New software eases analysis of insect in motion

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Cockroaches can skitter through a crowded under-the-sink cabinet, eluding capture or worse, making the insects a model for rescue robots that would creep through the debris of disaster in search of survivors.

But learning how they use all six legs at the same time to walk, run and turn has been a difficult and time-consuming task. Until now.

Using a pair of high-speed cameras and a custom computer program, researchers at Case Western Reserve University are able to simultaneously extract three-dimensional movement of a cockroach's 26 leg joints. They report their findings in the online journal PLoS ONE.

"Each leg does something a little different but in concert," said John Bender, a postdoctoral research associate in the department of biology and lead author of the study. A cockroach doesn't inch ahead on the push of one leg. So, to understand just one step requires a synchronous picture of what each joint in each leg is doing as the insect propels forward.

The new technology allowed Bender and his collaborators to provide the first detailed analysis of how the cockroach uses the tiny trampoline-like trochanter-femur joint that lies between the stubby coxa and long femur.

The analysis showed the joint reduces bouncing as the body's weight shifts forward, and then rolls to lift the tibia off the ground as the leg begins its forward swing.

Bender, biology professor Roy Ritzmann and undergraduate researcher Elaine Simpson, who has since graduated, used synchronized digital high-speed cameras to produce 3-D images of the leg joints of a moving cockroach. The cameras shoot 500 frames per second for 8 seconds.

Bender led development of software that enabled them to analyze in hours 106,496 individual 3-D points, with about 90 percent accuracy. He estimated that the old method of analyzing the 3-D movement of all 26 joints frame-by-frame would take at least a couple of weeks. By automating much of the work, the team sought also to eliminate some of the subjectivity of analyzing each frame by human eye.

The researchers say the software can benefit others who seek to analyze movement of other insects and have made the software free and open-source for other investigators to use and add enhancements. Bender and Ritzman are using the software now to study changes in coordination that occur during changes in walking speed and turning.

Provided by Case Western Reserve University