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# REVIEW ON DESIGN AND DEVELOPMENT OF ADVANCED BIO-MECHATRONIC HAND

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**ABSTRACT**

The objective of the work described in this paper is to review the development on artificial hand which can be used for functional substitution of the natural hand (prosthetics) and for humanoid robotics applications. The artificial hand is designed for replicating sensory-motor capabilities of human hand.

## I. INTRODUCTION

The purpose of these paper is to review and study about the papers released by other various authors on the topic of bio-mechtronic hand. Through this paper we will study and understand about various different methods through which an bio-mechatroin hand can be developed.. Through reviewing various articles and study done on it ,we belive we can design more suitable and cost efficient product which can allow the users to satisfy their needs and perform the task or work as per requirement of the users.

L. P. Usha, presented a design process for a novel 3D Bionic Arm which also uses SCP as artificial muscle. The ultimate aim was to develop a low cost Bio Mechanical device with multiple degrees of freedom and multi-sensing capabilities, which is also low weight and noiseless in nature. The purpose has been served to a certain extent but still can be improved in many aspects. One of the biggest limitation of this device is its lack of pressure feedback. Pressure sensors can be incorporated along with Advanced EMG Algorithms and processing. With future growth of the 3D printing industry, many advanced and robust prosthetic devices can be designed.

Loredana Zollo, proposed a biomechatronic approach to the design of an anthropomorphic artificial hand able to mimic the natural motion of the human fingers. The hand is conceived to be applied to prosthetics as well as to humanoid and personal robotics; hence, anthropomorphism is a fundamental requirement to be addressed both in the physical aspect and in the functional behavior. In this paper, a biomechatronic approach is addressed to harmonize the mechanical design of the anthropomorphic artificial hand with the design of the hand control system. More in detail, this paper focuses on the control system of the hand and on the optimization of the hand design in order to obtain a humanlike kinematics and dynamics. By evaluating the simulated hand performance, the mechanical design is iteratively refined. The mechanical structure and the ratio between number of actuators and number of degrees of freedom (DOFs) have been optimized in order to cope with the strict size and weight constraints that are typical of application of artificial hands to prosthetics and humanoid robotics.

M.C. Carrozza , studied an "ideal" upper limb prosthesis should be perceived as part of the natural body by the amputee and should replicate sensory-motor capabilities of the amputated limb. However, such an ideal "cybernetic" prosthesis is still far from reality: current prosthetic hands are simple grippers with one or two degrees of freedom, which barely restore the capability of the thumb-index pinch. The design and fabrication of a novel prosthetic hand based on a "biomechatronic" and cybernetic approach. Our approach is aimed at providing "natural" sensory-motor co-ordination to the amputee, by integrating biomimetic mechanisms, sensors, actuators and control, and by interfacing the hand with the peripheral nervous system.

P. J. AGNE, described, the functional effectiveness of a myo-electric prosthesis with sensory feedback compared with that of a split-hook is described. Thirty independent observations were made on a single subject with a right below-elbow amputation wearing the myo-electric prosthesis and the split-hook prosthesis. Using a first order autoregressive model for making inferences about the two sets of data, the split-hook was found to be functionally better ($p < 0.001$) than the myo-electric prosthesis. Functional effectiveness was defined operationally as scores on the Minnesota Rat e of Manipulation Placing Test and the Smith Test of Han d Function. No predictions are mad e regarding the use of either prosthesis for other amputees. However clinical evidence suggested suitability of the myoelectric prosthesis with sensory feedback for some other functional tasks.

M E Cupo designed The AdVAntage Arm is an above-elbow (AE) body-powered arm to improve upon, and overcome, some of the major limitations of conventional prostheses. It is the result of research and development (R&D) accomplished at the Center for Engineering Design (CED), University of Utah and Sarcos Research Corporation (SRC), Salt Lake City, UT. The AdVAntage Arm was developed to provide the following main features: lightweight, independent elbow and terminal device (TD) control, and a cable recovery system for full TD actuation at any elbow position. The Department of Veterans Affairs (VA) Rehab R&D Service's Technology Transfer Section (TTS), with collaboration from the VA National Prosthetic and Sensory Aids Service (PSAS), managed a multi-center clinical evaluation of the precommercial AdVAntage Arm (the Arm). The purpose was to objectively assess and affirm the Arm's functional advantages, reliability, clinical application, and commercial readiness. Eleven VA prosthetic services served as evaluation sites with a total of 16 subjects with amputation (14 unilateral and 2 bilateral). Fifteen prosthetists provided their comments. Overall, the results demonstrated that the Arm could be fit for use by persons with transhumeral, and even with forequarter, amputation. Once the learning curve was overcome, the majority of subjects reported that the Arm offered several functional advantages over their conventional prosthesis. Its overall light weight, separation of elbow and TD function, and cable recovery system allowed opening and closure of the TD at any elbow position; resulting in a more fluid manner of use and allowing subjects to perform more activities from waist level and above (especially in the outstretched and overhead positions). At the conclusion of clinical trials, 10 subjects elected to keep the Arm for continued use. The manufacturer is committed to the commercial marketing and technical support of the arm. Based upon the clinical findings, the AdVAntage Arm was recommended for commercial production and availability, upon prescription, to appropriate veteran beneficiaries.

M LeBlanc, reported that the design and development of a novel prosthetic hand that is lighter in weight, less expensive, and more functional than current hands. The new prosthesis features an endoskeleton embedded in self-skinning foam that provides a realistic look and feel and obviates the need for a separate cosmetic glove. The voluntary-closing mechanism offers variable grip strength. Placement of joints at three locations (metacarpophalangeal and proximal and distal interphalangeal) within each of four fingers affords realistic finger movement. High-strength synthetic cable attached to the distal phalanx of each finger is used to effect flexion. A multiposition passive thumb provides both precision and power grips. The new prosthesis can securely grasp objects with various shapes and sizes. Compared to current hands, weight has been reduced by approximately 50%, and cable excursion required for full finger flexion by more than 50%. The new endoskeletal prosthesis requires approximately 12-24% less force input to grasp a variety of everyday objects, largely due to its adaptive grip. Production cost estimates reveal the new prosthesis to be significantly less expensive than current prosthetic hands.

Robert Vinet, reviewed different approaches to define the motion of the fingers and the thumb in order to obtain prehension. The last part presents the design of a hand prosthesis based on a new plane of action for the thumb and on proposed design specifications and functional characteristics . The design methodology consists of two steps: the morphology design of the hand prosthesis and the 4-bar mechanism design for each finger. A 3-D computeraided design (CAD) interactive program was used as a design tool to obtain the hand morphology . This CAD technique was also used to check the geometry, the relative motions of the fingers, and the possibility of interference for the proposed model with two prehension patterns (tridigital and lateral) . It is noted that identical flexion angles of the finger joints were obtained for these two prehension patterns, the difference being in the inclination angle of the thumb's plane of flexion. This finding greatly simplified the design of the internal mechanisms of the fingers. CAD was a powerful tool in the design process of this hand prosthesis and will be more and more useful in the future.

Ciaran T. O'Neill , reported that Robotic artificial muscles are a subset of artificial muscles that are capable of producing biologically inspired motions useful for robot systems - i.e., large power-to-weight ratios, inherent compliance, and large range of motions. These actuators, ranging from shape memory alloys to dielectric elastomers, are increasingly popular for biomimetic robots as they may operate without using complex linkage designs or other cumbersome mechanisms. Recent achievements in fabrication, modeling, and control methods have significantly contributed to their potential utilization in a wide range of applications. However, no survey paper has gone into depth regarding considerations pertaining to their selection, design, and usage in generating biomimetic motions. This paper will discuss important characteristics and considerations in the selection, design, and implementation of various prominent and unique robotic artificial muscles for biomimetic robots, and provide perspectives on next-generation muscle-powered robots.

M. H. Raibert, presented, a new conceptually simple approach to controlling compliant motions of a robot manipulator. The "hybrid" technique described combines force and torque information with positional data to satisfy simultaneous position and force trajectory constraints specified in a convenient task related coordinate system. Analysis, simulation, and experiments are used to evaluate the controller's ability to execute trajectories using feedback from a force sensing wrist and from position sensors found in the manipulator joints. The results show that the method achieves stable, accurate control of force and position trajectories for a variety of test conditions.

R. Cabas, reported that , at the present time, the robotics hand research field is searching for those robots that could imitate the human hand, both in shape and in skill. As another option, some manipulator are developed, even though they do not imitate the human hand, they try to fulfil certain specific tasks with the biggest precision and skill. Some keys to make the robotic hands integrable in any manipulator are: built them lighter, a minimum amount of actuators and a simple sensorial system to simplify its control. The present work will describe the design of the RL1 Hand developed in the Robotic's Lab at the Carlos III University of Madrid. This robotic hand has 3 articulated fingers, which adapt themselves to the object which is being held. The fingers movement and auctioning are made through one direct current motor. The control is done through simple commands and can be sent from any computer, as a string of characters. To prove its ability the RL1 Hand was mounted in a robotic arm, ASIBOT Robot. This arm was developed to help disabled people or people with special needs.

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## II. CONCLUSION

From the study and research above done by the various authors, we can say that , a biomechatronic hand which can posses high degree of freedom (DOF), which can apply pressure as per requirement at the figure tips, has control over motion, has a safe and appropriate design. Match the requirements of prosthesis and humanoid robotics. It should be wearable by the user which means it can be perceived as the part of the natural body and should replicate sensory-motor capabilities of natural hand. It should also be cost efficient through which it can be affordable for every required person.

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