Research team develops insect-mimicking sensor to detect motion

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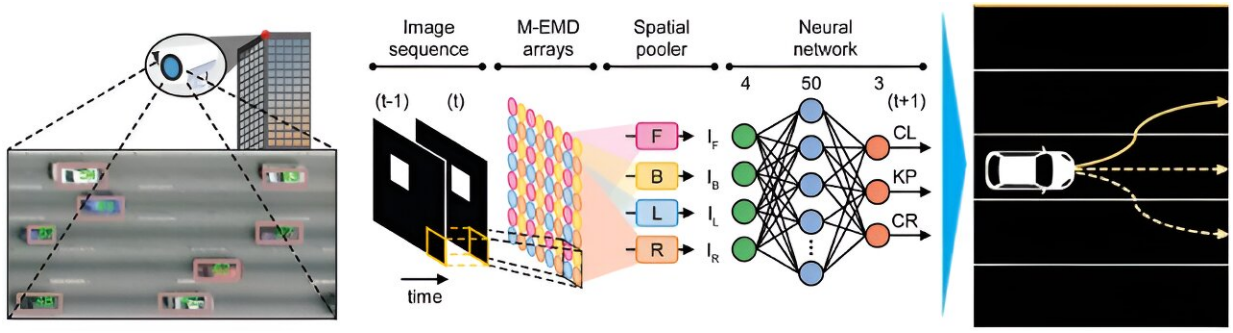


Neuromorphic computing system configuration based on motion recognition devices. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

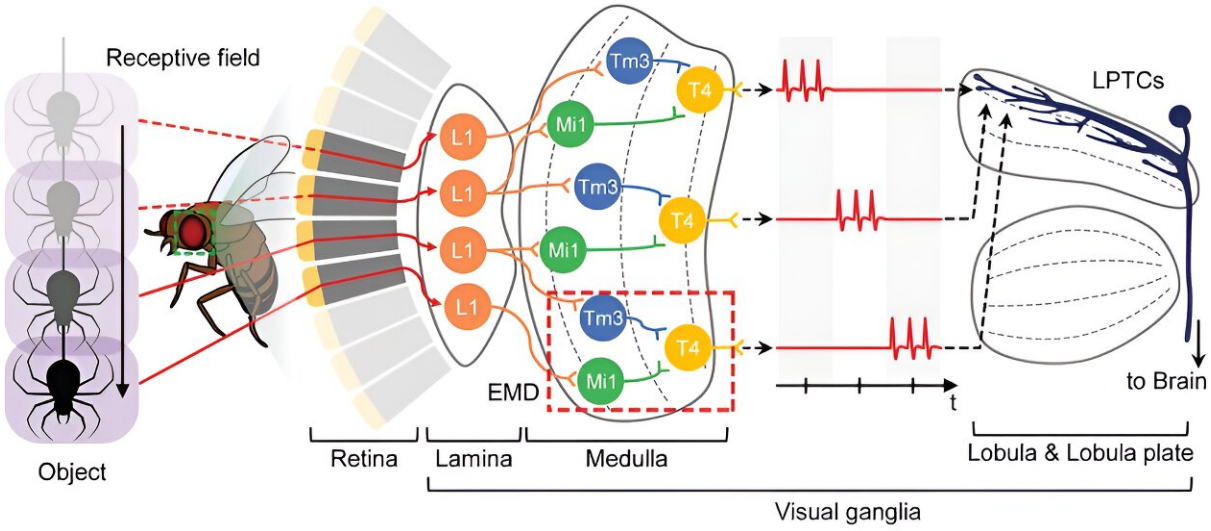
The recent development of an intelligent sensor that mimics the optic nerve of insects while operating at ultra-high speeds and low power offers extensive expandability into various innovative technologies. This technology is expected to be applied to various fields including transportation, safety, and security systems, contributing to both industry and society.

On February 19, a KAIST research team led by Professor Kyung Min Kim from the Department of Materials Science and Engineering (DMSE) announced the successful development of an intelligent motion detector by merging various memristor devices to mimic the visual

intelligence of the optic nerve of insects. The study is published in the journal *Advanced Materials*.

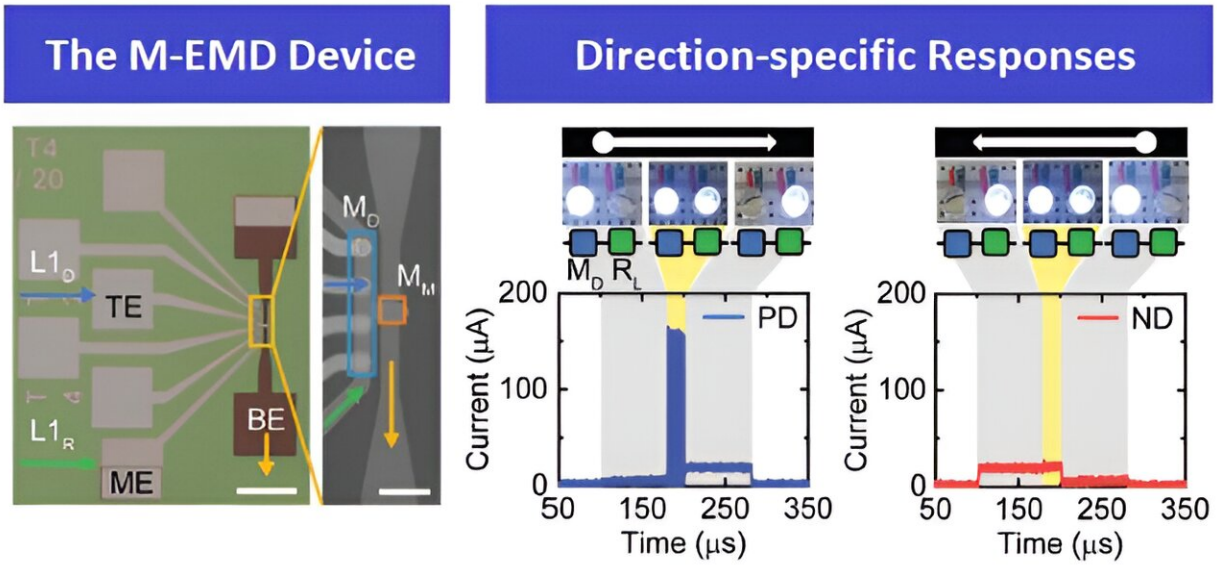
With the recent advances in AI technology, vision systems are being improved by utilizing AI in various tasks such as image recognition, object detection, and motion analysis. However, existing vision systems typically recognize objects and their behavior from received image signals using complex algorithms. This method requires a significant amount of data traffic and higher power consumption, making it difficult to apply in mobile or IoT devices.

Meanwhile, insects are known to be able to effectively process visual information through an optic nerve circuit called the elementary motion detector, allowing them to detect objects and recognize their motion at an advanced level. However, mimicking this pathway using a conventional silicon integrated circuit (CMOS) technology requires complex circuits, and its implementation into actual devices has thus been limited.



Working principle of a biological elementary motion detection system. Credit:

The Korea Advanced Institute of Science and Technology (KAIST)



(Left) Optical image of the M-EMD device in the left panel (scale bar 200 μm) and SEM image of the device in the right panel (scale bar: 20 μm). (Middle) Responses of the M-EMD in positive direction. (Right) Responses of the M-EMD in negative direction. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Professor Kyung Min Kim's research team developed an intelligent motion detecting sensor that operates at a high level of efficiency and ultra-high speeds. The device has a simple structure consisting of only two types of memristors and a resistor developed by the team. The two different memristors each carry out a signal delay function and a signal integration and ignition function, respectively. Through them, the team could directly mimic the optic nerve of insects to analyze object movement.

To demonstrate its potential for practical applications, the research team used the newly developed motion detector to design a neuromorphic computing system that can predict the path of a vehicle. The results showed that the device used 92.9% less energy compared to existing technology and predicted motion with more accuracy.

Professor Kim said, "Insects make use of their very simple visual intelligence systems to detect the motion of objects at a surprising high speed. This research is significant in that we could mimic the functions of a nerve using a memristor device.

"Edge AI devices, such as AI-topped mobile phones, are becoming increasingly important. This research can contribute to the integration of efficient vision systems for motion recognition, so we expect it to be applied to various fields such as autonomous vehicles, vehicle transportation systems, robotics, and machine vision."

More information: Hanchan Song et al, Fully Memristive Elementary Motion Detectors for a Maneuver Prediction, *Advanced Materials* (2024). DOI: 10.1002/adma.202309708

Provided by The Korea Advanced Institute of Science and Technology (KAIST)