Universitatea Tehnică „Gheorghe Asachi” din Iaşi

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PRO INVENT 2025

15 - 17 October 2025

Universitatea Tehnică *Gheorghe Asachi* din Iaşi

PROTEZĂ ACTIVĂ AUTOADAPTABILĂ PENTRU MEMBRUL INFERIOR
ACTIVE SELF-ADAPTIVE PROSTHESIS FOR LOWER LIMB

Cerere de brevet (Patent application): nr. a 2022 00747 - OSIM

Inventator (Inventor): Dimitrie-Cristian FODOR, Neculai-Eugen SEGHEDIN

1 Description of the invention

The described invention refers to a self-adaptive prosthesis for the lower limb intended for pediatric patients. It measures a series of the user's body parameters to maintain frontal anthropometric symmetry as the patient grows (Fig. 1).

Fig. 1 - Radiographs (A-P and lateral view) showing limb length discrepancy (LLD)

Fig. 2 – Female patient (14 years old) with modified prostheses used for 9 years

Fig. 3 – Female patient (14 years old) with transtibial prostheses used for 9 years

Fig. 4 – Patient (7 years) with the type required for a period of 4 years

By using this prosthetic device, the length of the patient's lower limbs will be equalized, preventing or reducing the occurrence of pathological changes in gait biomechanics, changing the body's center of mass which often leads to the damage of healthy joints. Thus, the need for frequent purchases of prostheses of different sizes (≈ one prosthesis per year Fig. 2-4) is eliminated, thereby also reducing frequent visits to the prosthetist.

2 Novelty and originality

Currently, classical tools are used that are subjective to determine LLD (for example the bubble level, the PALM-meter device, the classic block method or the imaging methods that are mostly invasive - they use X-rays) (Fig. 5). Thus, the novelty of the prosthesis consists in the automatic measurement of the LLD of the amputee, and the self-adaptation of the prosthetic length, through different methods (Fig. 6-10), until reaching a length equal to that of the contralateral biological limb and the self-adjustment of the size of the prosthetic cup for a personalized fit on the patient's abutment fit on the patient's limb and to monitor the patient' s condition and continuously self - adapt during and at the growth rate of the amputee.

Fig. 5 – Determination by the classical method of the limb length discrepancy

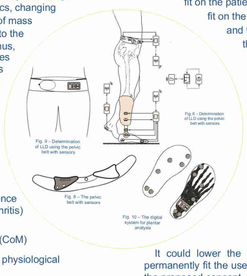

Fig. 6 - Determination of LLD using the pelvic belt with sensors

Fig. 7 - The pelvic belt with sensors

Fig. 8 - The digital system for plantar analysis

3 Advantages

- Permanent fit and alignment on the amputee's body
- The prosthesis prevents the occurrence of related pathologies (e.g. osteoarthritis)
- Eliminates the risk of abnormal displacement of the center of mass (CoM)
- Constant monitoring of the user's physiological parameters for predictability
- Universal attachment to the stump of the patient (Fig. 11)

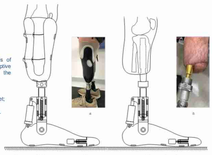

Fig. 11 – Different methods of attaching the self-adaptive transtibial prosthesis to the patient's abutment:

a. Adjustable prosthetic socket;

b. Implant – osseointegration.

- Costs are reduced because the same prosthesis is used for several years in the case of children

4 Conclusions

By implementing the presented concept and successfully completing the proposed can bring great benefits to pediatric amputees, their attendants and medical staff.

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It could lower the cost of procuring the necessary prostheses to permanently fit the user's ever-evolving body by using a longer period of the proposed concept.

This new concept offers an advanced and customized solution for the individual needs of its users and opens new horizons for their reintegration and independence.

Thus, users benefit not only from an improvement in biomechanical functionality but also from greater freedom and safety in their daily activities.

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Therefore, high results are expected because the self-adaptive prosthesis has a high degree of novelty (3 patent applications have been filed on this topic at OSIM) because there is no such device on the market.

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DISPOZITIV DE ALUNGIRE A OASELOR ÎN PROCESUL DE OSTEOSINTEZĂ
DEVICE FOR BONE LENGTHENING IN THE OSTEOSYNTHESIS PROCESS

Cerere de brevet (Patent application): Nr. RO138505 (A2)-Espacenet

Inventator (Inventor): Seghedin Neculai-Eugen; Hapău Vlad-Edmond; Doroftei Mădălina-Andreea; Bejenaru Ionuţ-Alin; Butuc Daniel- Cosmin

Descrierea invenției

Invenția se referă la un mecanism de alungire a femurului în timpul procesului de osteosinteză, prin deplasarea relativă a capetelor femurului. Sunt cunoscute sisteme de reglare a tijelor din structura aparatelor ortopedice utilizate în alungirea femurului. Acestea sunt compuse din diverse mecanisme, care permit îndepărtarea inelelor metalice inserate pe capetele femurului. Aceste mecanisme prezintă niște tije care permit deplasarea relativă a inelelor cu ajutorul unor filete normale. De asemenea, mai sunt cunoscute sistemele ortopedice, la care reglarea lungimii tijelor este realizată prin intermediul unui pivot. Ambele soluții prezintă dezavantajul acționării independente a tijelor, fapt care poate provoca o dezaxare a celor două capete ale femurului.

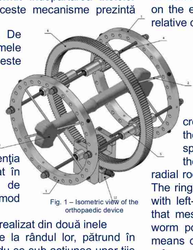

Fig. 1 – Isometric view of the orthopaedic device

Noutate și originalitate

Problema tehnică pe care o rezolvă invenția este realizarea unui aparat ortopedic, utilizat în alungirea femurului în timpul procesului de osteosinteză, cu reglarea tijelor distanțiere în mod centralizat de la un singur element de acționare. Dispozitivul, conform invenției este realizat din două inele în care sunt introduse niște tije radiale care la rândul lor, pătrund în capetele femurului, deplasarea inelelor făcându-se sub acțiunea unor tije filetate, care sunt acționate de niște manșoane cu filete interioare stânga-dreapta, manșoane care prezintă o porțiune danturată, care angrenează cu dantura interioară a unui inel, care prezintă o porțiune melcată exterioară, care angrenează cu un șurub melc, care este rotit cu ajutorul unui buton, care prezintă niște gradații, care se poziționează în funcție de un reper.

Avantaje

- Permite deplasarea relativă a inelelor, solidarizate cu capetele femurului prin alungirea simultană a tijelor de îndepărtare, care sunt acționate de la un element centralizat;
- Împiedică desfacerea accidentală a tijelor de alungire, prin utilizarea unor bucșe din material plastic, amplasate în manșoanele de acționare;
- Permite efectuarea unor curse de alungire de valori ridicate;
- Permite acționarea comodă a elementului, care îndepărtează inelele;
- Permite un control comod al deplasărilor secvențiale, care sunt necesare pentru deplasarea relativă a părților femurului în timpul procesului de osteosinteză.

Concluzii

Prin implementarea conceptului prezentat și finalizarea cu succes a transferului tehnologic, acest dispozitiv poate aduce mari beneficii personalului medical și, în special, pacienților. Prin urmare, sunt așteptate rezultate ridicate deoarece dispozitivul prezintă grad ridicat de noutate, neexistând pe piață un produs similar.

Description of the invention

The invention relates to a mechanism for lengthening the femur during the osteosynthesis process by relative displacement of the femoral ends. Systems for adjusting the rods in the structure of orthopedic devices used in femur lengthening are known. These consist of various mechanisms that allow the distancing of metal rings inserted on the ends of the femur. These mechanisms feature rods that allow relative displacement of the rings using normal threads.

There are also known orthopedic systems in which the length of the rods is adjusted by means of a pivot. Both solutions have the disadvantage of independent rod action, which can cause misalignment of the two ends of the femur.

Novelty and originality

The technical problem solved by the invention is the creation of an orthopedic device used in femur lengthening during the osteosynthesis process, with centralized adjustment of the spacer rods from a single drive element. The device, according to the invention, consists of two rings into which radial rods are inserted, which in turn penetrate the ends of the femur. The rings are moved by threaded rods, which are actuated by sleeves with left-right internal threads. These sleeves have a toothed portion that meshes with the internal teeth of a ring, which has an external worm portion that meshes with a worm screw, which is rotated by means of a knob with graduations that are positioned according to a reference point.

Advantages

- Allows relative movement of the rings, secured to the ends of the femur by simultaneous elongation of the removal rods, which are operated from a centralised element;
- Prevents accidental loosening of the extension rods by using plastic bushings located in the drive sleeves;
- Allows high-value stretching runs to be performed;
- Allows convenient operation of the element that removes the rings;
- It allows convenient control of sequential movements, which are necessary for the relative movement of the femur parts during the osteosynthesis process.

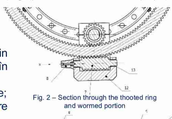

Fig. 2 – Section through the thooted ring and wormed portion

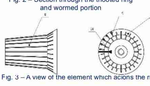

Fig. 3 – A view of the element which actions the rings

Conclusions

By implementing the presented concept and successfully completing the technology transfer, this device can bring great benefits to medical staff, but specially to pacients. Therefore, high results are expected because the device has a high degree of novelty, as there is no such device on the market.

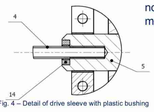

Fig. 4 – Detail of drive sleeve with plastic bushing

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DISPOZITIV PEDIATRIC PENTRU DETERMINAREA DIFERENȚEI DE LUNGIME A MEMBRELOR INFERIOARE
PEDIATRIC DEVICE FOR DETERMINING LOWER LIMB LENGTH DISCREPANCY

Cerere de brevet (Patent application): nr. a 2024 00436 - OSIM

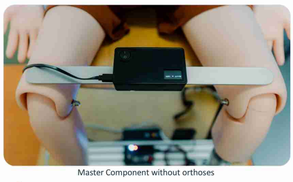
Inventator (Inventor): Dimitrie-Cristian FODOR, Cristian AGHION, Neculai-Eugen SEGHEDIN

Novelty and Originality

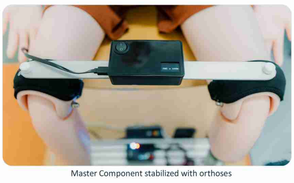
The invention concerns a pediatric device designed to determine limb length discrepancy (LLD) in both intact and amputated pediatric patients. It is applicable in the fields of preventive medicine and prosthetics, being useful for the continuous monitoring of children’s physical development. The device is capable of detecting limb length differences (Master Component) and, when functionally connected to an adaptable prosthesis, can also perform corrective adjustments (Slave Component).

Description of the Invention

This invention aims to address the technical limitations of current methods used to evaluate LLD in pediatric patients. Conventional approaches are often hindered by the subjectivity of clinical assessments, poor repeatability and traceability, and dependence on expensive, invasive imaging techniques such as X-rays for routine anthropometric monitoring. The proposed device enables objective, non-invasive quantification of leg length discrepancy based on data acquired from the patient—either in a clinical environment or at home. Furthermore, when integrated with a self-adaptive prosthesis, the system allows autonomous adjustment of the prosthetic limb length, ensuring alignment with the contralateral biological limb.



Master Component without orthoses



Master Component stabilized with orthoses

Conclusions

The integration of such technology could catalyze the evolution of novel standards in medical engineering, thereby facilitating the development of more efficient and customized devices that are tailored to the individual needs of patients. By enabling objective, repeatable, and non-invasive assessment of LLD—even outside clinical settings—and allowing autonomous adjustment of self-adaptive prostheses, this approach represents a significant step forward in pediatric rehabilitation and preventive care.

References

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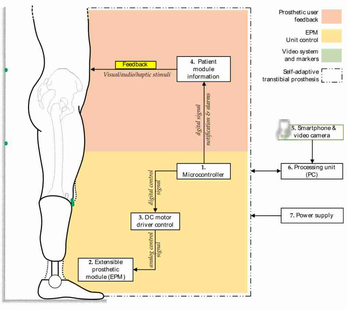
SISTEM PROTETIC PENTRU DETECȚIA ŞI COMPENSAREA DIFERENȚEI DE LUNGIME A MEMBRELOR INFERIOARE UMANE
PROSTHETIC SYSTEM FOR DETECTION AND COMPENSATION OF THE LENGTH DIFFERENCE BETWEEN HUMAN LOWER LIMBS

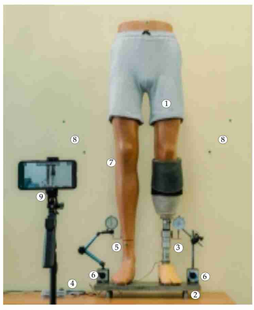
Cerere de brevet (Patent application): nr. a 2024 00055 - OSIM

Inventator (Inventor): Dimitrie-Cristian FODOR, Neculai-Eugen SEGHEDIN, Vasile-Ion MANTA, Otilia ZVORIȘTEANU, Dragoș-Florin ȚITARIU, Ștefan-Daniel ACHIREI

Novelty and Originality

The prosthetic system integrates a smartphone as the main control unit, assisting in both detecting and compensating lower limb length discrepancy (LLD). As shown in Figure, a microcontroller (1) manages the extensible prosthetic module (EPM) (3) and controls its DC motor through a driver. A feedback loop connects the microcontroller to a notification module (4), allowing the user to monitor system performance in real time. LLD detection is performed via a smartphone camera (5), which captures reference markers on the user and background. The data are transmitted wirelessly to a processing unit (6), where an image analysis algorithm extracts key parameters and sends commands to the actuator in the EPM. This enables automatic adjustment of the prosthesis length to correct asymmetry. The system is powered by an external source (7) to keep the wearable component lightweight. The displacement of the EPM is measured to verify adjustment accuracy.





Front view, overall, of the developed experimental setup (1—anatomical mannequin; 2—base plate; 3—EPM; 4—EPM control unit; 5—right lower limb growth simulation mechanism; 6—dial comparator; 7—markers on the mannequin; 8—pairs of markers on the surface behind the mannequin; 9—smartphone).

Description of the invention

The prosthetic system employs computer vision technology to restore the patient’s body symmetry by automatically detecting lower limb length discrepancies and correcting biomechanical imbalances. A camera integrated into a smartphone or dedicated device captures images of the patient, while an image-processing algorithm analyzes the position of reference markers to determine alignment deviations.

Based on this data, the system sends commands to the extensible prosthetic module, which automatically adjusts the prosthesis height until postural balance is restored.

Conclusions

This system is designed for transtibial amputees undergoing rehabilitation, a period when the residual limb often changes in volume and shape, as well as for pediatric users, whose limb length discrepancies tend to vary over time.

The proposed approach employs a smartphone-based application—an accessible, familiar, and user-friendly interface that minimizes setup time. Experimental findings demonstrate the practicality and effectiveness of this vision-guided automatic compensation method, which operates through a smartphone and is integrated within a transtibial prosthetic system.

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