# A friction-driven strategy for agile steering wheel manipulation by humanoid robots

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Researchers from School of Mechatronical Engineering, Beijing Institute of Technology. Credit: Zhaoyang Cai, School of Mechatronical Engineering, Beijing Institute of Technology

Humanoid robots have been one of the hottest research directions recently. Driving a vehicle can greatly improve the mobility of humanoid robots, allowing them to reach disaster sites faster.

A research team has proposed a friction-driven driving strategy inspired by human driving techniques and analyzed various steering strategies commonly employed by human drivers. Based on this strategy, they carried out an obstacle avoidance scenario, achieving a maximum steering wheel rotation speed of 3.14 rad/s.

The team published their findings in *Cyborg and Bionic Systems* on November 20, 2023.

Humanoid robots can potentially be used to perform tasks in hazardous situations, as they possess the ability to operate machinery designed for human use without the need for modification due to their human-like structure. Due to the limitations of the power system and small polygonal support area (foot area), humanoid robots have difficulty moving quickly.

In recent years, researchers have worked to combine humanoid robots and vehicles. This research allows humanoid robots to arrive faster and carry more tools. However, the narrow cab and fast operation requirements make it more difficult for humanoid robots to drive.

To explore better driving strategies for robots, the research team analyzed data from human driving processes and quantitatively compared three common driving strategies: "hand over hand," "hand on hand," and "single hand."

By quantitatively comparing these strategies in terms of joint motion range, shoulder motion area, and control speed, the researchers identified the most efficient and effective technique for humanoid robots. "Quantitative bionic analysis can give researchers more specific guidance," the corresponding author told us. They developed a friction-driven control strategy that mimics the actions of human drivers, enabling robots to navigate through confined spaces and handle obstacle

avoidance scenarios with ease.

The researchers built a comprehensive steering wheel operating force model to ensure precise control and prevent excessive force on the steering wheel. This model accurately captures the relationship between rotational resistance and the steering wheel's state, enabling the robots to exert the necessary force without damaging the mechanism. The team also devised a quadratic programming-based control framework that utilizes this model to achieve accurate tracking of the robot's position and target torque output.

"This universal controller can well constrain the contact force within the system performance, ensuring that the robot can drive the vehicle while ensuring its own safety," the team leader said.

This study opens up new possibilities in the field of humanoid robot driving, providing novel strategies for achieving higher speeds and maneuverability. In the future, researchers will continue refining the control strategy and exploring other application areas to advance humanoid robot development further.

**More information:** Zhaoyang Cai et al, A Friction-Driven Strategy for Agile Steering Wheel Manipulation by Humanoid Robots, *Cyborg and Bionic Systems* (2023). DOI: 10.34133/cbsystems.0064

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