robotics Swiss National Centre of Competence in Research

NEWS BULLETIN

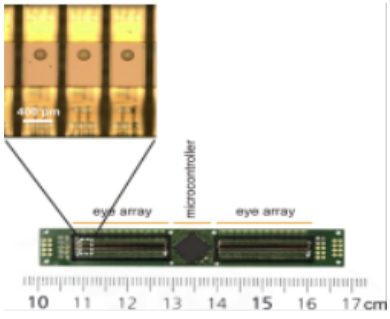
Issue 11

A Leap Forward in Vision

Taking cues from the natural world is growing ever more popular in robotics, and this week a team from NCCR Robotics and LIS, EPFL present a revolutionary new artificial compound eye, created with the fruit fly in mind, in a paper published by the Royal Society.

Evolution has cleverly equipped the arthropods' compound eye with key features that enable insects to fly in cluttered environments and react instantly to danger in order to survive. Their eyes are able to create low-resolution images with wide fields of view, high sensitivity to motion and a near infinite depth of field all at low energy cost. Every insect eye is made of many thousands of ommatidia, each of which is an individual sight receptor. Individual ommatidia are positioned slightly differently to their neighbours, allowing the brain to collect and compare information from all and piece together a complete image of the surrounding environment. These quick functioning, simple eyes are what allows insects to see danger and react so quickly when you, say, try to swat them.

With this in mind, the team lead by Prof. Dario Floreano, has created an artificial version of an ommatidium which functions through three hexagonal photodetectors arranged in a triangular shape underneath a single lens. These photodetectors then work together and combine perceived changes in structured light (optic flow) to present a 3D image of what is moving and in which direction relative to its standpoint. This means that even when it is the eye that is moving and the environment remains stationary, this relative movement is picked up. It is because of these three sensors each picking up and then combining optic flow in a different directions that the eye also now functions as a stand alone sensor, no longer requiring the multiple, perfectly aligned single eyes used in previous solutions, but functioning perfectly using only these three photodetectors.



The eye has been tested in a wide range of lighting conditions and has been shown to function in environments ranging from a poorly lit room to bright sunshine. The eye even functions three times faster than the insect eyes that it is modelled on, with 300 frames per second recorded during testing, all building up to provide an image of a given environment as the robot is moving through it and allowing the robot to spot obstacles and react quickly. In fact, the ability to rapidly extract data offline to provide an image suitable for navigation without the need for high energy expenditure is what allows this eye to be truly versatile.

This new sensor is 1925 x 475 x 860 µm in size and only 2 mg in weight, making it easily applicable for MAVs and other flying robots, where both speed and payload are of high importance. A further advantage of this method is that multiple sensors may be used together, each pointing in different directions, to provide a miniature omnidirectional camera for motion detection. Since the sensors work independently, they can be mounted in any configuration and even on flexible substrates. The team has demonstrated the operation of such a compositional eye in the shape of a bendable strip, which Prof. Floreano calls a Vision Tape, because it could be attached to any planar or curved object.

Future work could see the sensor embedded onto the surfaces of soft and flexible robots or in smart clothing to allow clothes for blind people to "see" obstacles, or medical endoscopes, allowing operations to happen with greater precision; or arranged in layers that may be adapted to arbitrary shapes, meaning that the possibilities for its use are endless.

References

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Further information related to the CURVACE project.

For Further Information please refer to:

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NCCR Robotics

The Swiss National Center of Competence in Robotics (NCCR Robotics) is a federally funded programme bringing together robotics laboratories from EPFL, ETH Zurich, University of Zurich and IDSIA to work on wearable, rescue and educational robots.

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