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# STUDY OF COMPUTER CONTROLLED FOUR FINGERED ROBOT HAND

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**ABSTRACT**

*When people are interacting with intelligent agents, they depend upon a more range of existing source of knowledge about machines, minds and intelligence. This knowledge guides these interactions and also it can be challenged and potentially changed by experiences. The science of computation has systematically abstracted away the physical world. Human beings totally interact physically with nature using their hands. Robotic hand systems can be used in hazardous and dangerous environments such as those are damaged in nuclear, military, chemical, underwater, and space applications. In our world, robot perform a huge role. However, as the potential use for robots grows, so there interaction with environment also grows. Computer controlled four fingered robotic hand is designed and developed with a simple and control strategy to grasp and place applications. The approach is based on anthropomorphic design with three fingers and an opposing thumb. Each finger has three links as well as three double revolute joints. The movement of each finger is done by a two antagonistic tendons. The robot hand system is interfaced to embedded computer with software control by means of fourteen independent commands for the movement of fingers. Reliable grasping and releasing is achieved with basic control mechanism and IR sensors. The hand can pick a variety of objects with various surface characteristics, shapes and size without having any changes to its surface description. Picking of the object is completed as long as the object is placed within the workspace of the hand and placed the object at the desired locations within the workspace by relevant software control by keyboard commands. Details of hand control hardware and software for mainly grasp and release applications are presented in this paper. Results of the experimental work for pick and place applications of different objects are enumerated.*

## I. INTRODUCTION

By using robots we can perform various tasks by replacing the human in the daily life. In order to accomplish the effective performance of precise tasks, robot hand must have special abilities, such as decision making in given condition, autonomy in unknown situation and stable manipulation of object. It must possess the information to be able to carry out complicated manipulative tasks in a natural conditions. Consequently, the sensors and the necessary software are required to support environmental interaction between the robot and the environment. The MIT hand developed by Jacobsen etal. is driven by actuators that are located in a place remote from the robot hand structure and connected by tendon cables. The actuators are build into the hands with the help of DLR-hand II which was developed by Hirzingeetal. Each finger of robot hand is equipped with motors, 6-DOF fingertip force torque sensor and integrated electronics. Kawasaki etal presented anthropomorphic robot hand called the Gifu hand III, which has a thumb and four fingers. The thumb has 4 joints with 4-Degree Of Freedom and each of the fingers has 4 joints with 3-DOF. So the distributed tactile sensor which is made of conductive link is arranged about 859 sensing points on the palm and the fingers. The pressure conductive rubber is utilized as a pressure sensitive material by Shimojo etal. They connect the sensor into a four finger robot hand and demonstrated its holding operations with a column, sphere, etc. The motion of robot hands is unlike that of the human because the working system of robot hands is different from that of MIT hand. Jacobsen S C etal utilizes 32 pneumatic actuators to drive three fingers and a thumb through a system of cables. A opaque sensing system is integrated with vision to perform trajectory planning.

Robotic hand shares with the human hand, some of the fundamental antique of motion, grasping, and manipulation. A understanding of the human way to move their hands could suggest an approach towards to programming hands that allow users to more easily control the different devices that may be used in a robotic system, by enclosing the hand hardware in functional modules, and neglecting the implementation-specific details. Recent results on the organization of the human hand in grasp and manipulating have demonstrated that, notwithstanding the complexity of the human hand, a limited variables are capable to account for most of the variance in the patterns of human hands configuration and movement. The results are concluded on the base of experimental tests in which subjects were asked to perform grasping actions on a wide variety of objects. DIST hand, utilizes Bowden cables to provide extrinsic actuation to a four fingered 16 DOF hand with 20 brush less DC motors. Fingertip force, joint angle and a novel conductive rubber tactile sensor increases the sensing capability of this hand. Robot hand created by NASA uses 14 DC motors to control 14 DOF. Flex shafts and lead screw assemblies are used instead of cables to eliminate frictional problems. A prosthetic device driven with servo motors, with 16 degrees of freedom (DOF), five fingers actuated through four-bar linkages and a large area tactile sensor is developed as Gifu hand III . DLR hand II, is a four fingered hand with 16 DOF is driven with thirteen DC motors with under-actuation connected by a four-bar linkage of two distal joints. Over 90 sensors and an electronics packaging give this hand great potential for research. RCH-1. This ultra-light 325 gm with 16 DOF hand was planned for prosthetics. High under-actuation through a passive cable–pulley system allows control of 5 fingers with 6 DC motors. This paper focuses on structural, hardware and software design considerations of a paradigmatic hand model.

**Structural Design of FFRH**

A re programmable multi functional manipulator designed to move material, parts, tools, and specialized devices through variable programmed motions for the performance of a variety of tasks is known as Robot. The aim of this paper is to present the design and construction of multi-fingered gripper as a robot hand for mainly general purpose manipulation/pick and place applications and has four fingers interfaced to palm and wrist.

The design of mechanical structure for FFRH consists of four digits: three fingers and one thumb, as shown in figure 1. Three digits are positioned at the corners of an inverted triangle and one digit is at the center of base of the triangle. Each finger consists of three rigid links i.e. the proximal, intermediate and distal phalanges constructed from two parallel plates. The phalanges are connected by three joints (the proximal, intermediate, and distal joints) which have parallel axes of rotation and are responsible for curling.

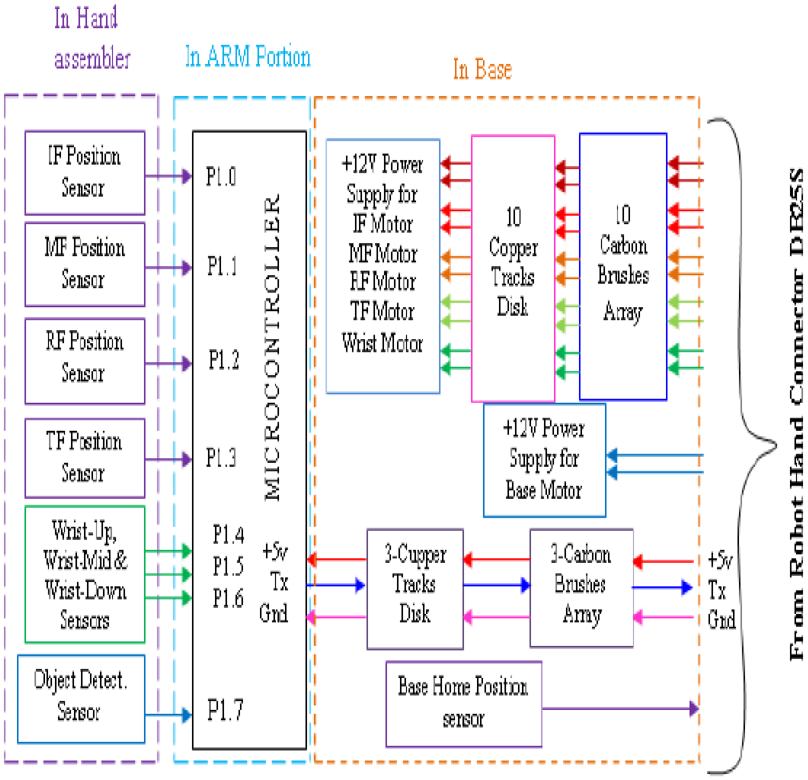


**Figure 1: Functional Block Diagram of FFRH**

**1: Functional Block Diagram of FFRH**

The thumb is similarly configured except that it consists of only two rigid links by the proximal and distal, connected by joints (the proximal and distal). The dimensions of FFRH are selected to be approximately the size of an adult human male hand.

**2: Mechanical structure of Robot Hand**

For practical reasons, epoxy is selected as the material for the plates, since it is strong, rigid, lightweight, relatively in expensive, and easy to machine. We also choose epoxy for the arm, wrist, and palm plates since it is not as susceptible to wear. Dial cords and gut wires with small diameter plastic tubes as sleeves are used for the tendons of the digit since these are flexible. The Grasper robotic hand differs from many other hands in that the joints of each finger are independently controlled for motion. Since the joint axes of each digit are parallel, the motion of each finger lies on a plane. The digits are mounted such that their planar workspaces are parallel and there Index does not collide. The motion of a Grasper finger as the digit's driving motor is activated by the keypad with feedback network.

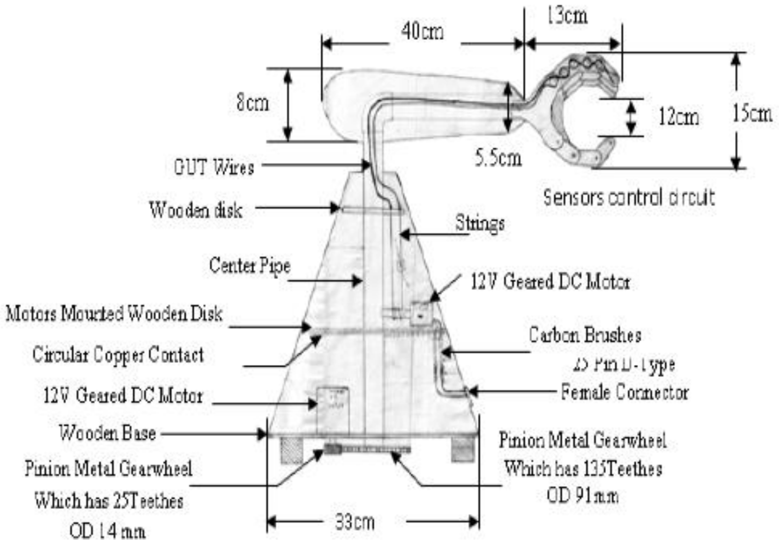


**Figure 2: Mechanical structure of Robot Hand**

**Embedded Controller Hardware Design**

Designing hardware is more constrained than designing software, while one may sometimes have great influence on the design of a chip in advance of availability. We obtained the volume required at prices that we can afford. Unavailability of even a single component in required quantity may lead to difficulty in implementation based on the design. The design of body part like human hand is more difficult.

The key commands from the Keyboard are encoded and are fed to the Robot Hand (RH) controller. The RH controller unit consists of the necessary electronic hardware required for driving all the geared DC motors. It also consists of the interface through decoder for transferring the control bits generated out of the control software from the Microcontroller, to the respective activator units located on the robot hand unit. Each finger consists of joints, for activating the motion; the geared DC motor is energized through Hand Motor Driver circuit. The driver circuit, as shown in the figure, supplies the required voltage at the appropriate current rating as per the specifications of the DC motors through connector. The Robot Hand Controller circuit diagram contains the Microcontroller, 8255 interface, and Key board interface, Serial to Parallel Converter, Hand Motor Driver, Buzzer and LCD modules. Each module is circuited separately and are interconnected with one another.

**Embedded Software Design**

Embedded systems are electro-mechanical products which relate mechanics, hardware and software. Examples of embedded systems are mobile phones, medical instruments etc. An embedded system contains a computer which is a part of a larger system that provides non-computing features to the user. The size of an embedded system vary from a small thermometer to a chemical plant's process controller.

The structured design approach involves solving a large problem by breaking the problem into several modules and works on each module separately and to solve each module, treats it as a new problem that can itself be broken down into smaller problems. Repeat the process with each new module or until each can be solved directly, without further decomposition. Structured software design is arranged hierarchically i.e. modules are

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arranged hierarchically. There is only one root (i.e., top level) module. Execution begins with the root module. Program control must enter a module at its entry point and leave at its exit point. Control returns to the calling module when the lower level module completes execution. In the RH controller, the main module has a major role, initialization and wait for one of the 14 key commands and if any key pressed, the corresponding module to the key is executed.

When the power is on, the initial module code is run and displays the message "welcome" for a duration of 5 seconds and then the LCD displays a message "Please Press Any Key". RH controller system waits for an external event to occur. If any key is pressed, the data (code) is read from one of the ports of 8255 IC, depending on the address, the respective finger or wrist or base is identified. The addresses vary from digit to digit, for base and wrist and they differ even to open or close. For example, the key data is 1E, the operation is Fore Finger close whereas the data is 1F the operation is FF open. An infinite loop executes until any key is pressed.

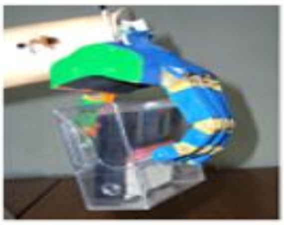
The control software for FFRH is developed in 89V51RD2 ASM language. Software tool used to reduce the program is Keil-IDE. Hex Code is generated by the Keil-IDE and it is burned into flash memory of 89V51RD2 using the Flash Magic Software. RH controller contains five major software modules such as Initialization, Display, Input status reading, and Individual joint control using Key Pad. The key board module is subdivided into small division like finger module, wrist module and base module.

**Experimental Results:**

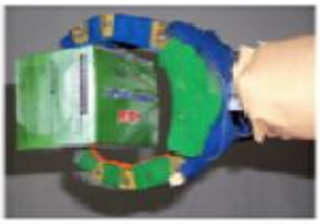
To test the grasping ability of the Robot hand, it was made to grasp different objects, each having different shape, size, surface conditions and hardness. The object was held so that the center of mass was within the workspace volume of the thumb and fingers and oriented to grasp so that the major axis of the object was parallel to the palm and aligned with the fingers. Once the objects were crudely positioned in the work space of hand, the hand was issued a pick and place command from the key board of the FFRHC system.

Different objects such as shown in bellow figures

a) Egg

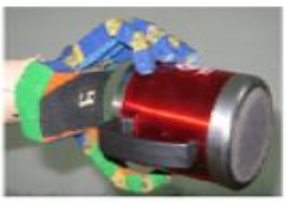


b) Floppy box



c) Power supply Box

d) Mouse



e) Pen Stand

f) Spray Can

## II. CONCLUSION

FFRH has been designed, built and tested. The robot hand movements operations with respect to all joints and objects detection, grasping and releasing different types of objects are tested. A good repeatability for every task performed is obtain. The maximum load of 0.75 kg is tested and succeeded in lifting the object of the same pay load. Object is arbitrary and tested the same and photographed are presented. The two test size restrictions on objects. Experiment are performed for grasping spherical objects. Maximum dia. of sphere is 120 mm and minimum dia. of sphere is 30 mm, is observed for any objects. The aspect of this design is that the ranges of weight can be increased by adding powerful motor and cables of higher tensile strength. Since these motors are mounted remote, they do not add to the load of manipulator.

In addition, the proposed artificial biometric tactile systems could be helpful to developing and implementing a low level embedded controller of a biomachatronic or robotic hand this kind of controller automatically adjusts grasp configuration and forces in a coherent way based on tactile events and thus leaves to the patient only the high level control of device. It has been demonstrated that this hand can grasp a variety of objects with different surface characteristics, size and shapes without having to reconstruct a surface description of the object.

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