

## TECHNOLOGY SOLUTION

### Robotics, Automation and Control



# Circumferential Scissor Spring Enhances Precision in Hand Controllers

Spring allows tunable deflection curve for optimum controller feedback

Innovators at NASA Johnson Space Center have designed a circumferential scissor spring mechanism, that when incorporated into a hand controller, improves the restorative force to a control stick's neutral position. The design also provides for operation on a more linear portion of the spring's force deflection curve, yielding better feedback to the user.

Physical hand controllers, such as translational and rotational controllers, use a non-circumferential scissor spring arrangement to return the control stick to a neutral position, but the linear response of a typical scissor spring arrangement can reduce a user's sense of control by allowing slack between deflections.

This innovation's design is driven by a spring mechanism whereby an expansion spring is looped around the channeled circumference of two rounded pivoting blades whose setup can be tuned to allow varying spring tension. This allows the user enhanced control stick sensitivity while operating drive systems, industrial automation, measuring technology, mobile machinery, and gaming systems.

This technology is currently implemented on NASA's Orion Spacecraft training simulators using three-axis hand controllers.

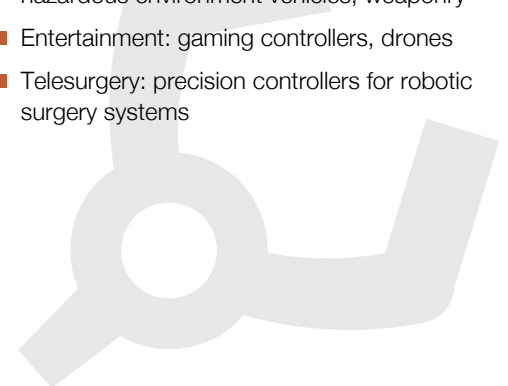
#### BENEFITS

- **Responsive:** Displacement of spring from neutral resides within linear portion of deflection curve, minimizing "dead zone" or slack between deflections.
- **Customizable:** Spring resides on outside of mechanism, facilitating easier replacement for force adjustment or maintenance.
- **Robust:** V-groove track profile (where spring resides) and proportionally small spring displacement reduces friction and increases durability.
- **Scalable:** Easy to scale deflection curve by using different combinations of spring types, component materials, and sizes.

#### APPLICATIONS

The technology has several potential applications:

- **Aerospace:** spacecraft, aircraft, remotely operated reconnaissance vehicles
- **Industrial and military:** mobile machinery, drive system and remote valve operation, hazardous environment vehicles, weaponry
- **Entertainment:** gaming controllers, drones
- **Telesurgery:** precision controllers for robotic surgery systems

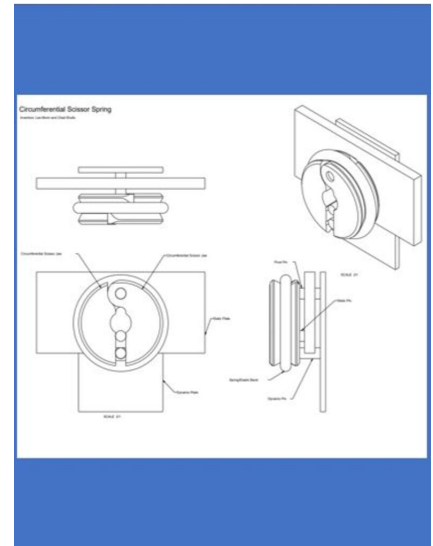


## THE TECHNOLOGY

The traditional scissor spring design for hand controllers has been improved upon with a circumferential spring controller mechanism that facilitates easy customization, enhanced durability, and optimum controller feedback. These advantages are partially facilitated by locating the spring to the outside of the mechanism which allows for easier spring replacement to adjust the deflection force or for maintenance.

The new mechanism is comprised of two rounded blades, or cams, that pivot forward and back under operation and meet to form a circle. An expansion spring is looped around the blade perimeter and resides in a channel, providing the restoring force that returns the control stick to a neutral position. Due to the use of a longer circumferential spring, the proportion of spring expansion is smaller for a given distance of deflection, so the forces associated with the deflection remain on a more linear portion of the force deflection curve.

The Circumferential Scissor Spring for Controllers is at technology readiness level (TRL) 8 (actual system completed and flight qualified through test and demonstration) and is available for patent licensing. Please note that NASA does not manufacture products itself for commercial sale.



Shown: Diagram of Circumferential Scissor Spring component design.

## PUBLICATIONS

Patent Pending



Shown: Three-quarter view of three-axis analog hand controller (left) engineered with Circumferential Scissor Springs, and side view of controller (right) with control stick being pushed inward, initiating circumferential spring return-tension.

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More Information

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