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Humanoid Robotic Arm for Tactual Interaction with Industrial Environment by using Mobile

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ABSTRACT

The general aim of our research is to build up a "Humanoid Robotic Arm" from the garbage materials which can support people in their daily life and also in industry. The vital component of such a robot for handling objects is the construction of its arm gripper. The design of our Robotic Arm is based on the observation of the motion range of a human arm. We have tried to depict simple mechanical knowledge to build this arm. Five DC motors are used here in five Gear boxes. The gear boxes are for the base of the arm, for the elbow, joint, shoulder joint, wrist joint and for the Gripper. Ball bearing is used here to rotate the arm 360 degree. And the brain was given to it by circuit board. The whole system is controlled by using a Mobile. We need two microcontrollers here. The used microcontrollers are PIC16F872 for receiver and PIC16F84A for controller. The designed manipulator able to perform various industrial tasks as per requirement and it has large industrially application on material handling and positioning any object or job. If we can utilize properly, industrial robots can enhance the perfection of life by releasing workers from scruffy, tiring, risky and heavy labor. In the modern world robots can cause unemployment by substituting human workers but robots also create jobs for engineers, programmers, supervisors or as a robot technician. In the era of industrial revolution in Bangladesh the uses of this kind of technology is increasing day by day.

Keywords: *Humanoid robot, Degrees of Freedom, Robotic arm, Basic design, Mobile, Various types of joint.*

1. INTRODUCTION

We humans are fortunate. The human body is, all things considered, a nearly perfect machine: it is (usually) intelligent, it can lift heavy loads, it can move itself around, and it has built-in protective mechanisms to feed itself when hungry or to run away when threatened. Robots are often modeled after humans, if not in form then at least in function. The word "Robot" was first used in a 1921 play titled R.U.R. Rossum's Universal Robots, by Czechoslovakian writer Karel Capek. For decades, scientists and experimenters have tried to duplicate the human body, to create machines with intelligence, strength, mobility, and autosensory mechanisms. Ishii, C [1] developed a robotic hand with new bending mechanism. I.B Celik [2] worked on development of a robotic arm controller by using hand gesture recognition. Mr. Bhushan C. Patil, Mr. Rabinder Henry [3] did their job on the Dual functional reconfigurable mobile robot. They focused on designing flexible mobile robot & various issues related to interfacing various modules with CPLD (Complex Programmable Logic Devices). Guangming Song [4] promoted the surveillance robot with hopping capabilities which was adopted with the Zigbee technology for wireless communication. His powerful home security robot could leap over particles more than 4 times its own size.

Reference [5] provides a brief description of the software framework of the arm of Robo-Erectus Senior- an Adultsize Soccer Playing Humanoid Robot. Patel [6] developed prototype provides total 5 Degrees of freedom within the Humanoid Robotic Arm.. The combat robot [7] which was radio operated had all the controls like normal car. Rong Xiong [8] worked with the Humanoid robot for table tennis playing. Reference [9] stands for the distance controlled rescue robot by using cell phone.

In our work we are controlling a Humanoid Robotic Arm by using mobile which can lift about 20kg at a time. And the design is almost same to the humanoid arm, which will have the following joints: the wrist joint, the elbow joint and the shoulder joint. A healthy human arm has in average a range of motion in the shoulder of about 160° in horizontal flexion and horizontal extension, 240° in forward flexion and hyperextension; the medial and lateral rotation is about 160°. The normal range of the elbow is 150°; the wrist has 70° in the radial deviation mode, 170° in flexion/extension and a maximum wrist rotation of 270°. The so-called anthropomorphic mechanisms, developed in industrial robotics, which must provide a good dynamic performance, are usually very simplified and are in mechanical sense only a rough copy of the human arm.

2. MECHANICAL CONSTRUCTION

A. Material selection

Material selection is a very important part in our research work. We have selected right kind of materials for right place. Our target is to collect the materials from unused product sources around us. Such as unused gear and bearing from the automobile workshop, remaining Particle board from furniture shop, Stainless Steel from unutilized pipes real estate industries etc.

But we also make some parts like rack gear as they were not precisely available. As we are considering the cost and the finishing, we are mainly using:

- Aluminum,
- Stainless Steel,
- Plastic,
- Cardboard etc

B. Basic Design

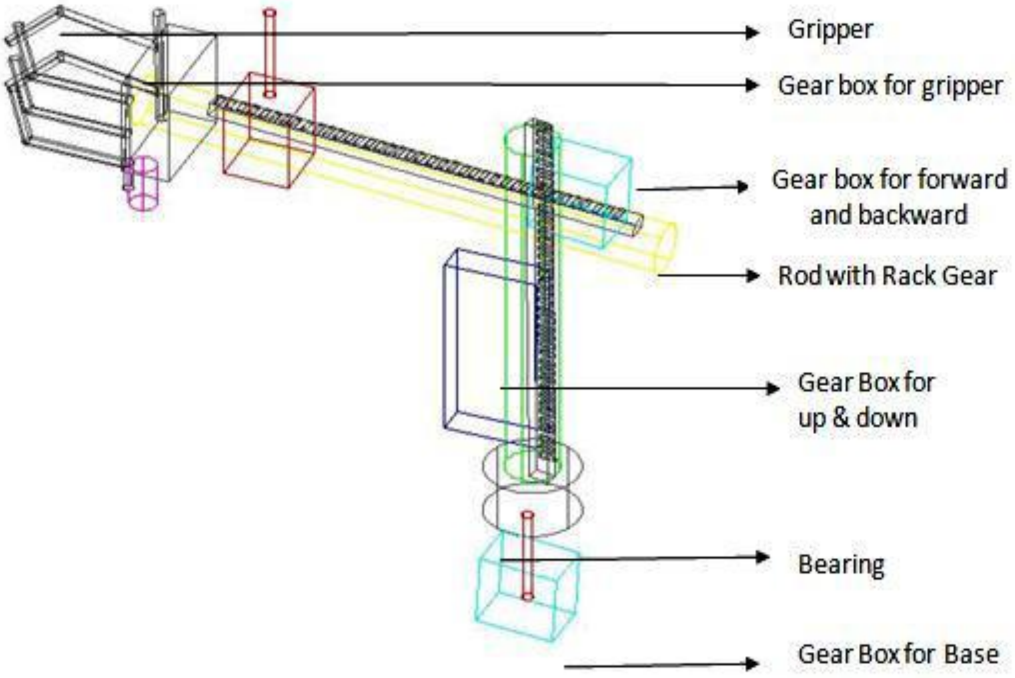

Fig.1. Basic Design of the Robotic Arm

3. CONSTITUENT SUB MODULES

A. Base Designing

A Particle board have used here as the base. The dimension of the base is 34 inch by 38 inch. It has four legs. This will help it to carry its total weight and to do any job perfectly. We have choosen particle board because it is chaeper and also good looking. The gear box for the base of the arm is connected with it. The box lies under the board which is connected with the bearing by a motor shaft. So the arm can rotate at a 360˚ angle. The four legs were connected with the boardby nuts. Some drills were made to pass the wires.Our base is little large because the arm is much heavier and the size of the arm is also large.

B. Degrees of freedom

Human Arm has two major joints: the shoulder and the elbow (the wrist, as far as robotics is concerned, is usually considered part of the gripper mechanism).Human shoulder can move in two planes, both up and down and back and forth. The elbow joint is capable of moving in two planes as well: back and forth and up and down. The joints in arm, and ability to move them, are called degrees of freedom [10]. Human shoulder provides two degrees of freedom in itself: shoulder rotation and shoulder flexion. The elbow joint adds a third and fourth degree of freedom: elbow flexion and elbow rotation. Robotic arms also have degrees of freedom. But instead of muscles, tendons, ball and socket joints, and bones, robot arms are made from metal, plastic, wood, motors, solenoids, gears, pulleys, and a variety of other mechanical components. Some robot arms provide but one degree of freedom; others provide three, four, and even five separate degrees of freedom.

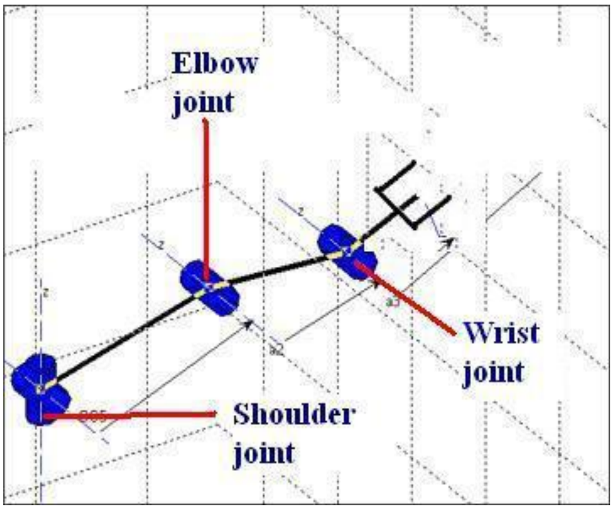

Fig.2.Various joints of an Arm

C. Shoulder Joint

The shoulder joint is a shaft that connects to a bearing mounted on the arm base the robot. Attached to the shaft is the drive motor for moving the shoulder up and down. In the arm for this research, the output of the motor was approximately 20 rpm, or roughly one-third of a revolution per second. For a shoulder joint, 22 rpm is a little on the fast side. We chose a gear ratio of 3:1 to decrease the speed by a factor of three (and increase the torque of the motor roughly by a factor of three). With the gear system, the shoulder joint moves at about one revolution every eight seconds. That may seem slow, but the shoulder joint swings in an arc of a little less than 50°, or roughly one-seventh of a complete circle. Thus, the shoulder will go from one extreme to the other in under two seconds. The size of the gear used here is approximately 62 mm (dia) .Number of the teeth are 60. The gear box should be powerful because it has to carry the most of the load. In the box we have used worm gear. We did this for the alignment of motor. We used ball bearing which is necessary to rotate the arm at 360˚.

D. Worm Gear

A worm is a gear [11] that assimilates a screw. A worm is usually meshed with an ordinary looking, disk-shaped gear, which is called the "gear", the "wheel", the "worm gear"[12] [13], or the "worm wheel". The prime feature of a worm-and gear set is that it allows the attainment of a high gear ratio with few parts, in a small space. Helical gears [14] are, in practice, limited to gear ratios of 10:1 and under; worm gear sets commonly have gear ratios between 10:1 and 100:1, and occasionally 500:1.In worm-and-gear sets, because the worm's helix angle [14] is large, the sliding action between teeth is considerable, and the resulting frictional loss causes the efficiency of the drive to be usually less than 90 percent, sometimes less than 50 percent.

E. Elbow Joint

The elbow joint is attached at the top of the shoulder. The elbow is constructed much like the shoulder arm. The construction of the gear box of the elbow joint gear box is little different from the shoulder gear box. The main purpose of the gear box is to help the arm to move forward and backward. The gear used here is of 52 mm in dia and the number of teeth are 50.

F. Wrist joint

The most important joint of the arm is the wrist joint. It will help the gripper to move rightward and leftward. So that the arm can do special job like pouring water. The construction of the box is almost the same of the shoulder and the elbow joint gear box. The size of the gear box has gears of 43 mm and 38mm in dia and number of teeth are 46 and 36 simultaneously. It is fitted with the upper arm horizontally. The final output shaft of the box connects the Gripper box.

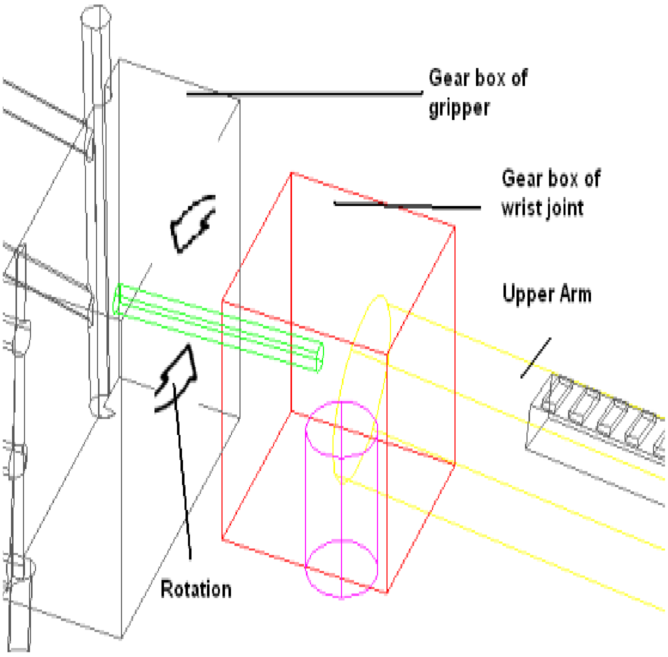

Fig.3. Connection of Wrist joint and Gripper joint

G. Gripper Joint

In the Robotics world, hands are usually called grippers (also end effectors) because the word more closely describes their function. Few robotic hands can manipulate objects with the fine motor control of a human hand; they simply grasp or grip the object, hence the name gripper. Gripper designs are numerous, and no single design is ideal for all applications. Each gripper technique has unique advantages over the others. We used the clapper type Gripper here. We used three fingers on one side and two fingers on the other side of the gripper base. So, it supports well to hold the object. The gear box of gripper joint [15] works on simple method. The box is powered by a simple DC motor. The motor shaft is connected with a Spur gear which is vertical. It is again connected with a worm gear by a shaft. Two spur gears are connected with the worm. As the worm rotates, it also rotates the spur gears in different direction. So, when the motor is powered positively then the grip opens and when the motor is powered negatively then the grip closed. Here all the gears are 43 mm in diameter which have 36 teeth.

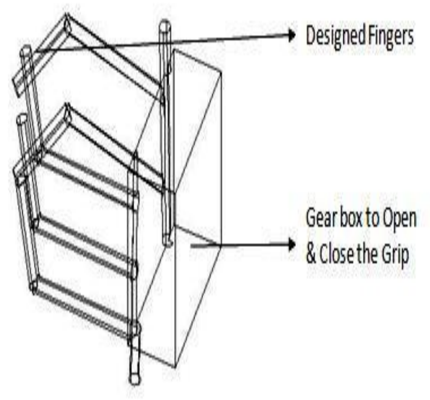

Fig.4. Basic Design of the Gripper

4. CONTROL ALGORITHM

We are controlling a robot by using mobile through wireless communication system, which is known as DTMF system [16]. According to the generated DTMF frequencies by pressing the keypad on the mobile phone we can control the motors behavior The heart of our humanoid robot is two Microcontrollers, which is configured by programming in the Micro C Pro, an advanced C compiler for the PIC Microcontroller Unit. One is for Receiver and another one is for Transmitter. We used PIC16F872 for the receiver and PIC1684A for the transmitter. Algorithms for receiver and transmitter microcontroller are shown in figure- 5 and figure-6 respectively.

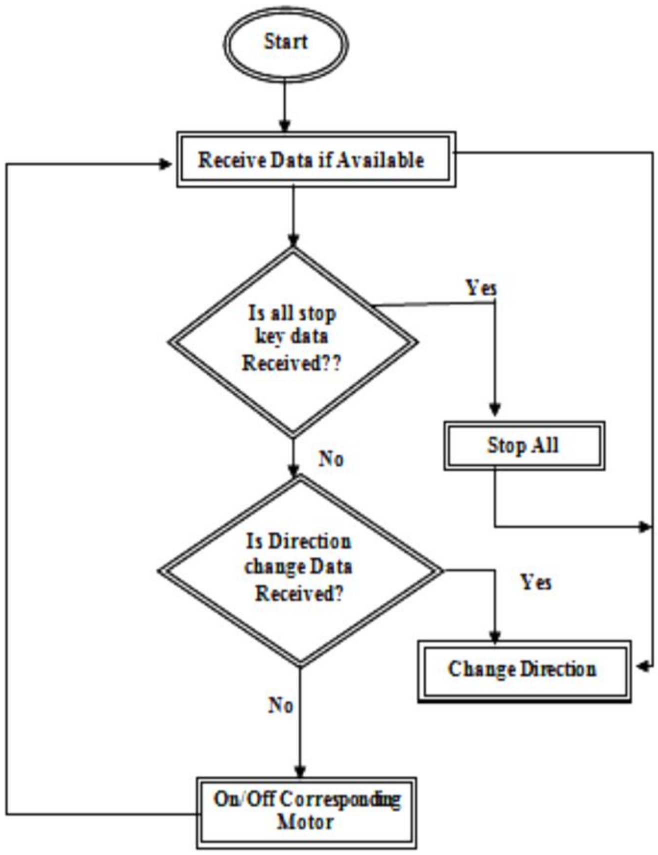

Fig.5. Flowchart algorithm of receiver microcontroller

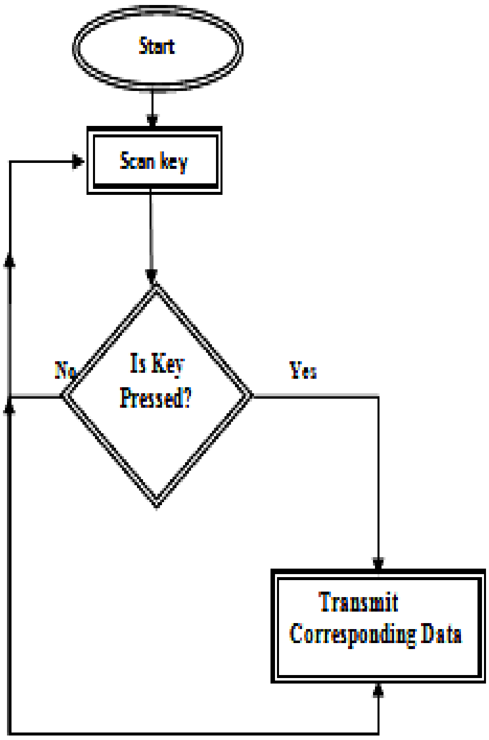

Fig.6. Flowchart algorithm of transmitter microcontroller

5. CONCLUSION

The Humanoid robotic arm have successfully been designed and constructed from the unused materials around us. So it tremendously reduces our cost and it also has a positive impact on environment, as the garbage industrial items are not misusing. In this design, the main support structure of the robot can be considered an exoskeleton because it is outside the "major organs." The motor of the base is capable to make movement of the arm 360° both clockwise and anticlockwise. The second and the third motors are for the shoulder joint and the elbow joint. The fourth motor is mounted on the wrist joint and the fifth motor is used for the gripper. All the control signals are created from a mobile phone and passes to the robot arm through a control circuit. The used microcontrollers [17] are PIC16F872 for receiver and PIC16F84A for controller, which are configured by programming in the Micro C Pro, an advanced C compiler for the PIC Microcontroller Unit. Our designed robotic arm provides wide range of omni-directional coverage over three dimensional spaces. Practical illustration shows that our implemented robotic arm can lift about 20kg at a time. In the heavy load situation this robotic arm plays a vital role as well as works as a helping hand in the industrial sector with providing delicate continuous safe interaction with manufacturing and at the same time in production atmosphere.

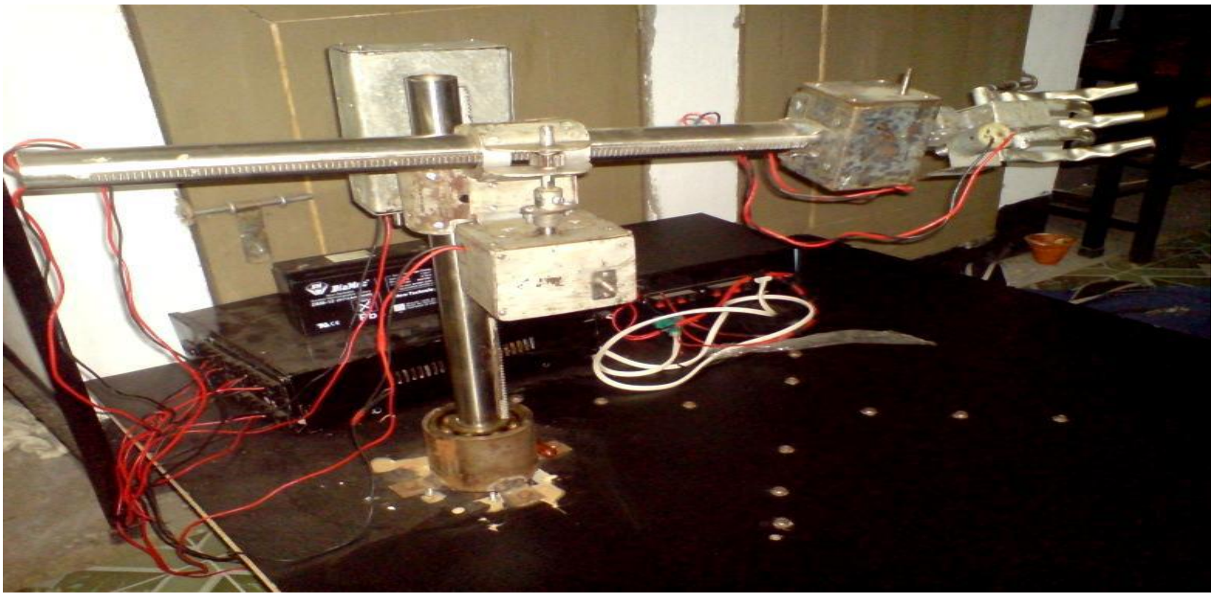

Fig.7. Final picture of Humanoid Robotic Arm

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