Design of a Joystick

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Summary:
This application note is intended to be a guide for designing a simple joystick using all the necessary hardware components. This includes pictures of all the individual parts connecting in unison together.
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Introduction

In this application note, how to design a dual axis return to center joystick will be described. This is explained as a joystick that that moves in the x direction (left or right) and the y direction (up or down). A return to center joystick will automatically return to the neural or vertical position after letting go of the handle. Information regarding the background of a joystick will first be described and how they compare with everyday joysticks used today. The components for a joystick will then be listed with a complete set of pictures connecting together visually. The components within a joystick are not always unique; a set of possible modification techniques will be described for one’s expertise.

Background of a Joystick

A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it’s controlling. They are most often used to control video games with multiple buttons having a state read from the computer. Other common uses of a joystick include controlling machines such as trucks, cranes, and wheelchairs. The first one built was used for an aircraft’s flight control in communication with the wings, built in 1908 named Bleriot VIII. The name ‘joystick’ originated in the early 20th century by French pilot Robert Esnault-Pelterie, although there are many competing claims to the author of the name. Commonly most joysticks are two-dimensional, having two axes of movement, although some are built three-dimensional. Generally they are configured with moving the stick to the left or right in the X axis, and moving it up and down signaling movement in the Y axis. For three axes, the x, y, and z are used in an aircraft’s roll, pitch, and yaw. Another important concept developed is an analog stick developed for many video game consoles. These joysticks are built with continuous states, returning an angle measure of the movement in any direction of the given plane usually using potentiometers. The use of analog joysticks took the place of digital joysticks, which were limited to only four directions (left-right and up-down).
Hardware Components

There are numerous parts that go into building a joystick, although the parts listed are only for a dual axis and return to center joystick. Each part within a joystick works together like a puzzle and must be perfectly implemented to achieve the product. There are numerous ways to build a joystick, specializing in different areas of desire. Some focus on the range of rotation, control of the handle, or resistive forces within a given direction. Each part of the joystick is listed below with a picture of the object. A short description of what each part does and what it visually looks like is also described.

Figure 1 below shows all the parts connected for a joystick and where each part is in contact to one another.

Handle/Top – Where the user handles the joystick usually designed in a ball or bat top.

Stick/Shaft – connects the handle to the body of the joystick in a rod formation.

Figure 2. (From left to right) Shows bat design and ball design connecting to the shaft
**Pivot** – central point, pin, or shaft on which a mechanism turns or oscillates.

**Spring** – Used for sending the joystick back to the center position, which is located below the pivot.

![Figure 3. Shows Different Size and shape springs](image)

**Actuator** – Gives the bottom of the shaft more area and precision in pressing the switches.

**E-ring** – This is a type of fastener that attached to the bottom of the shaft, used for aligning and securing parts along it.

![Figure 4. Different Sized E-rings](image)

**Mounting Plate** – connected directly and securely to the control panel in the formation of a plate.

![Figure 5. Different mounting plates with unique cut layouts](image)
**Guide/Dust Washer/Disk/Cover** – Surrounding the shaft on top of the control panel, in the formation of a flat disk.

![Figure 6. Varying sizes of washers](image)

**Restrictor Gate** – Controls where the joystick can be moved, in the formation of a plate with holes cut within it.

![Figure 7. Restrictor Gate connected to the mounting plate](image)

**Other Parts** – This include the wire harness which controls the switches around the bottom of the joystick. Other designs include extra plates, different pivot possibilities, or securers along the shaft.

![Figure 8. (On left) A wire harness which can be used in many circuit based joysticks. (On right) All the various parts required in putting together a joystick](image)
Modifications of the joystick components

Every joystick has certain modifications that are used for different specialties whether it may suit the needs of a gamer or control the operation of a crane. These changes can be modified through the hardware components listed above. One design that can be modified is the spring, which can modify the tension on a joystick. This is important as it affects how smooth the movements of a joystick can be controlled, while being able to send the joystick back in a neutral position after letting go of it. Having a thicker/larger spring will result in making the reset stronger and movements more affected.

![Spring Image]

Like all joysticks the length of the handle can be modified, the mounting height, and even the durability of the material. Changing the resistor gates can give a completely different output as there are various modifications that can be used. They can restrict the area of rotation in any directions or even limit the number of positions the joystick can be moved.

Figure 9. (Below) Shows different types of restrictor gates used for various products

![Restrictor Gates Image]
Figure 10. (Below) Shows some of the limits that restrictor gates can give. The directions can be limited to two-directional, four directional, or even more. The reason to restrict certain directions can be used to reduce the number of mistakes one will need to do.

Conclusion

The joystick has been around for a long time and has reconstructed how we control objects with precise stability. Creating a dual axis and return to center joystick was shown in figures using all the necessary parts shown in figure 1. Joysticks are very unique as a cookie cutter design does not exist, where most people can make certain modifications to their desire. Changes in the exterior housing and internal components such as the spring/restrictor gates have been proven to be effective for customization for any uses. The design of a dual axis and return to center joystick has been described as a very simple tool and effective way of control.
References

Background of a joystick


Joystick components


Joystick attributes and brand parts


Information on restrictors