Stabilization of a wheeled inverted pendulum assistant robot

December 22 2017

Rosie, the housekeeper from *The Jetsons*, has been the archetypal representative of helper robots since she wheeled onto televisions screens in the early 1960s. While Rosie vacuumed and washed dishes without a hint of incoordination, it turns out that a real-world counterpart would be far more likely to tip over.

Researchers from King Fahd University of Petroleum & Minerals in Saudi Arabia have now proposed a control design for a wheeled inverted pendulum assistant robot called I-PENTAR. They published their design in *IEEE/CAA Journal of Automatica Sinica (JAS)*, a joint publication of the IEEE and the Chinese Association of Automation

"One of the key challenges in using robots is... uncertainty," wrote Magdi Mahmoud, an author on the paper. "The challenge is how to increase the performance of such robots with the existence of this uncertainty. The development of more robust and fast controller algorithms can tackle uncertainty.

Mahmoud and his team examined four stabilization approaches for their control design, aimed at maintaining stability in the face of uncertainty. Uncertainty cannot be entirely removed, so the robot must account for it. Each approach involved analyzing the input-output relationship and how the robot maintain stability even as the input changed.

The robot, I-PENTAR, has a waist joint, two arms—with elbows—and a wheeled inverted pendulum mobile platform. I-PENTAR must be able to

assess the ground upon which it moves, including the angle and grip, and it must be able to remain upright with control. The researchers found that a dynamic feedback structure best modeled the results they wanted in simulations, so they experimentally tested the control algorithm. The goal was to achieve stability even with the presence of uncertainty.

"The upper balancing enables the robot to keep its original position without losing its balance," wrote Mahmoud. "The robot was initially tilted 8 [degrees] but the angular velocity of the tilt angle was zero... After almost 3 [seconds], the position of the center of the base returned to its original position."

More information: Magdi S. Mahmoud et al, Robust control design of wheeled inverted pendulum assistant robot, *IEEE/CAA Journal of Automatica Sinica* (2017). DOI: 10.1109/JAS.2017.7510613

Provided by Chinese Association of Automation