Efficient Animal-Mimicking Robot

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Courtesy of SynEvol
Credit:EPFL'S CREATE LAB & DEFLT UNIVERSITY OF TECHNOLOGY

To achieve rapid and adaptable ground locomotion, roboticists have increasingly looked to four-legged animals, such as horses and dogs, aiming to replicate their efficient movement.

The faithful and resilient reproduction of the smooth, natural movements seen in animals presents a substantial difficulty for robotic systems. Although certain existing four-legged robots have demonstrated notable agility and responsiveness to environmental shifts, these systems typically incorporate sophisticated actuators and computational elements that demand significant power.

A novel four-legged robot, PAWS (Passive Automata With Synergies), was recently created by researchers at EPFL's CREATE Lab and Delft University of Technology (TU Delft). This robot replicates the fluid and adaptable movements of animals using a reduced number of actuators. Presented in a Nature Machine Intelligence paper, PAWS utilizes motor synergies, coordinated muscle activation patterns enabling agile animal motions with reduced energy consumption.

"Biological systems significantly influence robotic design," stated Francesco Stella and Mickael Achkar, the paper's lead authors, to Tech Xplore. "Yet, drawing design principles from nature frequently relies heavily on subjective human insight and skill. We aimed to establish a more systematic and methodical approach to this process."

Unlike other quadruped robots that dictate movement through active control, PAWS utilizes flexible joint connections, or compliant mechanical couplings, for locomotion. This enables realistic, animal-like dynamic motion with reduced actuation. Stella and Achkar clarified, "Animals employ motion synergies—the central nervous system's coordination of muscle group activation, not individual muscles, for efficient movement." They added, "Our work began with dog motion data to extract key synergies, which we then computationally translated into a tendon system with fewer motors than joints. From this minimized actuation, we computationally engineered PAWS (Passive Automata with Synergies)

To test PAWS's passive motion capabilities, the team placed it on a treadmill, disconnecting all motor connections to its tendons. They observed that the robot successfully ran, even without active motor input, and navigated obstacles along its path.