strong, and wear-resistant. However, many prostheses wear out or break, requiring regular repair or replacement.
- **Thermoregulation:** Prostheses can overheat or, conversely, cool down, which creates discomfort depending on climatic conditions.

5. Psychological and social aspects

Emotional difficulties: People who have lost limbs may experience psychological problems such as depression or anxiety related to using a prosthesis. The process of adapting to a new life with a prosthesis takes time and support.

Social stereotypes: Prostheses can be a cause of social stigma. People with prostheses sometimes face prejudice or misunderstanding, which can make it difficult for them to socialize and integrate.

6. Lack of specialists

Lack of skilled prosthetists: Even with modern technology, quality prosthetics requires skilled professionals such as prosthetists and engineers. In some parts of the world, access to such professionals is limited.

These issues highlight the need for further advances in technology, improved accessibility and improved training to make prostheses more effective and user-friendly.[4]

The Role of Hooke's Law in Prosthetic Design

Hooke's law in prosthetic design allows one to calculate the deformations of various parts of the prosthesis under load and predict their behavior during everyday use. Lower limb prostheses can be equipped with elastic elements that will act as shock absorbers, reducing the load on the joints. Thus, prostheses will be able to adapt to different movement conditions (walking on an inclined surface, ascents and descents).

Example of materials:

Nitinol is an alloy that can restore its shape after deformation, which makes it promising for use in mobile elements of prostheses.

Polyurethane elastomers are materials with high elasticity and durability that can be used to create mobile parts of a prosthesis.

The creation of a mathematical model of a prosthesis based on Hooke's law allows one to calculate its behavior in real conditions. To do this, it is necessary to take into account not only deformations and forces, but also the parameters of the material.

Example task:

(Determining the force applied to the prosthesis) A person weighing 70 kg walks on a surface with a slight slope. The force of gravity acting on the prosthesis can be calculated using the formula: $F=mg$ where m is the mass of the person and g is the acceleration of gravity (9.8 m/s^2)

(Calculation of deformation of a spring element) Knowing the force, one can calculate the deformation of a spring with a stiffness coefficient k from the formula: $x=F/k$.

This will allow you to understand how much the spring element of the prosthesis will compress under load.[1]

Conclusion.

Some of the challenges may be related to the high cost of materials or the need for additional research to optimize them. However, further research may lead to more affordable solutions.

Research and practical experiments show that the use of Hooke's law in the design of prostheses opens up wide possibilities for increasing their comfort. Elastic materials such as nitinol or polyurethane elastomers can become the basis for new prostheses that will respond more naturally to physical loads.

Literature.

1. N. N. Priorov "Amputation of limbs and prostheses" Medgiz 1941
2. A. N. Remizov "Textbook of medical and biological physics" Moscow 2003
3. Petrov V. G., Zamiladskiy Yu. I., Burov G. N., Kurdybaylo S. F. "Technologies for manufacturing upper limb prostheses" publ. Hippocrates 2008
4. Anton Kruglov "Anthropology of the cyborg" Moscow 2023
5. Санакулова, М. М., Ибрагимова, М. Н., & Элмуротова, Д. Б. Томосинтез в рентгенодиагностике. *Меж. Научно-образовательный электронный журнал «Образование и наука в XXI веке» B*, (14), 1149-1155.
6. Elmurotova, D., Meyliyev, L., Abdullayeva, N., & Bozorov, E. (2023). Maintenance and use of medical devices.
7. Эльмуротова, Д. Б. (2007). Усиление электролюминесценции кристаллов ZnSe (Te, O) после γ-облучения. *ÔТП,-2007. l*, *41*(10), l.
8. Арзикулов, Ф., Мустафакулов, А. А., & Болтаев, Ш. (2020). Рост Кристаллов Кварца На Нейтронно-Облученных Затравках. In *Приоритетные*

направления развития науки и образования (pp. 139-152).