

Using Servo for D&T Projects

~ How to get started ~

An Introduction

A servo is not a simple motor although it may work like one. From the outside, it resembles a rectangular black box. Within the box is a small DC motor with a gear-train and an electronic circuit to control the movement of the motor in a very precise way. It is therefore an electro-mechanical device. It accepts an electrical signal to move an output disc or arm. The output can then be linked to other mechanism to do useful work. Servos are used in the industries to operate valves, like those in petroleum refineries and on board crude oil tankers. Smaller servos find applications in radio-controlled models like airplanes and robotics. We shall take a closer look at these hobby servos and see how they can be used in D&T projects.



Servos with disc and horn



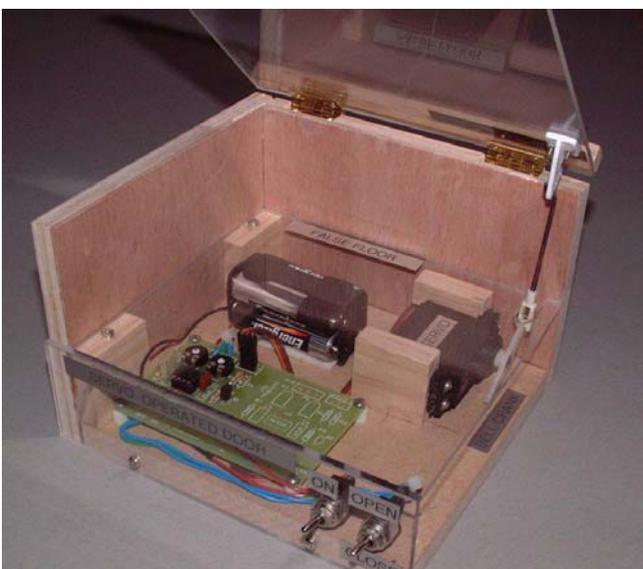
Different sizes of servo

D&T Projects

Servos are useful in D&T projects because they are small and sufficiently powerful to move light mechanisms like levers, cams and cranks. Once they are set up properly, the project can be expected to operate reliably for some time. The output motion in a servo is always rotary, but when a connecting rod is attached to the output disc, the rotary motion is transformed into a linear movement.

Lever: This first example uses the classical third class lever to open and close a door. The effort is placed between the load and pivot; the effort being the force coming from the servo and the load is the weight of the door. The hinge is the pivot.

To use the servo effectively in this project, the factory installed output disc is replaced with a long horn. It is then placed near to the pivot so as to maximize the travel available from the servo output. A connecting rod is attached between the servo horn and the door at a point close to the pivot (hinge line). Once the mechanical parts are in their places, the rotary travel of the servo horn is adjusted so that the resultant linear motion is sufficient to open and close the door.

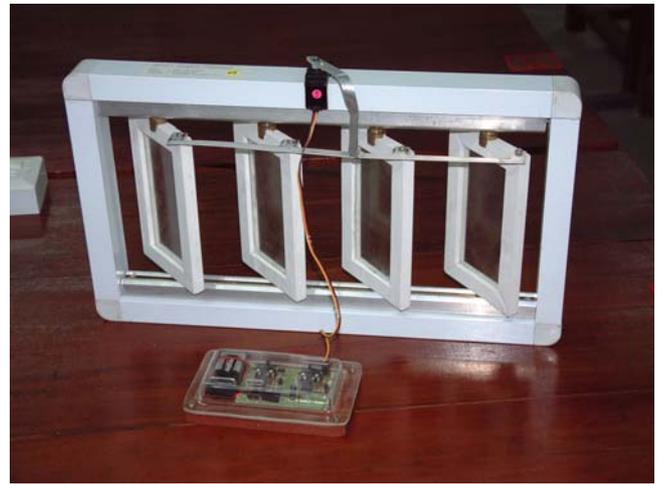


Lever operated door



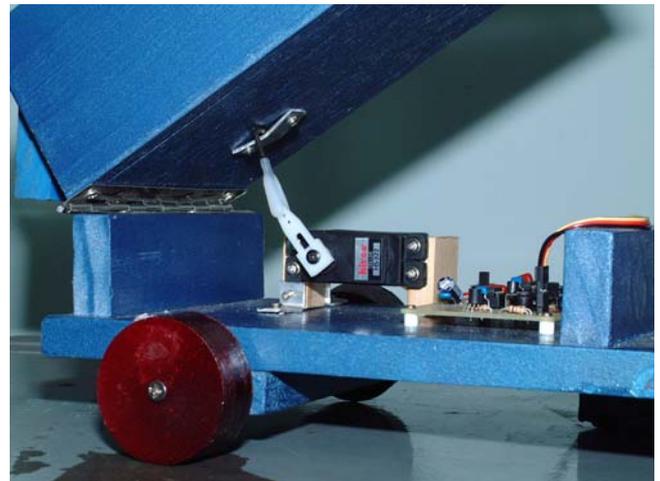
Lever in open position

Swivel windows: The aim here is to mechanize the operation of a louver window. The individual louver panes are mechanically linked so that a single linear motion is capable of moving all the panes. An arm connects the servo output disc to the link of the window panes. When the servo rotates, motion is transferred to the window link to open and close the panes. It is a neat way to motorize a traditionally manual job and is useful for windows that are out of normal human reach.



Swivel window

Tipper truck: The student has decided to jazz up his toy truck project so that the bed can tip up and down like the real thing. The operating principle is similar to the lever project. The servo is installed below the bed and a connecting rod is attached between the servo horn and the bottom of the bed. In the normal position, the bed lies flat. When a switch is activated, the bed tips over and spill its content out.

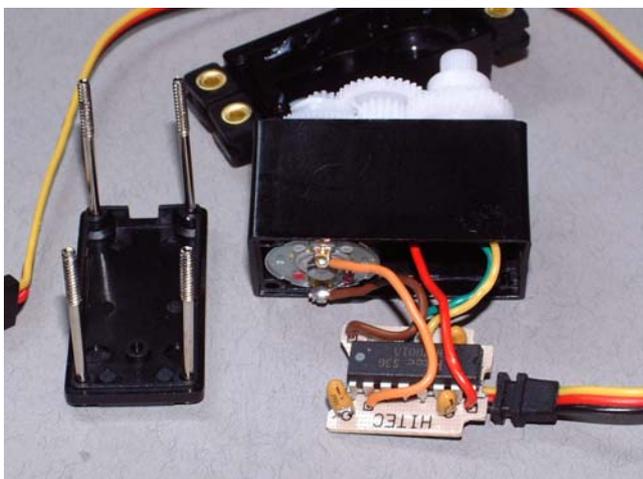


Servo operated tipper truck

A closer look at the servo

It is important to understand a little more about the servo before using it in a project. A standard hobby servo is capable of providing between 3 and 5 kg.cm torque. Therefore, the load that the servo is attached to must not exceed the torque value. Failing to observe this basic rule would result in a non-working project.

Parts of a servo: The mechanical movement is derived from the output disc. This can be replaced with horns that are supplied as accessories with the servo. The longer horn provides for further linear travel which is useful to move mechanism for larger distance. Generally, it is not advisable for you lengthen the horn as the output torque will progressively weaken. The servo must be mounted on the project firmly. It should not move under load. The control cable should be routed so that the insulation is not subject to abrasion or stress. Do not extend the cable on your own as this may lead to electrical contact problem.



Internal construction of a servo



Servo with horn selection

Important factors: There are other factors to keep in mind when using a servo. As part of the design process, ensure that there is sufficient space for all the necessary components. Beside the servo, there is the controller circuit board and batteries. You may also design a space to install the power and control switches.

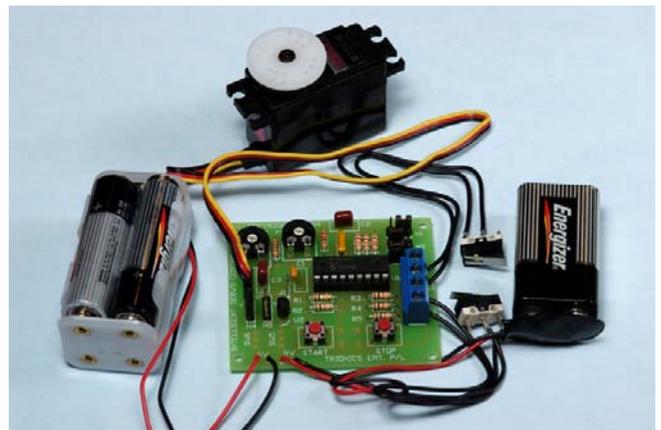
The design process

The success of a project depends on how carefully it is planned and thought through from the beginning to the end. If you should decide to use a servo in your project, it would further complicate the whole design. It is therefore important that you include the servo and all its components right from the beginning of the design stage. Do not treat the servo installation as the tail end of the project. To assist you in using a servo in your project, follow the outline below.

- Determine the correct torque of the servo for the expected load.
- Decide on the mechanical linkage between the servo and the mechanism. You may have to build a working model with cardboard to be sure that the travel distances come out right.
- Work out a detailed drawing of the mechanism with dimensions. This is to ensure that everything fit into the space allotted.
- Provide for sufficient space for all the parts including switches. Bear in mind that there is a control cable between the servo and the controller circuit. Work within the length of this cable.
- Plan an assembly sequence for your project so that you have access to the inside of the housing. This step is important as it allows you access to tight spaces and corners. Part of your project would have to be made such that they can be detached for repair or battery replacement. All this requires some planning before hand.

Intelligent Servo Controller

The servo controller circuit has been designed to effect the movement of the servo output in several ways. It is recommended that you attach the servo to the controller to test its various functions. Do this before you install the servo into the project. The details are in the instruction that accompanies the controller circuit. Please note that for the entire setup to work properly, the batteries must be fresh. The 9-volt battery is used to power the controller circuit. The four AA-batteries are for the servo. Both must be used at the same time. Mount the controller board in the project so that you have access to the controls P1 and P2. These are used to adjust the travel displacement of the servo output. At the planning stage, you may also want to include switches to control the function from a panel on the outside. Do not forget to include a power switch.



Intelligent servo controller

What does it control? The servo provides rotary motion. Straight from the factory, the output disc can rotate about 100 degrees. The exact angle of travel can be set with P1 and P2 on the controller. There are two other switches on the controller, one to start the servo in motion and the other to stop. There are seven different types of motion that you can programme with the jumper settings. These are explained in the instructions but the following paragraphs give some examples.

The possible movements: In our first example above, the controller is set to Manual Reverse Mode. In this mode, when the START button is pressed once, the servo rotates to the open position set by P2. When START is pressed a second time, the servo returns to the original position set by P1. This mode is very useful to operate lever mechanism.

Other possible movements include automatically oscillating between two positions, multi stops within one revolution and others.

Programming the controller: The controller circuit can be programmed by the placements of three jumpers. There are two positions for each of the three jumpers, yielding a total of nine possible combinations. At the moment, only seven are designed. The programme function also allows the controller to be reused in other projects.