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MODELING A LINEAR ACTUATOR FOR AN ANKLE JOINT DEVICE.

Abstract: Electric actuators are very popular in the field of engineering and technology because of their ease of use and low operating costs. In this study, an electric linear actuator (manufactured by Miniature Linear Motion, model: Series L12) is modeled considering each physical parameter associated with it and modeled in Solidworks Simulation to observe its characteristics.

Key words: Electric Linear Actuator, Medical Device, Biomechanics, Ankle Exoskeleton, Design, Simulation

Аңдатпа. Электр жетектері техника мен технология саласында өте танымал, өйткені оларды пайдалану оңай және пайдалану құны төмен. Бұл зерттеуде электрлік сызықтық жетек (миниатюралық сызықтық қозғалыс, модель: L12 сериясы) әр байланысты физикалық параметрді ескере отырып модельденеді және оның сипаттамаларын бақылау үшін Solidworks Simulation-да модельденеді.

Түйін сөздер. Электрлік Сызықтық Жетек, Медициналық Құрылғы, Биомеханика, Тобық Экзоскелеті, Дизайн, Модельдеу

Аннотация. Электроприводы очень популярны в области техники и технологий из-за их простоты использования и низких эксплуатационных расходов. В этом исследовании электрический линейный привод (изготовленный миниатюрным линейным движением, модель: Серия L12) моделируется с учетом каждого связанного с ним физического параметра и моделируется в Solidworks Simulation для наблюдения за его характеристиками.

Ключевые слова. Электрический Линейный Привод, Медицинское Устройство, Биомеханика, Экзоскелет Голеностопного Сустава, Дизайн, Моделирование

Introduction

The actuator is an integral part of every robotic system that can actuate the hinge for the necessary movement of the device. Depending on the energy conversion mechanism, the actuators are divided into three classes: electric, pneumatic, and hydraulic.

The choice of actuators for auxiliary devices requires making decisions in which designers usually face opposite requirements. Although some options may depend on the context of the application or the design philosophy, it is usually desirable to avoid increasing the size of the drives to obtain lighter and more transparent systems, which ultimately contributes to the implementation of this device.

A linear actuator is a means for converting rotational motion into a pushing or pulling linear motion that can be used to lift, lower, slide or tilt machines or materials [1]. They provide safe and clean traffic management, efficient and maintenance-free.

Electric linear actuators use a DC or AC motor with a few gears and a lead screw that pushes the main rod shaft [2]. The difference between the actuators is determined by the size of the engine.

In robotics, it is used to improve the quality and accuracy of production while controlling production costs. Electric linear actuators control and repeat precise movements, adjust the speed of acceleration and deceleration, as well as adjust the amount of force required.

This paper presents a new solution using for exoskeleton an electric linear.

This study consists of four sections, which provide information on linear actuator for ankle joint devices, modeling of electric linear actuator, as well as numerical characteristics to verify the feasibility of the study.

Methods

There are many different types of linear actuators, when deciding on the use of it is important to choose the right actuator for the ankle exoskeleton [3]. It is important for the drive to know the requirements that best suit your situation.

The L12S (Figure 1 b) is very compact and weighs from 28 to 56 g, depending on the selected stroke length. Its size makes it an ideal device for robotics, as well as for other projects with limited space and weight [4].

a. b.

Figure 1 - Linear drives: a) CAD model in Solidworks; b) the original prototype

Some considerations on choosing the right drive to work with are given below.

When checking where the drive will be placed, it is important to determine the type of movement required [5].

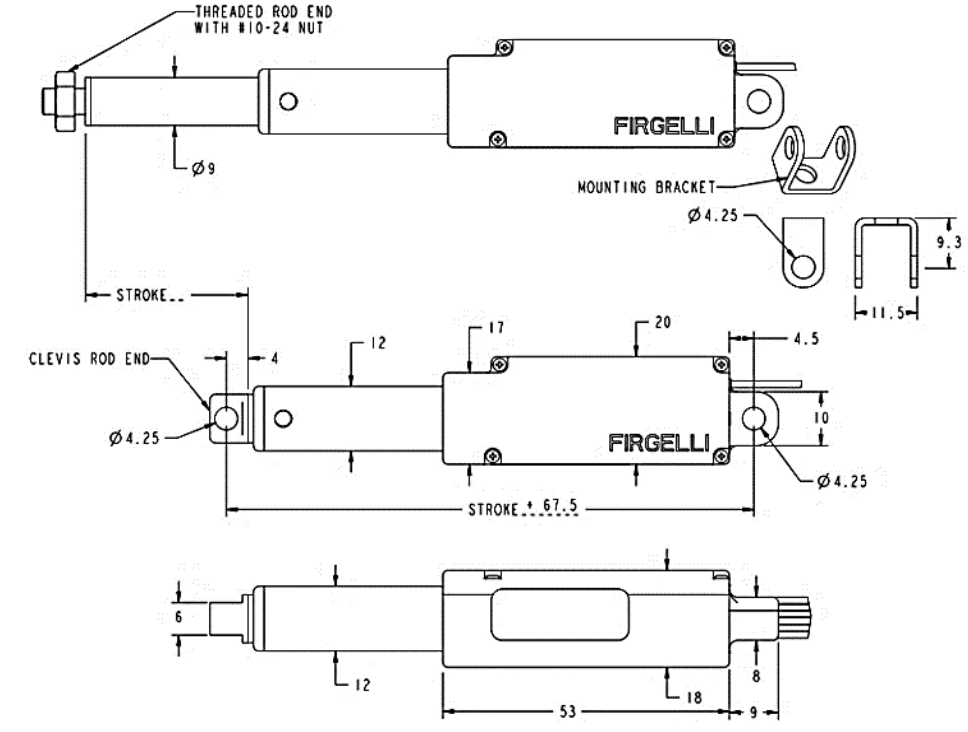

Figure 2 – Block diagram of a linear actuator

Opening and closing a door or valve is different from activating a process on a machine. The drives are designed to move objects in a straight line or for circular motion. It is very important to evaluate these movements and how they fit into the process.

The electric actuators have been refined and improved to fit any application. Although they are the most popular and widely used drives, this does not mean that they are suitable for all conditions. It may be necessary to consider a pneumatic or hydraulic drive when power is limited or unavailable [6].

The main function of the drive is to transmit power in the form of work. The actuators lift, tilt, move, activate, and shift objects and materials. The amount of work performed by the drive will depend on the force required to move the load, which is determined by its load capacity. Manufacturers provide information and data on the load capacity of their products, which should be studied to determine whether the power provided is suitable for operation [7].

The drives come with different motors and different stroke lengths. The stroke length is determined by the length of the shaft or the lead screw. Before using the drive, it is necessary to determine how much movement will be required to perform the work [8].

Speed is an important factor when choosing a drive, it is important to consider the weight that needs to be moved. When it takes a lot of effort to move the load, the actuator will move slower [9-10]. The drive speed is measured by the distance per second.

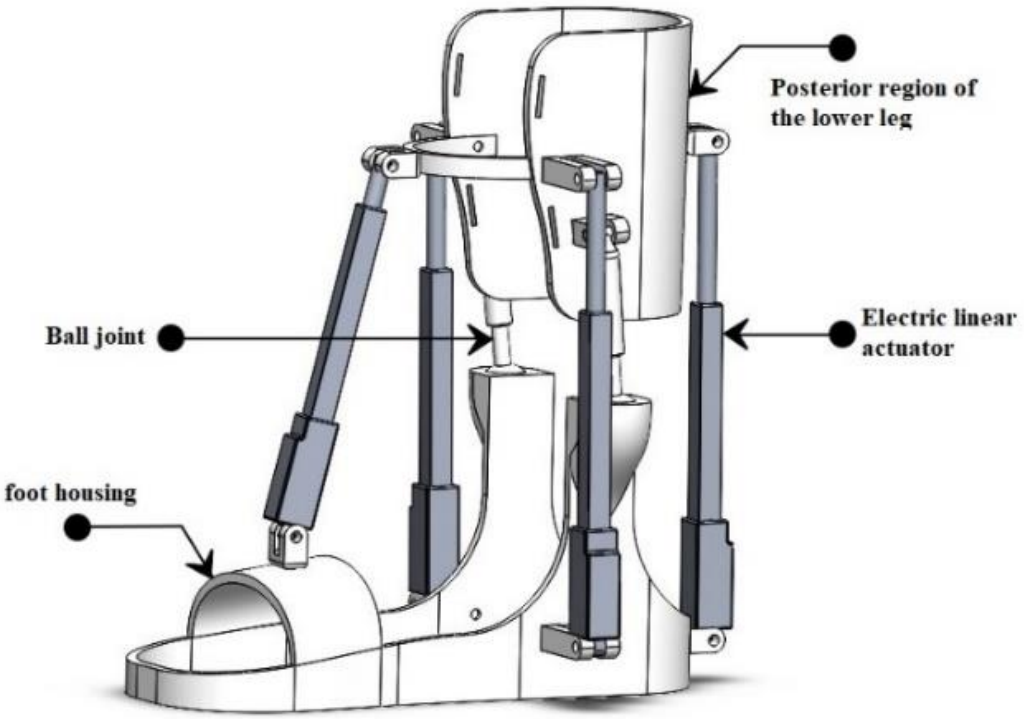

Figure 3 – Ankle joint exoskeleton with electric linear actuators

Each drive has a different mounting method. With a double swivel mount, the drive is placed on both sides of the mounting point, which allows it to rotate. A conventional stationary installation allows the drive to produce pushing or pulling movements from a given position. Proper installation ensures optimal drive performance and efficiency. This should be carefully considered in the course of work [11-12].

If the space where the drive is required seems limited and limited, you may think that you will not be able to install the drive due to its size or length [13]. There are drives that are designed to work in a confined space. Several manufacturers offer various forms of telescopic actuators that can fit into any size environment [14-15].

Simulation

3D modeling and simulation calculations were performed in a virtual environment using the Solidworks Simulation software and the Motion Simulation add-on.

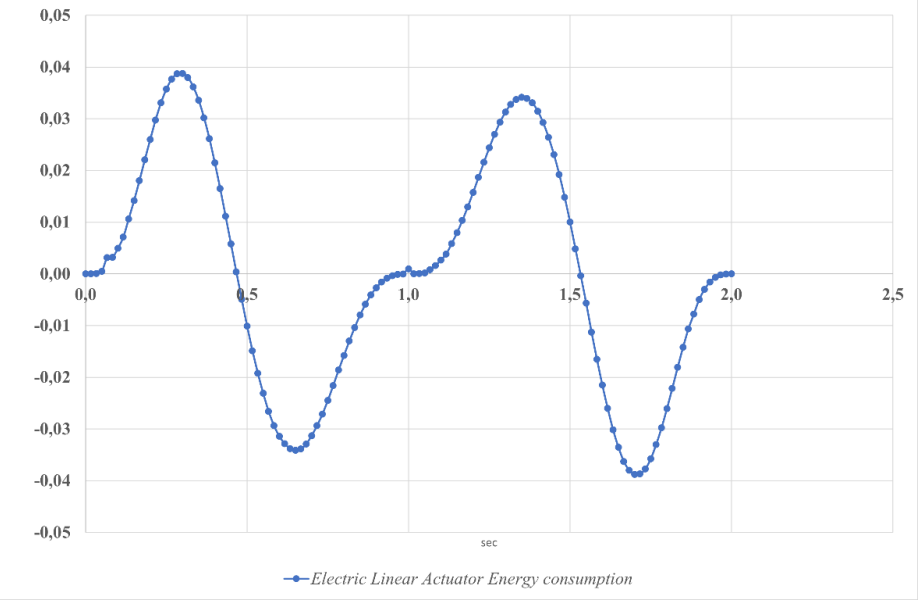

Figure 4 – Maximum effort drive in 2 seconds

Fig. 3 shows at what maximum effort the drive 40 N. By observing the graph, movements from all directions have peaks of maximum values. In 2 seconds, the drives can move freely as shown in the graph.

Conclusion

In this article, linear actuators convert rotational motion into pushing or pulling linear motion, which can be used to lift, lower, slide or tilt the exoskeleton. Although the functions of all linear actuators are the same, there are several different ways to achieve motion. The basis of the linear drive design is an inclined plane. Linear actuators come in several configurations suitable for any possible application, environment, setup, or industry.

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ПРИМЕНЕНИЕ ВОЛОКОННО-ОПТИЧЕСКИХ ДАТЧИКОВ НА ОСНОВЕ ВОЛОКОННЫХ РЕШЕТОК БРЭГГА ДЛЯ МОНИТОРИНГА ДОРОЖНОГО ПОКРЫТИЯ

Аннотация. Статья посвящена исследованию применения волоконно-оптических датчиков на основе волоконной решетки Брэгга для мониторинга дорожных покрытия. Волоконно-оптические датчики на основе волоконной решетки Брэгга являются наиболее перспективными инструментом для эффективного и долгосрочного мониторинга дорожных покрытия в различных условиях и пользуются большим спросом для прогнозирования механических свойств и возникновения повреждений дорожных покрытий.

Ключевые слова: мониторинг, дорожное покрытие, волокнно-оптические датчики, волоконные решетка Брэгга.

Аннотация. Мақала жол жабынын бақылау үшін талшықты Брэгг торына негізделген талшықты-оптикалық сенсорларды қолдануды зерттеуге арналған. Талшықты Брэгг торына негізделген талшықты-оптикалық сенсорлар әртүрлі жағдайларда жол жабындарын тиімді және ұзақ мерзімді бақылаудың ең алдыңғы қатарлы құралы болып табылады. Талшықты-оптикалық сенсорлар механикалық қасиеттері мен жол жабынының зақымдануын болжау үшін үлкен сұранысқа ие.

Түйінді сөздер: мониторинг, жол жабыны, талшықты-оптикалық сенсорлар, талшықты Брэгг торы.

Abstract. The article is devoted to the study of the use of fiber-optic sensors based on the fiber Bragg grid for monitoring road surfaces. Fiber-optic sensors based on the fiber Bragg grid are the most promising tool for effective and long-term monitoring of road surfaces in various conditions and are in great demand for predicting mechanical properties and the occurrence of damage to road surfaces.

Keywords: monitoring, road surface, fiber-optic sensors, fiber Bragg gratings.