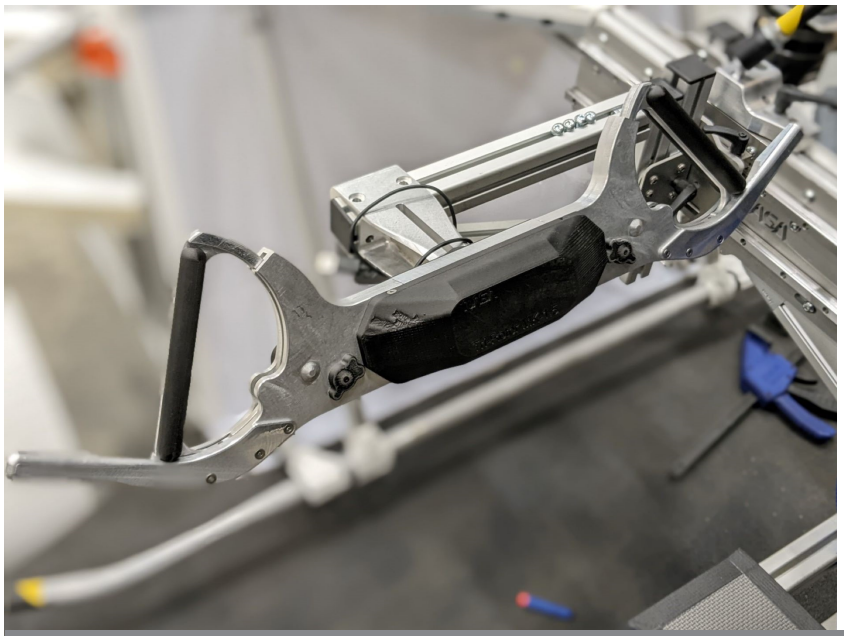

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Robotics, Automation and Control

Tri-Rotor Steering Wheel Yields Programmable Vehicular Control

Allows piloting a lunar terrain vehicle using only the hands

Innovators at NASA Johnson Space Center have developed a programmable steering wheel called the Tri-Rotor, which allows an astronaut the ability to easily operate a vehicle on the surface of a planet or moon despite the limited dexterity of their spacesuit.

This technology was originally conceived for the operation of a lunar terrain vehicle (LTV) to improve upon previous Apollo-era hand controllers. In re-evaluating the kinematics of the spacesuit, such as the rotatable wrist joint and the constant volume shoulder joint, engineers developed an enhanced and programmable hand controller that became the Tri-Rotor. It consists of two handles held apart by a main body whereby the handles rotate in-plane with the wrist and a central steering hub. The hub pivots in a similar fashion to an automotive steering wheel. These elements mean that an operator would only have to use their hands for directional and throttle controls. To combat fatigue during vehicular operation, the Tri-Rotor allows the astronaut to support their hands on special protrusions located on the outside of the control handles.

Due to the programmable nature of the Tri-Rotor, it may have commercial applications in any industry that utilizes a control stick, steering wheel, or yoke. The device may be especially useful in hazardous environments where operators clad in protective gear have limited dexterity.

BENEFITS

- Features hands-only operation of a vehicle
- Offers fine motor control for precision operation
- Fully programmable
- Can be constructed from multiple materials
- Manufacturable
- Can be operated in conditions with limited dexterity
- Features hand supports to combat fatigue while operating vehicle

THE TECHNOLOGY

Since NASA's Apollo program of the late 1960s and 1970s, many previous LTV hand controllers (e.g., joysticks, T-handles) were developed and utilized albeit with shortcomings. Some of these options yielded the desired level of control but were too physically taxing to use for long periods of time in a spacesuit environment. Others simply did not offer the necessary fine motor control. Thus, there has been a long-standing need for controllers that improve upon both of these limitations.

The Tri-Rotor is a novel hand controller designed to reduce operator fatigue, add control capabilities (beyond those of a joystick), and increase the fidelity of control inputs. The design consists of two slotted handles that rotate independently within opposite sides of the Tri-Rotor main-body. Each handle is programmable and can rotate 45 degrees. In this iteration, the right handle rotates counterclockwise and acts as an accelerator and brake. The left handle rotates both clockwise and counterclockwise and controls "crabbing" – whereby the vehicle's rear wheels turn in the same direction as the front wheels facilitating diagonal or possibly lateral movement. The main-body of the Tri-Rotor rotates upon a central pivot like an automotive steering wheel and can provide directional input for Ackermann-like steering.

The handles on the Tri-Rotor are designed with spacesuit kinematics in mind and are operated using the pronated and supinated motions of the astronaut's hands allowed by the wrist bearings between the glove and the forearm of the spacesuit. The device's central steering pivot is also operated by the hands and is leveraged by the up and down motions of the arms – allowed by the constant volume joints in the spacesuit's shoulders. This hand controller design staves off operator fatigue and sheds the need for separate fine-dexterity controls without sacrificing precision.

The Tri-Rotor Hand Controller has a technology readiness level (TRL) 5 (component and/or breadboard validation in relevant environment) and is now available for patent licensing. Please note that NASA does not manufacture products itself for commercial sale.

Shown: A suited astronaut tests the user interface of a Tri-Rotor steering wheel prototype

APPLICATIONS

The technology has several potential applications:

- Aerospace
- Assistive technology
- Automotive
- Demolition
- Hazardous materials
- Manufacturing
- Maritime
- Military
- Mining and construction
- Robotics

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MSC-27385-1, MSC-TOPS-122

More Information

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NP-2023-12-3207-HQ