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DESIGN & FABRICATION OF A ROBOTIC ARM MODEL WITH MAGNETIC GRIPPER

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Abstract*- Repetitive tasks and high accuracy have become the two contradictory needs of any industrial process. By introducing autonomous robotic applications, simple repetitive tasks can be accomplished keeping the demands of the accuracy and speed. This paper represent the design, fabrication and control of a model robotic arm which is used to loading and unloading the light metal sheets with magnetic gripper. Two servo motors act as actuators to control the motion of the arm and the orientation of the wrist. The arm is used to lift the sheets and finally unload them in its final destination. The actuator control is achieved using a microcontroller. The end effectors to grip, transferring and unloading the objects are magnetic which is made by relays. This research can play a vital role in the sector of industrial process automation. The arm can move in two direction radial about 270 degree as well as vertical about 180degree*

Keywords: Repetitive Tasks, Autonomous, Magnetic Gripper , microcontroller and Actuator

1. INTRODUCTION

A qualitative comparison of the cost effectiveness of manual labor, hand automation and soft automation as a function of the production volume [1]. The robot can convey many different meanings in the mind of the reader, depending on the context.[2] Here, a robot will be taken to mean an industrial robot, also called a robotic arm.

Robots have replaced humans in the assistance of performing those repetitive and dangerous tasks which humans prefer not to do, or are unable to do due to size limitations, or even those such as in outer space or at the bottom of the sea where humans could not survive the extreme environments. So the development of robotic field means development a country. For automaton the industry, robot plays a vital role. In this sector a robot can do the work of hundred workers at a time.

A robotic arm is a type of mechanical devices which is an industrial robot, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effector and it is analogous to the human hand. In many industry human can be replace by robotic arm because of its low cost and low time consuming for loading and unloading metallic goods.

There are concerns about the increasing use of robots and their role in society. Robots are blamed for rising unemployment as they replace workers in some functions. The use of robots in military combat raises ethical concerns. The possibility of robot autonomy and potential repercussions has been addressed in fiction and may be a realistic concern in the future.

The first robotic arm was developed in the 1950s by a scientist named George Devol, Jr.,[3] before which robotics were largely the products of science fiction and the imagination. The development of robotics was slow for a while, with many of the most useful applications being involved with space exploration. The use of robots to aid in industrialization weren't fully realized until the 1980s, when robotic arms began to be integrated in automobile and other manufacturing assembly lines.

2. MAIN COMPONENTS

To make the robotic arm the following parts/components are required (as shown in Table 1).

Table 1: Parts/Components of the robotic arm

Servo Motor(HS-422)	Relay (6V)
LED (Liquid Crystal Display)	Resistance
LM7805 (Voltage regulator)	Power Supply
Regulator: constant 5V	Bero-board
Crystal (20 MHZ)	BC555(Transistor)
Servo Motor: +6V	Microcontroller
Microcontroller: +5V	

3. STRUCTURAL DESIGN AND FABRICATION

The top-down approach is employed in the design of the robot arm but the fabrication of the arm was done by component and the components were integrated to obtain the whole arm. The structure of robot arm is shown in Fig.1.

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The total mechanical structure of robotic arm is made by light wood. The lower base of robotic arm is 22.86cm diameter. The height of the columns are 21.59cm each which supports the upper base of robotic arm 17.78cm diameter. The arm of 27.94cm length is attached with the upper base. The actuators (two servo motors)are set up at middle of upper base for equilibrium. The motors are actuated by 5volt power supply. The servo motor which is attached to upper base is set at 180 degree angle by programming in the microcontroller. Similarly the second servo motor is set at 180 to 270 degree angle. For magnetizing the gripper, three relays are used which are act at 5 volt. The relays are attached to one another for magnetizing and they are capable for gripping any metallic object. The battery which is used to run the model is 5 volt and 1 ampere.

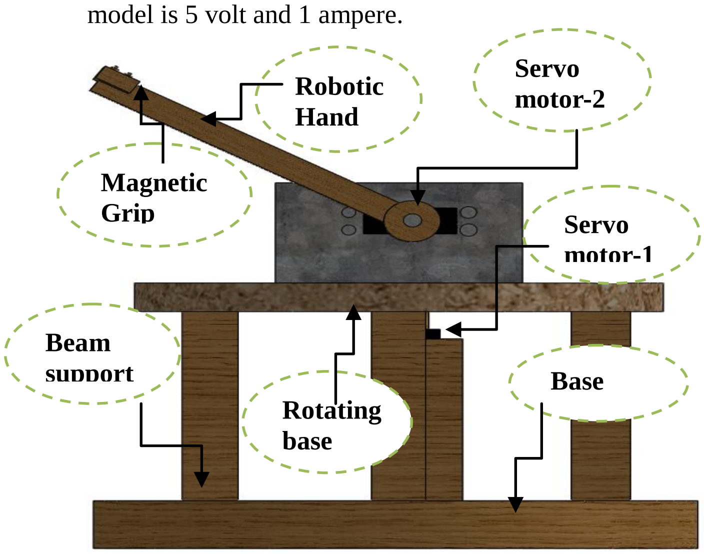
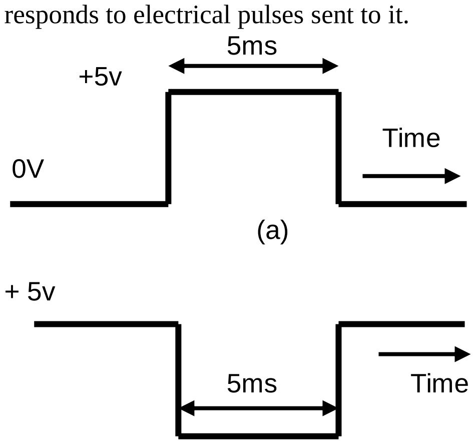


Fig. 1: Schematic diagram of the robotic arm

3.1 Actuators

A servomotor is a rotary actuator that allows for precise control of angular position. It is a specific type of motor and rotary encoder combination, usually with a dedicated, that forms a servo mechanism. Servomotors are used for both high-end and low-end applications .Each servo has a built-in processor that responds to electrical pulses sent to it.



(b)

Fig.2: High pulse whose pulse width (duration) is 5ms (0.005s) & Allow pulse whose pulse width is also 5ms in length

The microcontroller creates an electrical pulse by sending voltage to one of its pins for a very specific amount of time by the suitable programming. When the voltage is on, the microcontroller gives output +5V. When the voltage is off, 0V is output and it happens rapidly thereby creating pulses of HIGH and LOW voltages (Fig. 2).

The duration of these pulses is known as the pulse width. The longer the voltage is applied, the larger the pulse width. The pulse width is measured in seconds, but we often use milliseconds (ms) to describe them because the pulse duration can be very short. With Do-Loops and For-To-Next loops, the microcontroller can produce a series of pulses at a regular rate. This repetitive series of pulses is known as a ***pulse train*** (as shown in Fig. 3)**.**

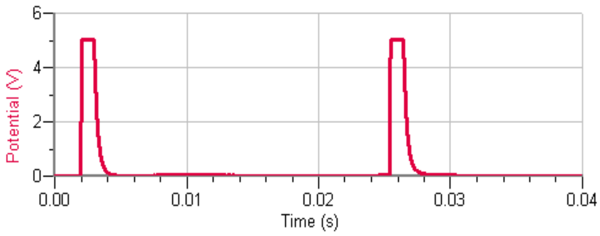


Fig. 3 : A train of 0.001s-pulses with a 0.020s delay between pulses as measured by an oscilloscope

Servos interpret pulse widths as positions. Each position along the arc traced out by the rotating shaft has a corresponding pulse width. When we send a pulse to the servo, the control board calculates which way the shaft should rotate in order to reach the corresponding position. There are two ways that servo motor wire their servos: positions increasing clockwise, and positions increasing counterclockwise (as shown in Fig. 4).

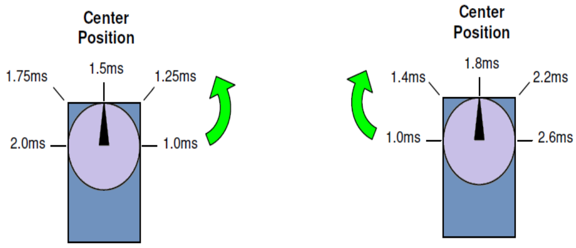


Fig.4: The pulse width positions of servo (clock wise & counterclockwise)

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3.2 Magnetic Gripper

A magnetizer is a device that stores electrical energy via capacitor or capacitor bank, with high current switching device to discharge the stored energy into the coil. To generate a pulse magnetizing field, two main components are necessary: a magnetizer and a coil. The magnetization coil is essentially a set of conductors configured to provide the correct orientation of the magnetic field to saturate the magnetic material.

Magnetizing coils are designed to give the necessary field strength in the proper pattern. Relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit

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by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a conductor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "relays". In this robotic arm three relays are used for proper magnetizing. By magnetizing any metallic object can be picked up (as shown in Fig.5).

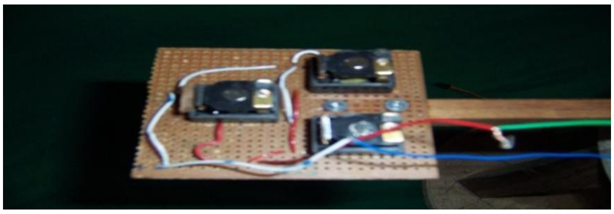

Figure-5 There relay for magnetizing

4. CIRCUIT DIAGRAM AND ELECTRONIC HARDWARE

4.1 Circuit Diagram

In this circuit, the microcontroller gives input to the servo motor by using port B. For this purpose pin B6and B7 are used. By the pin B4, microcontroller gives input to the magnet circuit with the help of transistor BC555. For magnetic signal LED (green) is used at the pin B4 between microcontroller and transistor. Here input voltage is 6V which is used for servo motor and transistor. Voltage regulator (LM7805) converts this 6V to the 5V for microcontroller (as shown in Fig.6).

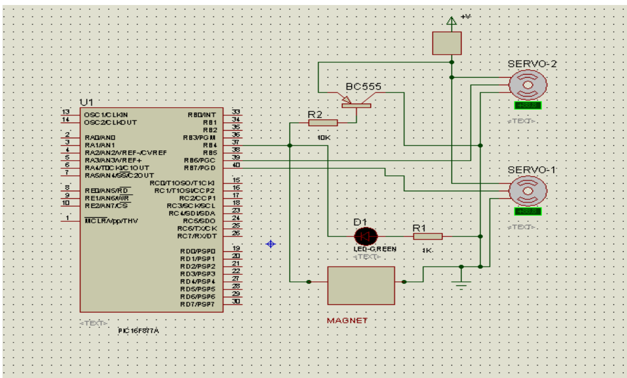

Fig.6: Circuit diagram

4.2 Electronic Hardware

The robotic arm is controlled by a microcontroller driving the actuators (servo motors) via latches and transistors. The microcontroller receives commands from the parallel port via infrared. Latches were used for de multiplexing, as only two 8-bit microcontroller ports were used to drive two motors. For the transistors, a combination of npn/pnp power and switching transistors are used. The factors considered in choosing these were current (ampere) rating, voltage rating and switching speed. Switching speed of the transistors was a crucial factor as it determined how fast I could drive the servo motors run, hence, the speed of robot arm movements. Suitable IC packages with multiple transistors were used to achieve more compact control circuit. The electronic hardware device (as shown in Fig.7) was used in the robotic arm.

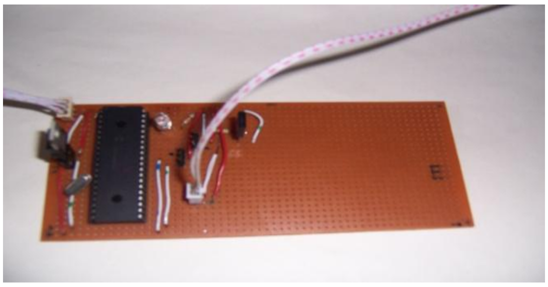

Fig.7: Electronic hardware device

5. WORKING PRINCIPLE

The robotic arm (as shown in Fig.9) acts just like a human hand. It has gripping power due to magnet. By the gripping, it can hold light metal sheet on moving position. After a time interval the power of the magnet is on and it holds a sheet metal to carry it form one position to another position.

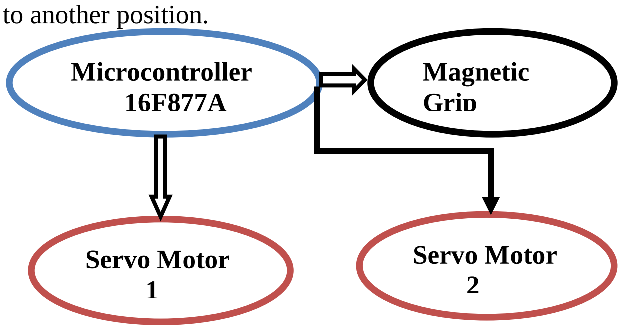

Fig. 8: Block diagram of robotic arm

Fig.9 Photo grapey of the robotic arm

For transport the sheet metal, two servo motor are used here. One servo motor rotates horizontally which take the hand to the horizontal position and another rotates vertically which take the hand to the vertical position.

This phenomena occurs randomly in a loop (as shown in Fig.8). The total system control by microcontroller. The microcontroller is preprogrammed to take a decision for any give input and outputs its decision to the motors and magnetic grip. When the hand placed its right position, microcontroller gives the output for on the magnetic grip. For swishing the motor BD555 Transistor is used here. LM7805 is used for continuous power supply in the circuit.

6. DISCUSSION

The aim of this research was to design, fabrication and control a model robotic arm which is used to loading and unloading the light metal sheets with magnetic gripper. The works are completed by considering some factors which is given below:

- The robotic arm is made by light wood.
- The length of arm is selected very carefully because of avoiding heavy weight.
- The diameter of upper base of robotic arm is selected comparatively small because servo motor which is used in my project can rotate only 5kg-6kg load.
- The height between upper and lower base of model is made by hard wood for stability.

The structure of robotic arm is made by light wood. The arm attached with the upper base is used to lift the metal sheets and finally unload them in its final destination. Two servo motors act as actuators to control the motion of the arm and the orientation of the wrist about 180 degree. For magnetizing the gripper, three relays are used. The robot control is achieved by using a microcontroller. The arm can move in two direction rotational (about 270 degree) as well as vertical about 180 degree).

7. CONCLUSION

Repetitive tasks and high accuracy have become the two contradictory needs of any industrial process. By introducing autonomous robotic applications, simple repetitive tasks can be accomplished keeping the demands of the accuracy and speed. From this requirements the objectives are set and the research works (design, fabrication, installation and controlling the robotic arm) have been done successful. From the above discussion the following conclusion can be drawn.

a) The mechanical as well as electrical construction of the robotic arm is very simple.
b) The robotic arm can loading and unloading the light metal object by magnetic gripper.
c) The arm can move in vertical direction up to 180 degree
d) The arm can also move in radial direction up to 270 degree
e) The speed and directional control of the arm can be easily done by the program of the microcontroller.
f) This research can play a vital rule in the sector of industrial process automation.

8. ACKOWLEDGEMENT

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