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Design of Low-Cost Soft Robotic Hand

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Abstract— The paper aims to design low-cost "soft robotic hands" mechanically to obtain better effectiveness. Soft robotic hands are significantly attracting focus as the end-effector of robotics. Compared with the other rigid counterparts Soft robotic hands are more secure for interaction with human robots as well as environmental robots. Apart from that, it is very easy to control with the lowest cost. As the robotic hands are made with soft materials hence it is also light weighted along with more compliance. The objectives of the paper are to design low-cost soft robotic hands mechanically to obtain better effectiveness, to know the various materials required for designing the soft robotic hands and to comprehend the effectiveness of the soft robotic hands. The rationale for designing the soft robotic hands can be explained as obtaining a greater advantage to achieve an extra "degree of freedom" to perform various things which cannot be performed by a human hand

Index Terms — Low-cost, soft robotic hands, degree of freedom

1. Introduction

In the current scenario, "Soft robotic hands" are concentrated on the bending of the actuator and the creation of the soft fingers of the robot so that the gripping of the robot can be enhanced on a significant scale. For the designing of the soft hands of robots, the designing of the palm of the robot is the very crucial part to grasp. This type of hand is "inexpensive to fabricate". By the utilization of the soft hands in robotics, bending in different grasping axes, as well as deflection in the side-to-side axis, can be performed like the motion of human hands. Apart from that, with the help of the "Hybrid bending soft fingers (HBSF)", the effective design of the soft hand of robots is possible. In this research paper, the aim of the research paper, objective, and questions of the research paper is also demonstrated. The rationale for executing the research and the significance of research conduction will also be elaborated in the chapter. Apart from that, the visual representation of the different sections of the chapters will also be displayed in the research paper.

2. Literature Review

There is a long history of research and development in the area of soft robotic hands. One of the earliest examples is the Stanford/JPL Hand, developed in the early 1980s. This hand was designed to be used in space applications and had several features that were later adopted in other designs, such as variable stiffness and the ability to grip a wide range of objects. In the 1990s, a number of research groups began developing soft robotic hands for use in human-robot interaction and medical applications. These designs were typically made from silicone rubber and used pneumatic actuation[1]. One of the most notable examples is the "MIT Hand II", developed by Daniela Rus along with her team. This hand was able to perform a wide range of tasks, including opening a door, using a telephone, and picking up a raw egg without breaking it[2]. In recent years, there has been a renewed interest in soft robotic hands, driven in part by the advances in materials and manufacturing methods that have made it possible to create more complex and functional designs. For example, 3D printing has been used to create soft robotic hands with embedded sensors and actuators. New materials, such as shape-memory polymers, are also being explored for use in soft robotic hands[3].

In the past decade, there has been an increasing interest in developing soft robotic hands for various applications in industry and daily life. "RIT professor Dr. Lamkin-Kennard" has the teams for designing the robotic hands by the utilization of the "artificial pneumatic muscles". The team varies with various specifications in designing, but the utilization of the "soft robotics hands" is limited to the muscles applied to actuate the robotic hands[4]. Additionally, the new vision of "Dr. LaminKennards" was to make an inflatable

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system that applied soft robotics in order to handle itself. The motivation for the project is to explore the world of soft robotics more as well as expand the potential capabilities.

The rationale for designing the soft robotic hands can be explained as obtaining a greater advantage to achieve an extra "degree of freedom" to perform various things which cannot be performed by a human hand. There are several reasons for designing a soft robotic hand[5]. First, soft robotics can provide a high degree of dexterity and compliance, which is beneficial for tasks such as handling delicate objects or working in close proximity to humans. Second, the use of compliant materials can result in a reduction in weight and size, as well as a lower manufacturing cost. Finally, the unique properties of soft materials can provide advantages in terms of safety and reliability. One of the primary goals of designing a soft robotic hand is to create a device that is able to safely interact with humans [6]. Because "soft robotic hands" are made of flexible materials, they are able to conform to the shape of an object and avoid causing damage. One reason is that soft robotics can provide a more human-like grip, which is beneficial for tasks such as handling delicate objects or providing assistance to people with limited hand mobility[7]. Additionally, it can be safer to use around people and animals than traditional, rigid robotics. It tends to be more energy efficient than rigid robotics, meaning that it can operate for longer periods of time without needing to be recharge[8].

Prosthetic upper limbs are part of a market that is changing quickly. Surveys indicate low acceptance and dissatisfaction with current prosthesis designs, despite their development in device design[9]. This study presents the results of a survey that was conducted among people in Australia who have differences in their upper limbs. It asked them about their current prosthetic use and their preference for using an informal prosthetic in the design of future prosthetic hands[10]. The survey is conducted with 27 participants of the upper limb online for investigation. Openended questions, quantitative questions, and "ranking design features" were all part of the survey. Questions about the issues that were encountered and the features that are wanted in future designs for prostheses are also present in the survey[11].

The survey isolated common key concerns regarding weight, manipulation, feedback, aesthetics, dexterity, sensory as well as cost; Techniques like soft robotics as well as additive manufacturing could address each of these issues[12]. The technology of precision engineering holds promise for the development of novel and useful prosthetic hands. Because it directly addresses some planning limitations, mechanical planning is essential to improving mechanical prostheses. Cost, benefits, and weight. The most well-known method for mechanically constructing prosthetic hands is to minimize effort, minimize weight, and minimize the number of prosthetic hands in order to restore as much control and resilience as possible to people who have devastating disabilities [13].

3. Methodology

In the first step of the process, a rough sketch of robotic hand has been made so as to make is easy to create a model in the software. Wired thread is used to move the fingers accordingly. Active Duel Mode Twisting Actuator and spring action is used for to and fro movement of the finger.

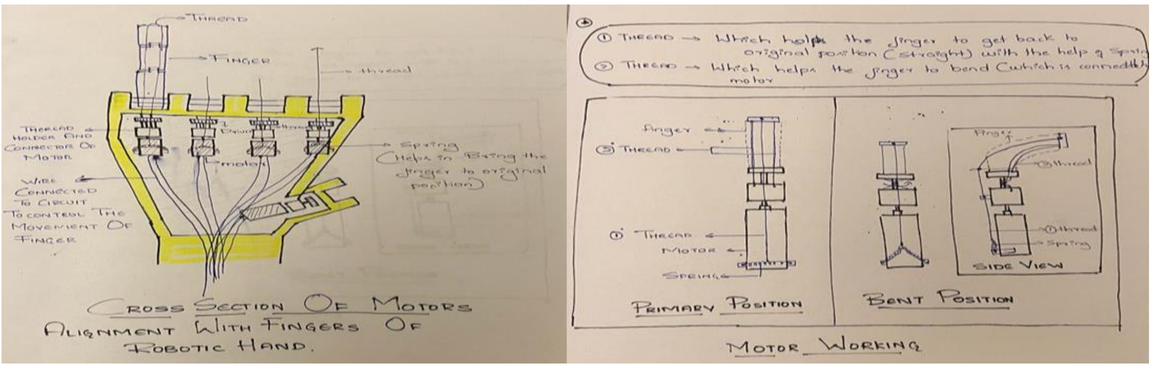

Figure 1: Rough sketch of soft robotic hand

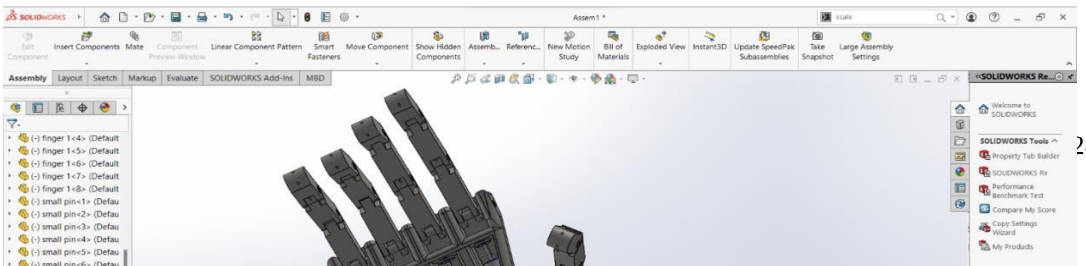

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Figure 2: cross section of the hand with motors placement

The figure shows the cross section of the robotic hand with the motors placed inside the palm of the robotic hand. The holes on the every finger represents the place the wired thread are places so as to control the motion of the finger. Five of Active Duel Mode Twisting Actuator are placed just below each finger and the threads are attached to it so as to move the finger in front and backward directions receptively. All the wires from the motors are been drawn out of the circle portion at the bottom of the hand and connected to Arduino board and the muscle sensor is conned to Arduino with respect to the program coadded into Arduino by taking the electrical pulses from the muscle sensor the motor with rotate in both directions in case of prosthetic hand. Else it can be also controlled with the buttons as a pic and place robotic hand in industries.

In addition to this, the design of this hand was designed in such a way that follows the principle of the human hand for operating. In other words it can be said that the idea of the basic design of it was taken from the human hand. It can be seen that the design takes into account the design of human finger joints for the design of the joints of the robotic hand. It can also be observed that the ratio of the length of the palm to the finger was maintained in the way that generally human hands have. So, it can be concluded that it can be a good replacement in the places where the human becomes in doing some work. In addition to such advantages it can also be observed that it also provides a more durable and strong item in terms of material. So, it is believed that more advancement in the work can be achieved through it. In order to improve functionality and offer a more natural user experience, prosthetic arm design has undergone substantial evolution. Several essential parts are usually found in a contemporary prosthetic arm.

The socket is manufactured to order to suit the user's residual limb comfortably and securely. It acts as a bridge connecting the prosthetic arm's remaining limb to the rest of it. Different actuators and joints are used in prosthetic arms to replicate the movements of a natural arm. These could include wrist and elbow joints that include hydraulic or motorised systems to allow for flexion and extension. Sophisticated prosthetic arms use complex control systems that frequently make use of myoelectric sensors. These sensors take in electrical impulses from the user's remaining muscles and convert them into movements that are particular to the prosthetic arm. Various sensors can be incorporated into prosthetic arms to enhance their functionality and provide feedback. force senses Determine the force or pressure exerted on the prosthetic hand to facilitate a deft grip.Feeling senses By identifying pressure or contact on the hand's surface, provide sensory feedback.Actuators and Gyroscopes aids in keeping the prosthetic arm oriented and balanced. Batteries or other energy sources power prosthetic arms, supplying the required force to operate the actuators and sensors. In order to look more natural and blend in with the user's body, many prosthetic arms come with a cosmetic coating. In general, the goal of prosthetic arm design is to mimic the flexibility and dexterity of a normal arm while incorporating control systems and sensors to increase usefulness and improve the user's quality of life. Technological and material innovations keep pushing this subject forward, giving users more sensory feedback and increased mobility.

4. Material Selection

As the project is about low cost soft robotic hand by the end of some research using . Polylactic Acid (PLA) filament suits majorly for the soft robotic arm as it is less cost and can withstand more stress and also the breaking point is acceptable for the model. As a result of its relatively low production costs and ability to be made from a variety of renewable resources, PLA has quickly become a widely used material. While its wider deployment has been hampered by a number of physical and processing problems. In the world of 3D printing, the substance known as PLA constitutes the majority of all plastic filament usage. The fact that it has a low melting point, high strength, minimal thermal expansion, good layer adhesion, and great heat resistance when annealed all combine to make it an ideal material for the purpose of 3D printing. PLA, on the other hand, has the lowest heat resistance of any of the primary polymers used for 3D printing if it hasn't been annealed beforehand. In some parts steel has been used for the soft movement at the joints.

5. Linking With Objectives

The first objective of this research was to design a robotic hand to make it affordable for everyone. This robotic hand is easily placed on the body of the patient. A soft robot is always safer for the interaction of humans and for “internal deployment” inside a human body. The second objective of this research was to design a hand with the help of various kinds of materials like rubber, plastic, steel, etc. The materials depend on the working condition of the robotic hand. The robotic hand is used everywhere like core industries, healthcare industry, etc. for the core industries, the working principle of the robotic hand is totally different. In this kind of industry, heavy loads are done by the robotic hand like welding, shipping, carrying the load, etc. for that reason, industrial robotic hands are always made of steel or heavy duty materials. For the robotic hand, various kinds of mechanisms are used by the researcher to make it perfect. A hydraulic system is used in the robotic hand to carry the high load. Various configuration systems are presented inside the hydraulic system to continue the working capacity. The third objective of this research was to develop the design platform. In this design, the researcher used steel and PLA filament as a material and this material is used as a universal material for robotic hand. At first, the researcher designed a two-dimension sketch with proper dimension values. Then this sketch is converted into a solid body with the help of extrude operation. Holes are created by the researcher to install the pin which provides the support of finger models

6. Conclusion

A robotic hand is a very important gadget that is used in every industry. this robotic hand is used in the core industry as well as health care sector industries. This robotic hand can do any kind of work possible. three sections are presented in this report that are literature review section, methodology, and data analysis. In the literature review section, all kinds of journal papers are discussed here. methodology section mainly describes which method is used. The data analysis section described that primary analysis has been done here and with the proper design of the robotic hand model. Recommendations will be discussed in this research report. Various kinds of objectives are presented in this research that will elaborate on in this section properly. This discussion can make this research better in the future with the help of these point.

7. Recommendation

This section mainly discussed the future implementation of the robotic hand. Every industry needs different types of working strategies. That's why the research was properly done to solve any issues which are related to this. The robotic hand is used to do various kinds of hard work which are not possible for humans. The researcher can develop its working principle to make it perfect from other systems. “brain-computer interface” can be used to get good performance. The researcher is also working on artificial intelligence technology to properly install this model. The researcher also focuses on the material section which is very important to make it strong and also eco-friendly. The researcher needs to attach the automatic technology to the robotic hand . The robotic hand can enhance productivity and economic growth that creates new opportunities worldwide.

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