CHAPTER II

Literature Review

2.1 Previous Research in Prosthesis Development

Researches in the area of prosthesis are still going on. In order to get a historical background to improve mechanical manipulator grasp functionality, several studies have been done to quantify and better understand the nature of human hand operations [8].

Musa Hakan ASYALI, ***et. al. [9]*** says that multichannel EMG signal controls are not suitable due to early fatigue problems and high effort requirements to perform even simple activities. Their study presents a new voice controlled active hand prosthesis to perform several basic tasks. The first designed a novel multifingered prosthetic hand with the ability of picking up and releasing objects using 3 DC motors and gears to transfer motion to the linked parts of the fingers and flexible thin-film resistive force sensors at the fingertips of the prosthetic hand to adjust the grip force at the fingers. The second part of the study involves the use of HM2007 speech recognition IC and a PIC microcontroller to drive the DC motors moving the fingers.

Deepak Kumar ***et. al.[10]*** says There are a few options for providing a handicapped person with the control of a prosthetic hand. Some of these include E.M.G. and audio cues. Since Voice control is not cosmetically suitable for such an application, a circuit has been designed which depending on the duration/style of a whistle, controls the motion of a prosthetic hand. The circuit is robust to change in the ambience. The cost factor has also been taken in to consideration. The final product is designed for the needs of a typical Indian patient.

Gruppioni E, ***et. al*** [11] says Current solutions for the control of active upper-limb prostheses are mostly based on EMG signals acquisition and processing and on electronic switches. Even though efficient for most clinical cases, these solutions can be unsatisfactorily for the control of prostheses with multiple joints. Voice-control can be a possible solution for these clinical cases. The aims of this work were therefore 1) to identify a non-redundant vocabulary for the voice-control of an active upper-limb prosthesis, by maximizing the recognition performances of the voice controller VR-STAMP (Sensory Inc., Sunnyvale California), and 2) to integrate the VR STAMP with a prosthesis controller. A non-redundant vocabulary was identified comprising 26 words. The vocabulary was tested on 16 subjects, reporting no statistically significant differences between words recognition. The median number of recognitions per word per subject was 10/10 with an interquartile distance of 1. For the development of the voice controlled prosthesis, a firmware for the VR-STAMP was firstly developed; then, the VR STAMP was interfaced via serial-port with the prosthesis controller CLC2000 developed and commonly used by the INAIL Prostheses Centre.

Ralph Alter [12], sayes that the (EMG) can be sensed directly from the surface of the skin. Several experimental prostheses have been developed previously, which use EMG signals for control purposes. The major shortcoming of most of these devices has been the lack of graded control of their behavior. A system has been developed which utilizes surface EMG signals from the biceps and triceps of an amputee's arm to provide graded control of an elbow prosthesis. The development included as an intermediate step the control of a simulated forearm in a digital computer, in real time. an actual mechanical elbow prosthesis can now be voluntarily controlled through the subject's EMG signals. The use of nerve signals as the control signal for a prosthesis offers many potential advantages over the use of the EMG signal; the practical problems involved in observing nerve signals, however, combined with the lack of information as to how to properly interpret them, makes this approach infeasible now. Preliminary experiments aimed at deriving the necessary information in order that nerve signals can ultimately be used are described here. The results are still inconclusive.

David Harvey ***et. al.[13]*** Investigates the design of a prosthetic arm to mimic its human counterpart. In particular it examines alternative mechanisms to data acquisition and transmission. This study provides the basis for the development of a prosthetic limb that operates as a part of the human body's neural network. As opposed to a conventional prosthesis that only provides motion of the extremity, this design aims to lay the foundations for incorporation of added sensory feedback into the nervous system so as to provide the tactile sensations experienced by a human arm. The transform of the input signals to the required output location is done with traditional coordinate reference systems. The physical structure of the hand has been modeled such that it can be easily assembled. It has been simplified such that it only has six of the twenty degrees of freedom while retaining some of the important motions of the human hand. A two-finger model has been constructed. This model exhibits the full range of motion required to grip an object with some degree of force. A virtual reality model package has been developed in visual basic to control the model in such a manner that it is able to demonstrate the potential of the project.

Steven den Dunnen [14], says Upper extremity prostheses can be divided in two main categories: body powered and externally powered. Human powered devices are controlled by a force that is delivered by the user, which often involves moving a limb. In an externally powered prosthesis the energy is provided by an external power source, such as a battery. The majority of these devices is actuated by picking up myo-electric signals from the user.

Not many individuals with an upper limb absence use their prosthesis on a regular base. Rejection rates of 50% have been reported due to various reasons on both user-level (need for wearing, predisposing characteristics, availability) as prosthesis-level (comfort, control and functioning, durability and maintenance, cosmetics). For each type of prosthesis the reasons for rejection, the priorities of the user and the dissatisfactory properties are different.

The dissatisfactions, expectations, reasons for rejection and most common usage of a prosthesis were combined into a vision, where durability, feeling comfortable (physical comfort and appearance), natural control (simple, fast, low effort, feedback) and the primary activities (grasping objects of daily living, possible manipulation of object by sound hand, stability, feedback, automatically adjust to shape object) were the major focus points. Based on this vision, a strong, low weight, multi-articulated, under actuated, body powered voluntary closing hand prosthesis with multiple separate fingers was aimed for.

Academic and commercial prostheses which had multiple (multi-articulate) finger integrated were evaluated and combined with self obtained knowledge which showed the pinch force stability of the grasp are at stake due to the (obvious) counteracting leverages in the finger and the distribution of the actuation force amongst all the fingers. A second problem that was encountered was the dependency of each other of the phalanges and fingers when using an under actuated system. After consideration the best way to increase the pinch force was to integrate a variable force transmission which provides a leverage after all the fingers have touched the object (speed of grasp is maintained, output force is increased and displacement decreases). The dependency of the phalanges is removed by using a one way lock in the proximal phalanx, still enabling the mechanism to provide feedback to the user by the distal phalanx.

Various mechanisms of the finger, one-way lock and variable force transmission were designed after which one of each was conceptualized. A prototype of the finger was made and evaluated. This resulted in the design of two improved fingers, of which one was made twice. The three prototypes were combined in to one hand, which was tested to grasp several objects of daily living. The outcomes were promising, as the mechanism appeared to function as intended.

Chandrashekhar P. Shinde[15], says an artificial arm should be as near to the natural hand as possible. Various designs of artificial arm are available in the market, categorized as mechanical, electrical and Myo-electric arm. Myo-Electric arm is stimulated by muscle signal available from the stump of amputee. In this method the MES signals are picked from the surface and the time domain features associated with the intended motion are extracted using suitable technique. The intended action of the arm is understood from the EMG signal parameters which are obtained by using defined circuit scheme. The pulses are generated by using microcontroller and the respective motor is driven for movements of the hands and wrist, hand open, hand close, wrist flexion, wrist extension etc. In this research the authors used proportional myoelectric control of a one-dimensional virtual object to investigate differences in efferent control between the proximal and distal muscles of the upper limbs. Restricted movement was allowed while recording EMG signals from elbow or wrist flexors/extensors during isometric contractions. The signals recorded by the surface electrodes are sufficient to control the movements of a virtual prosthesis. The presented method offers great potential for the development of future hand prostheses.

Paul Ventimiglia [16], Current prosthetic hands have limited functionality and are cost prohibitive. A design of a cost effective anthropomorphic prosthetic hand was created. The novel design incorporates five individually actuated fingers in addition to powered thumb roll articulation, which is unseen in commercial products. Fingertip grip force is displayed via LEDs for feedback control. The hand contains a battery and micro-controller. Multiple options for signal input and control algorithms are presented. A prototype will serve as a platform for future programming efforts

Kathryn J. De Laurentis ***et. a1.[17]*** presents the mechanical design for a new five fingered, twenty degree-of-freedom dexterous hand patterned after human anatomy and actuated by Shape Memory Alloy artificial muscles. Two experimental prototypes of a finger, one fabricated by traditional means and another fabricated by rapid prototyping techniques, are described and used to evaluate the design. An important aspect of the Rapid Prototype technique used here is that this multi-articulated hand will be fabricated in one step, without requiring assembly, while maintaining its desired mobility. The use of Shape Memory Alloy actuators combined with the rapid fabrication of the non-assembly type hand, reduce considerably its weight and fabrication time. Therefore, the focus of this paper is the mechanical design of a dexterous hand that combines Rapid Prototype techniques and smart actuators. The type of robotic hand described in this paper can be utilized for applications requiring low weight, compactness, and dexterity such as prosthetic devices, space and planetary exploration.

Fabrizio Lotti ***et. a1.[18]*** discusses the reasons why simplified solutions for the mechanical structure of fingers in robotic hands should be considered a worthy design goal. After a brief discussion about the mechanical solutions proposed so far for robotic fingers, a different design approach is proposed. It considers finger structures made of rigid links connected by flexural hinges, with joint actuation obtained by means of flexures that can be guided inside each finger according to different patterns. A simplified model of one of these structures is then presented, together with preliminary results of simulation, in order to evaluate the feasibility of the concept. Examples of technological implementation are finally presented and the perspective and problems of application are briefly discussed.

Most of the system apparently having various functions which assumed to be difficult to operate by the disable people. To make the simpler system and easier to operate by the disabled persons I developed and simplify the prosthetic arm control system by using a voice controlled system which uses short commands to move the prosthetic arm.