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Artificial compound eye

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Simple structure of insect's compound eye, gives to us an opportunity to build very efficient and cheap opto-electronic vision systems for orientation, navigation and preventing collisions between unmanned air vehicles. Nevertheless, there are only a few designs that implement the idea of facet vision systems:
First one is a system that has micro-lens array on a matrix of photodetectors [1]. It contains two main subsystems. The first one is an array of 16 x 16 convex microlenses with radius of curvature r ≈ 400 μm. The second subsystem enables photodetection and electrical readout. It consists an array of thin silicon radiation sensors and blocking diodes. Each photosensor placed in focal position of corresponding lens. Some interesting feature of this approach is possibility of elastic deformation of prototype assembly (dynamical FOV) that is a big advantage.
Another approach is the development of an artificial compound eye, called CurvACE [2]. As in the biological compound eye, CurvACE contains three material and functional layers. The first layer contain array of polymeric microlenses molded on a glass carrier, which focus light onto second layer that includes silicon-based photodetectors array. Last layer is a flexible electromechanical board that transmits output signals to processor units. The use of a single microprocessor in such a solution may not be sufficient since a high speed of signal processing from each photodetector is required.
An interesting research in [3] is based on vision principle of Xenos peckii eye. It's a biologically-inspired ultrathin digital camera where the lens has two-layer structure: honeycomb-packed concave hexagonal microprism and microlens plates. They can be integrated together on conventional CMOS image sensor. After microassembly of the microprism and microlens plates, the device was fully integrated on a CMOS image sensor (2M pixels, unit pixel: 1.75 x 1.75 μm), and the total track length of the bioinspired ultrathin digital camera is 1.4 mm. Approach of microlens array placement on CMOS-sensor has a principal advantage: small size and weight of utilized elements. But the major drawback of such solution is a lack of multichannel sequential read-out efficiency that is very important in true parallel signal processing.
Said frankly all these designs are far from the principal idea of insect compond eye because they do not perform parallel image processing in the multiple independed facet elements. The proposed design of the compound eye with the multiples facet elements equipped with image processing units can be considered as the closest one to an insect's compound eye then the above-mentioned ones [4].

References

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Topics

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