Control in the Palm of Your Hand

Selecting the right control interface can be the key to the success of a device. Without a control that provides the required amount of functionality for the intended application of the device, the unit becomes a less effective tool. This article reviews the available options with a joystick control and provides guidance on how to select the correct one.

By Jim Cooper

Joysticks have become the user interface of choice for many industrial and high-performance control systems. For applications as diverse as security-camera surveillance, motorized wheelchairs, microscopes, construction equipment, and submarines, joysticks provide the flexibility and precision needed by system designers and users alike.

With these applications, however, come increased requirements for reliability, durability, and overall quality. Manufacturers of front-panel control systems need an input device that matches the sophistication of their underlying control software, can stand up to continual use, and is a cost-effective component of the overall system.

The 9000 Series from APEM exhibits the critical features of a high performance joystick.

The joystick, as the primary interface between the user and the system, can literally make or break the device, and it presents one of the most prominent visual and physical attributes of the system, conveying a strong impression of the device's overall quality. User studies have shown that an interface that feels well-constructed will be treated as a fine piece of equipment, reducing abuse at the same time that it raises the product's image in the mind of the customer.

Selecting the Right Joystick

The intuitive nature of the joystick has made it a natural for precision control applications. Joystick manufacturers have expanded upon the basic functionality to create a range of specialized products, adapting everything from the core materials to the overall look and feel, to meet the special requirements for each application.

Choosing the right handle, for example, is not just a question of how the unit looks but also how it will be used. Using a smaller handle requires the user to grip the joystick with just the forefinger and thumb. This provides the finest control, and at the same time, limits the amount of force a user can exert, in comparison to a large handle which can be gripped with the whole hand.

In contrast, assistive mobility applications (such as motorized wheelchairs) sometimes require a much larger grip—often a sphere or a ball—to satisfy the users ergonomic needs. Devices can even be modified to accommodate chin or forehead activation.

Core Control Features/Ergonomics

A joystick typically controls movement in three different ways—forward and back, side to side, and in/out—referred to in camera applications as pan, tilt, and zoom. The fingertip control is designed to allow the widest range of control possible with the most natural and comfortable motion of the hand, and with minimal effort. This allows the user to focus on the work, not on the tool.

Pan and tilt motions can be guided or unconstrained, as appropriate for the application. The guided option allows the motion to be gently biased toward the axes (N,S,E,W). It is possible to move the handle away from the poles using slightly greater force. In this way, the joystick guides the user's hand naturally along the normal path of movement, while allowing for adjustment when necessary. The third dimension (forward and back in mechanical applications, zoom in cameras), is accomplished by twisting the handle, which can be formed with grooves, or flutes, for a better grip. The twist should operate within a constrained range of no more than 60&#176 (30&#176 off center in each direction). This allows the user to access the full range of the device without twisting the wrist—greatly reducing the likelihood of repetitive stress injuries.

Interface Circuitry

The internal circuitry of the joystick translates the user's motion into electrical signals that can be interpreted by the device control software. In the past, these

movements were typically sensed by a potentiometer—a variable resistor in which a sliding wiper blade moves across a fixed contact, mirroring changes in the position of the joystick. The problem with a potentiometer-based system is that the sliding component is a mechanical device subject to wear and corrosion. More modern systems now make use of contactless technology, in which a field is generated within the joystick at the base of the shaft. As the shaft moves, the sensing part of the circuit detects the change in the field and outputs an analogue voltage proportional to the distance moved. Friction and wear are eliminated, and the result is a joystick that can perform up to five million cycles without a failure.

There are several options for how the joystick then transmits position data to the main system. The best joysticks support multiple configurations, starting with standard, orthogonal signals such as those produced by potentiometer-based systems, and ranging to schemes for mixing signals, such as for operating two motors.

Durability

If the joystick breaks, the entire product is effectively broken.

Durability begins with the basic design so contactless systems are inherently longer-lasting. The quality of internal components also matters—look for products where internal components are metal rather than plastic.

An unpleasant but real problem in some environments is the propensity for intentional or unintentional operator breakage or abuse. The use of metal components throughout the device, especially at critical points like end-stops and the Z-axis mechanism, limits this risk.

In the factory environment, protection against dust, oil, and liquids is ensured by a neoprene sealing boot. Of course, a sealing boot is also useful in protecting joysticks in any environment from the occasional spilling of a soft drink or coffee.

Reliability and Fault Tolerance

Here again, contactless designs have the edge—no gradual drift or ‘noise’ as experienced with potentiometer-based joysticks. The performance of potentiometer-based systems gradually degrades over time as a result of friction and wear on moving parts, leading to unpredictability and loss of precision in the control signal. This ‘creeping degradation,’ usually manifested as an unstable center, can lead to poor performance of the control product and potentially dangerous situations.

Conversely, the most advanced joysticks, such as the 9000 Series joysticks offered by APEM, utilize contactless designs that employ inductive sensing, making the sensor subsystem immune to mechanical wear.

Some systems require fault tolerance for safety. If the sensor fails, two things must happen to ensure that the device being controlled returns to a safe operational state. First, the joystick must know that a fault condition exists. This usually requires the constant generation of an internal redundant ‘mirror’ signal, which can then be compared with the main signal being produced. If a difference is detected,

the unit can then send a special signal to the controlled device, allowing it to ‘return to center,’ or whatever action is most appropriate.

For mobile applications in particular, radio frequency immunity is important so that the signal is not affected if, for example, a wheelchair moves near a radio signal. Joysticks can provide several levels of RFI immunity, depending on the risk in the application.

Configurability and Customization

The most cost-effective joystick models are not necessarily the cheapest, but those that can accommodate an application’s requirements without the cost of a complete custom solution. Seek vendors that can support specific branding and design requirements—for example, with custom mold rubber handle sheaths using a company’s colors and logo—and can support multiple handle options, output signal configurations, and either guided or free motion.

Installation and Manufacturing Features

Finally, the joystick selected must fit seamlessly into the front panel, whether using drop-in or sub-panel mounting. Space is always an issue, and a low-profile sub-panel joystick enables it to be designed into the thinnest possible panels.

Applications

The benefits of today’s industrial joysticks are best seen in the context of their many applications.

Precision Camera Control Products

The requirements for camera control in the microscopic and other imaging markets are quite different. These products require the highest quality and resolution available. The best joystick models exceed the finest level of control achievable by the human hand.

Assistive Technology

Going beyond the core requirements for strength and reliability, a redundant, fault-tolerant design ensures that if a unit does fail, it fails in a safe way. In a wheelchair system, this might mean returning to center and switching off the propulsion. The joystick handle must be ergonomically fitted to the needs of the user, to allow easy grasping, or low resistance to make the handle easier to move.

Coordinate Measuring Machines (CMM)

CMM developers require the highest level of accuracy and consistency. This is an application where the user doesn’t want to worry about calibration of the measuring device, so the non-degrading contactless option is the best choice. The joystick should offer the same level of control whether on a tabletop or a gantry system.

Conclusion

As a central and prominent component of any control panel, the joystick conveys the brand image and lasting sense of quality of the entire system. The right joystick

device achieves a balance among precision, reliability, customizability, and price, and allows OEMs to offer their customers a first-class user experience and long-term dependable performance.

ONLINE

For additional information on the technologies and products discussed in this article, visit APEM Components Inc. at www.apem.com.

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