# A new method to achieve smooth gait transitions in hexapod robots

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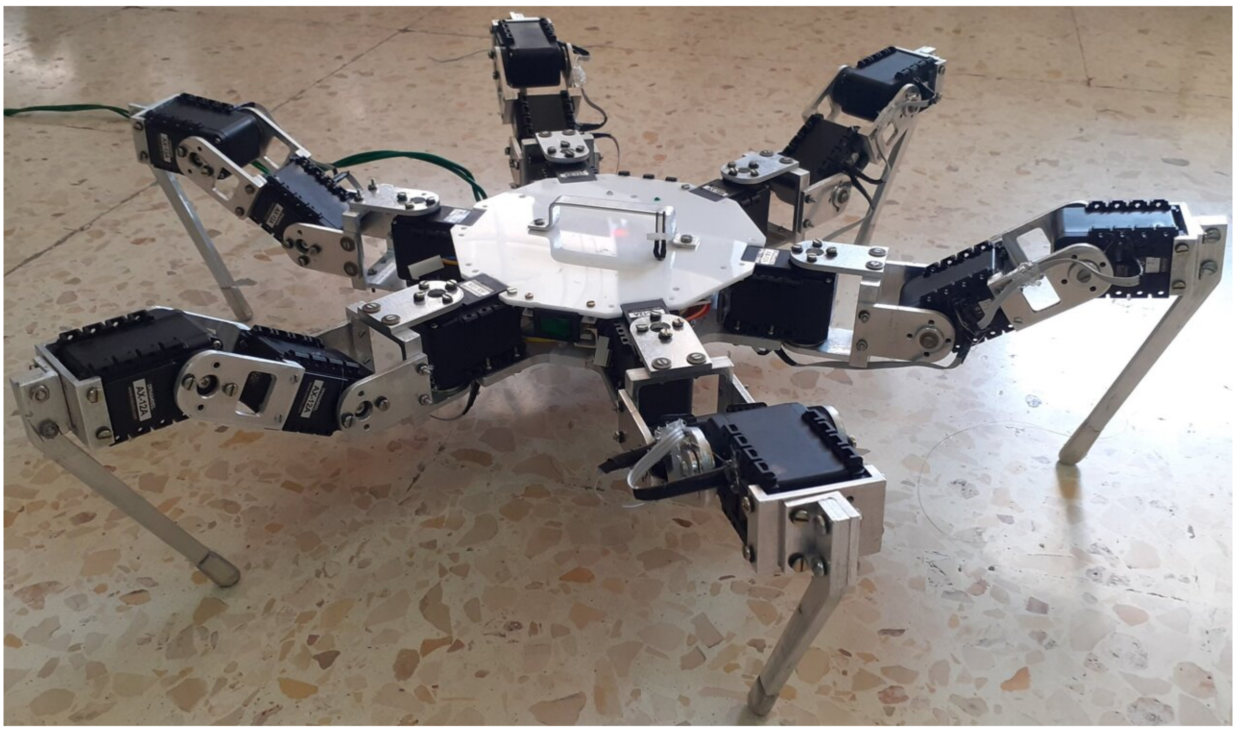


The real Hexapod robot used to validate the team's control method. Credit: *Heliyon* (2024). DOI: 10.1016/j.heliyon.2024.e31847

Robots that can navigate various terrains both rapidly and efficiently could be highly advantageous, as they could successfully complete complex missions in challenging environments. For instance, these robots could help to monitor complex natural environments, such as forests, or could search for survivors after natural disasters.

One of the most common types of robots designed to navigate varying terrains are legged robots, whose bodies are often inspired by the body structure of animals. To move swiftly in varying terrains, legged robots should be able to adapt their movements and gait-styles based on detected changes in their environmental conditions.

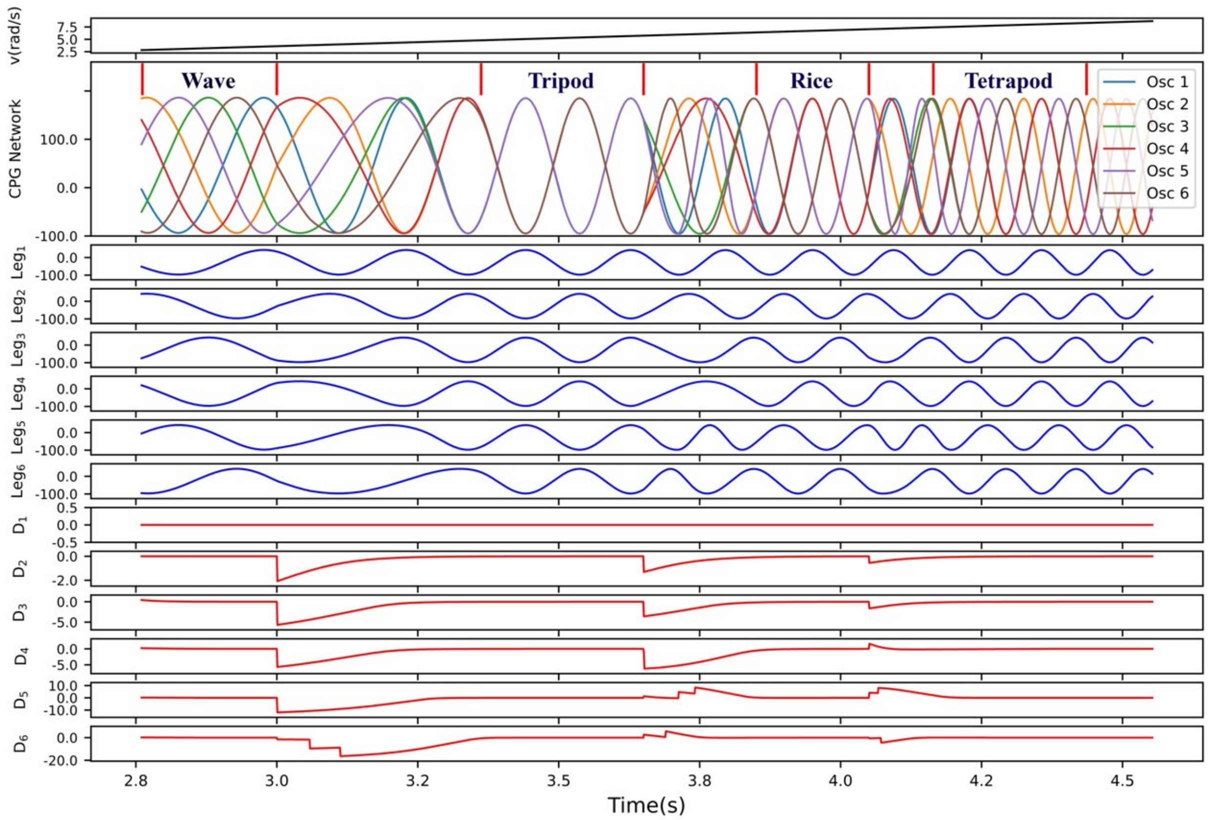
Researchers at the Higher Institute for Applied Science and Technology in Damascus, Syria, recently developed a new method to facilitate a smooth transition between the different gaits of a hexapod robot.

Their proposed gait control technique, introduced in a paper published in *Heliyon*, is based on so-called central pattern generators (CPGs), computational approaches that mimic biological CPGs. These are the neural networks underpinning many rhythmic movements performed by humans and animals (i.e., walking, swimming, jogging, etc.).

"Our recent publication is a foundational component of a larger project that aims to revolutionize the locomotion control of hexapod robots," Kifah Helal, corresponding author of the paper, told Tech Xplore.

"While machine learning techniques have not yet been integrated, the architecture we've designed lays the groundwork for such advanced applications. Our methodology is crafted with future machine learning integration in mind, ensuring that when implemented, it will significantly enhance malfunction compensation."

Helal and his colleagues first set out to design and simulate a six-legged (hexapod) robot. This simulated robotic platform was then used to test their proposed control architecture based on CPGs.




Gait transitions between different gaits while changing the angular velocity of oscillators from (2.5–7.5) rad.$s^{-1}$. The term $D_i$ represents how much the $leg_i$ is far from the synchronization so the figure shows how it affects the instantaneous frequency of oscillator to synchronize the network. Credit: *Heliyon* (2024). DOI: 10.1016/j.heliyon.2024.e31847

"Our control method leverages the principles of CPGs where each leg of the hexapod robot is governed by a distinct rhythmic signal," Helal explained. "The essence of different gaits lies in the phase differences between these signals. Our paper's core contribution is the novel interaction design among the oscillators, ensuring seamless gait transitions."

Helal and his colleagues also developed a workspace trajectory generator, a computational tool that translates the outputs of oscillators integrated in a hexapod robot into trajectories for its feet, ensuring that these trajectories remain effective during transitions. In initial tests, their proposed control architecture was found to enable stable, efficient and swift changes in gait in both a simulated and real hexapod robot.

"The most striking outcomes of our research are the harmonious blend of transition smoothness and speed," Helal said. "Essentially, it's the fusion of fluidity and quickness that sets our work apart from other previous efforts. We also validated a mapping function that ensures the robot's foot trajectory remains effective throughout these transitions."

The new architecture introduced by this team of researchers could soon be tested in further experiments and applied to other legged robots, to allow them to swiftly adapt to environmental changes while retaining their agility.

In their next studies, Helal and his colleagues plan to further improve their method, to tackle potential malfunctions and further boost its performance when robots encounter particularly challenging terrains.

"Looking ahead, we plan to delve deeper into machine learning to further refine our robot's environmental adaptability," Helal added. "We're particularly excited about exploring malfunction compensation and integrating pain sensing as feedback mechanisms.

"These advancements will not only improve the robot's interaction with its surroundings but also pave the way for more autonomous and resilient robotic systems."

**More information:** Kifah Helal et al, Workspace trajectory generation with smooth gait transition using CPG-based locomotion control for hexapod robot, *Heliyon* (2024). DOI: 10.1016/j.heliyon.2024.e31847

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