On-line Tracking and Ejection System for Investigating Dynamic Behavior of Running Insects

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Recently, investigation and observation of a single-insect have much importance since it allows us to clarify phenomena that are difficult to address in case of a large population of insects [1]. Investigating insects also gave us more information about its mechanical properties and dynamic behaviour. Conventionally, insects' characteristics are investigated through stimulation. In this case, the insect is exposed to an external stimulus, whether be it a chemical, electrical, thermal, photic or mechanical stimulations, and then the response of the insect is measured and analysed.

Conventionally, it was quite difficult to observe and investigate running insects such as ants with mechanical stimulation owing to their size and agility unless they are immobilized. Therefore, insects are immobilized before investigation to drastically reduce their moving speed or completely hinder their movement. However, this immobilization also results in the reduction of the functionality and response speed of the subject insect. Therefore, the exact natural behaviour of such insects in the case of mechanical approach has not been fully investigated. In order to obtain reactions that are close to natural ones, running insects should be investigated while they are moving freely on a 2D field.

In order to get the most natural responses to the mechanical stimulation applied to a running insect there should be no forces exerted on the insect other than the mechanical stimulation force. This means that the insect should not be immobilized and it should be allowed to move freely inside the environment, but this raises a new problem. Since the microscope's FOV is fixed in place and its dimensions are relatively small, the target insect can easily move outside the FOV where we can no longer apply stimulation nor observe its response.

Considering this background, we newly propose a robotic system as shown in Fig. 1. This system mainly consists of a high-speed inkjet mechanism acting as robotic hands to stimulate an insect, a camera with a high-speed online vision sensor [2] acting as a robotic eye to track the trajectory of the insect. This system allows for investigating more natural and dynamic behaviour of running insects with high functionality, which is difficult to achieve with previous approaches. Our system has a large potential and impact to influence investigations in the bioscience field.

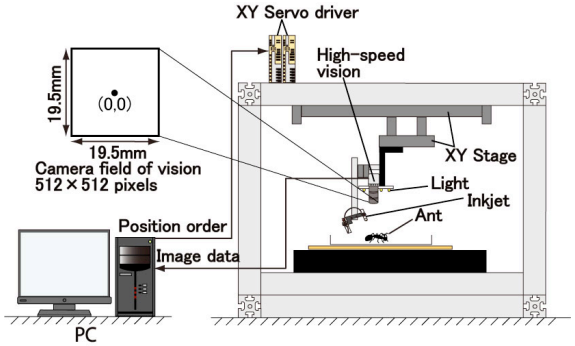

Fig. 1: Components of the developed system.

References

[1] K. Matsuura et al., "Queen succession through asexual reproduction in termites," *Science*, 323, pp. 1687, 2009.

[2] Q. Gu et al., "Fast FPGA-based multi-object feature extraction" *IEEE Tran on Circuits and Systems for Video Technology*, vol. 23, no. 1, pp. 30–45, 2013.