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Hydraulic-Powered Robotic Arm

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Abstract-*Have you ever seen a car lifted into the airat an auto repair place? Have you ever wondered how an elevator can lift a load of people up into the air? Well, the answer is hydraulic systems. Hydraulic systems use a liquid, usually oil, to transmit force. This system works on the same principles as other mechanical systems and trades force for distance. Hydraulic systems are used on construction sites and in elevators. They help users perform tasks that they would not have the strength to do without the help of hydraulic machinery. They are able to perform tasks that involve large amounts of weight with seemingly little effort. This work illustrates a simple approach to demonstrate the principle of hydraulic power by manufacturing and operating a robotic arm model from simple and recycled materials.*

***Keywords*—Hydraulic power, Robotic arm, Simple materials.**

1. INTRODUCTION

Generally, there are two methods for power transmission, namely: hydraulics and pneumatics. Hydraulics involve movement by fluid under pressure. Pneumatics involve the mechanical properties of air and other gases. Engineers develop hydraulic arms for a variety of reasons. Hydraulic arms can be used in situations that are too difficult or dangerous for people to deal with directly or in automated systems. Examples include arms that lift heavy weights and arms that hold a load and unload them into a specific position.

The science behind hydraulics is called Pascal's principle. Essentially, because the liquid in the pipe is incompressible, the pressure must stay constant all the way through it, even when you're pushing it hard at one end or the other. Now, pressure is defined as the force acting per unit of area. So, if we press with a small force on a small area, there must be a large force acting on the larger area to keep the pressure equal. That is how the force becomes magnified. Other details concerning hydraulic power and applications can be found.

The present work involves constructing and operating a mechanical arm that lifts and moves small objects such as soda can, matches box, *etc.*, using hydraulics for power. It is a simple demonstration device for engineering education. The work includes construction of: (*i*) Single axis for use in the completed mechanical arm, (*ii*) Grasping hand, (*iii*) Lifting arm, (*iv*) Rotation base.

1.1. TOOLS AND MATERIALS

It should be noted that pieces of wood, cardboard, or hard plastic may be used. The tools and materials of this work can be listed as:

1.Eight plastic 10 *ml* syringes with rubber piston, Fig. 1a.

2.Two pieces of cardboard (0.20×0.20) *m*, Fig. 1b. 5- Two pieces of cardboard (0.25×0.05) *m*, Fig. 1c.

3.Two pieces of cardboard (0.30×0.05) *m*, Fig. 1d. 4. Two pieces of cardboard (0.20×0.05×0.10×0.15) *m*, Fig. 1e.

5.One piece of cardboard (triangle), Fig. 1f.

6.Two pieces of cardboard (0.06×0.04×0.03) *m*, Fig. 1g.

7.Flexible transparent rubber tubes.

Fig. (1.a)

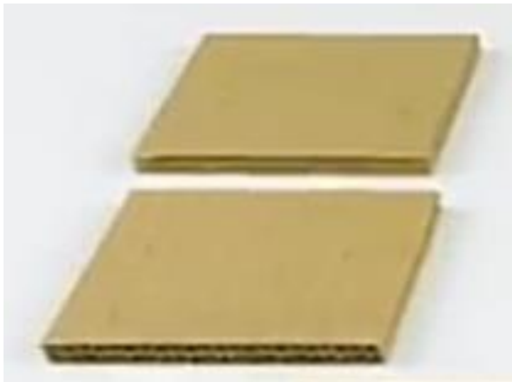

Fig. (1.b)

Fig. (1.c)

Fig. (1.d)

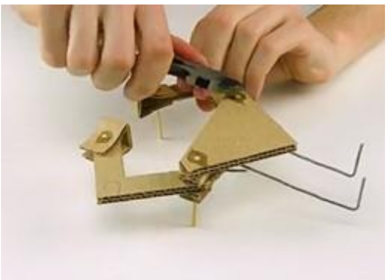

Fig. (1.e)

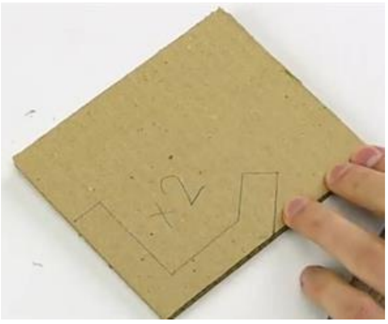

Fig. (1f)

Fig. 1. Some of the tools and pieces used for the hydraulic-powered robotic arm model.

1.2ASSEMBLY OF THE PRESENT MODEL

A Parts Assembly

The two large pieces of cardboard are simply glued; one on top of the other. A hole is drilled in the middle of them to fit a used battery, Fig. 2a. This battery is used to fix the other parts of the arm on the base.

The grasping hand is assembled using small pieces of cardboard and suitable glue as can be seen in Fig. 2b, which shows a triangular piece of cardboard, two paper clips, and the claws themselves. Also, assembly requires five pairs of Popsicle sticks with two or three layers of cardboard in between in the middle bit; one to turn the arm and four for the "remote control".

Then, pieces are glued together starting with the upper arm because this is the narrowest part, Fig. 2c. Yet the syringes have to be fitted between both sides. From there on, parts are glued till the grasping hand at last.

Four plastic syringes are used to move the four mechanisms which govern the model movement. Each syringe is fixed in its proper location using suitable accessories, Fig. 2d.

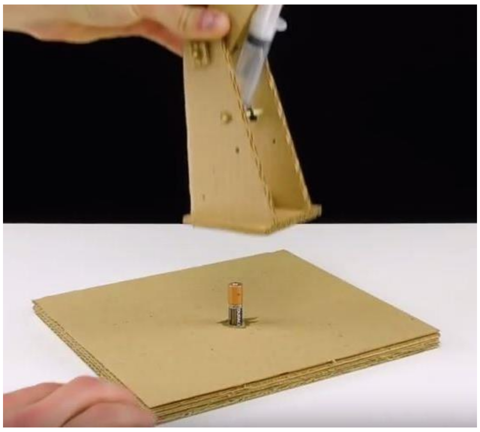

Fig. (2a)

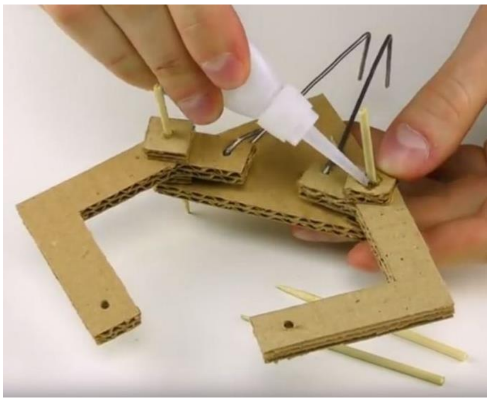

Fig. (2b)

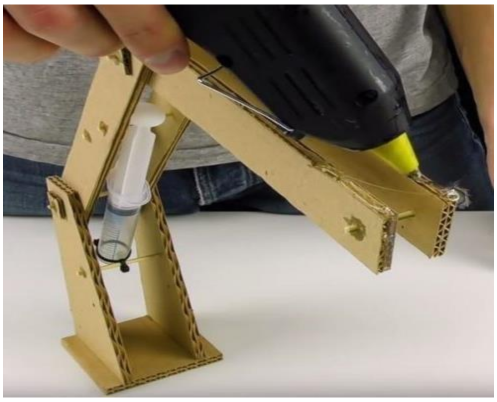

Fig. (2c)

Fig. (2d)

Fig. 2. Assembly of the main parts.

B. Powering up the Hydraulic Arm

When everything is in place, it is time to add the hydraulic fluid. In real equipment, this would be top grade hydraulic oil. But, here, water is used instead. Four different color of water are used by means of food coloring.

Then, the four unused syringes are carefully filled up and connected with the other four syringes of the mechanisms with the flexible tubes.

To make things a little more comfortable, a simple remote control unit may be built. Yet again two big pieces of cardboard are needed as base and zip ties to fix the syringes. Using the four leftover pairs of Popsicle sticks, levers can be built, Fig. 3.

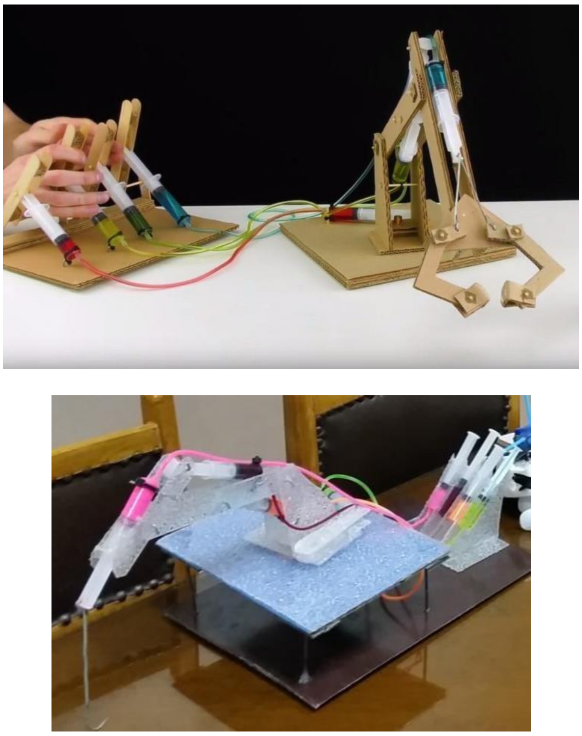

Fig. 3. Powering up the hydraulic arm model [6].

2. TEST AND OPERATION

A. Present Model

Three tests were successfully applied to the model as following:

1- When pressing on one of the syringe and related to another syringe located between the arms, it produces a force to move one of the arms up or down.

2- When pressing the syringe that relates to the grasping hand, it works to close and open the grasping hand to hold things.

3- When pressing on one of the syringes, which is related to another syringe responsible for model rotation, it produces a force to rotate the model.

Figure 4 illustrates the test of the present model.

A complete cycle of operation is shown from Fig. 4a to

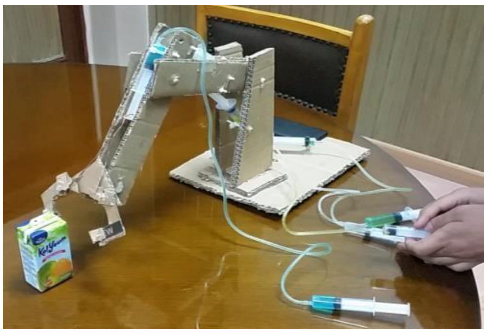

Fig. (4a)

Fig. (4b)

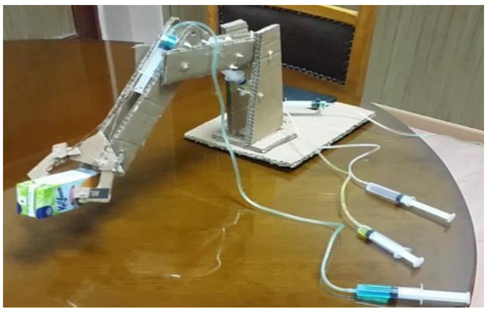

Fig. (4c)

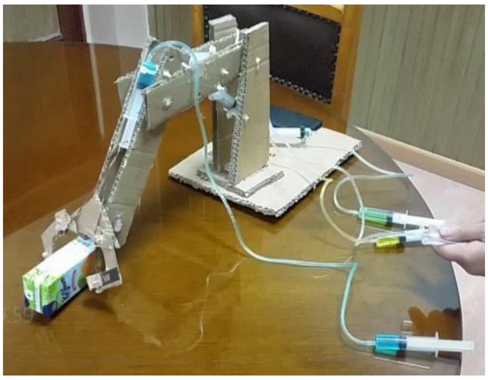

Fig. (4d)

Fig. 4. A complete cycle of model operation

B. Other Models

Based on the success of building and operating this model, other models were also built by other. Some of these models are shown in Fig. 5.

Fig. (5a)

Fig. (5b)

Fig. 5. Some models that were built by other students.

3. CONCLUSIONS

After testing the present model and based on the above illustrations and observations, the following points can be stated:

1. The design of the present model is easy and simple for manufacturing and implementation.
2. Low-cost and even recycling materials can be used to produce this model.
3. Due to its small size and weight, this model can be used anywhere.
4. This model is an effective and simple tool to educate the concept of hydraulic power to engineering students.
5. The grasping hand can be replaced with a shovel or a pontoon used in the drilling for wider demonstration.

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