Researchers take next step with cyborg beetles – controlling their gait

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A beetle with 16 stimulation electrodes (two electrodes per muscle) implanted into the eight muscles (controlling protraction, retraction, levation and depression motions in both front legs). Credit: *Journal of The Royal Society Interface* (2016). DOI: 10.1098/rsif.2016.0060

(Tech Xplore)—A small team of researchers at Nanyang Technological University in Singapore has taken the idea of controlling live insects using electronics a step further—by controlling its gait. In their paper published in *Journal of the Royal Society Interface*, the team describes how they created their 'cyborg' beetles, why they did so, and where they see the technology going in the future.

Over the past several years, scientists have found that they can control the movement of various insects by implanting electrodes that stimulate leg muscles in a prescribed fashion. Up till now engineers have created cyborg bugs that can be made to fly, scuttle and crawl in directions given via a computer. Now, the researchers with this new effort have announced that they have moved such research to the next level by creating cyborg *Mecynorrhina torquate* beetles that can have their speed, step length and walking gait controlled by computer.

To create the cyborg beetles, the researchers first soaked them in alcohol for 12 hours; they then cut them open to insert probes that allowed for recording the electrical signals that were generated naturally as the beetle moved around. Next, the team inserted electrodes capable of faithfully reproducing the insect's own impulses. The bugs were then controlled via a computer that sent signals to the electrodes. The team reports that they were able to cause the beetle to walk in whatever direction they chose adjusting for speed, step length and gait.

The team also explains that the purpose of creating such beetles and learning more about how to control them is to learn more about how to create robot-like entities that are simpler than today's robots. Such cyborgs, they note are much more efficient and use just a hundredth of the power needed to run an all-electronic insect robot. Also, most of the energy expended by a cyborg comes about via natural biological processes that do not need to be replicated. And, a cyborg bug does not require programming to maintain stability—the bugs' own biological

systems keep it upright and in proper position for movement. The researchers note that learning more about how to create cyborgs also helps in robot design and they believe cyborgs might one day be put to practical use, such as in search and rescue efforts.

More information: Feng Cao et al. Insect–computer hybrid legged robot with user-adjustable speed, step length and walking gait, *Journal of The Royal Society Interface* (2016). DOI: 10.1098/rsif.2016.0060

Abstract

We have constructed an insect–computer hybrid legged robot using a living beetle (Mecynorrhina torquata; Coleoptera). The protraction/retraction and levation/depression motions in both forelegs of the beetle were elicited by electrically stimulating eight corresponding leg muscles via eight pairs of implanted electrodes. To perform a defined walking gait (e.g. gallop), different muscles were individually stimulated in a predefined sequence using a microcontroller. Different walking gaits were performed by reordering the applied stimulation signals (i.e. applying different sequences). By varying the duration of the stimulation sequences, we successfully controlled the step frequency and hence the beetle's walking speed. To the best of our knowledge, this paper presents the first demonstration of living insect locomotion control with a user-adjustable walking gait, step length and walking speed.