Abstract

Artificial machine vision systems are becoming increasingly widespread, necessitating the development of new computing technology. Currently, a large camera is used to record visual data, which are then converted to a digital signal and categorised for computational tasks using the von Neumann architecture. Categorizing visual input takes a lot of energy and time because this design requires two physically distinct computing and memory units. To avoid such costs, optically active in-sensor memristive technology is presented as a feasible alternative, with the human brain acting as the driving force behind the development of such low-cost hardware primitives. Certainly, human eyes help to reduce the computational complexity and energy cost of the brain by performing initial image processing and encoding visual information as electrical spikes. Modern technology makes use of oxide-based perovskite synapses/memristors, despite the fact that they have a very large bandgap, mostly in the ultra-violet region. As a result, opportunities for coloured bionic vision are limited. Furthermore, complex and expensive production methods with high-temperature processibility are a source of concern.

The project's goal is to develop a low-cost, wavelength-dependent colored vision system based on lead-free halide perovskites (HPs) memristors that is analogous to human vision. A reservoir computing (RC) approach will be explored with the help of a single-node echo state machine, where a suitable stoichiometric engineering approach will be used to alter the charge carrier dynamics of the HP memristors to promote a photosensitive vision system. Different assemblies will be built employing photosensitive HP pixels with the goal of using edge, movement detections, and shape classification. Complex pattern categorization will also be attempted by encoding them into light pulse trains, a memristive version of saccadic image processing and classification. Converting increasingly complex images to spatiotemporal patterns will allow low-resolution pixel matrices to recognise and classify higher-resolution images. Because of its success in spatiotemporal analysis at a low training cost, the employment of the RC technique is crucial here. As a result, combining RC ideas with light-sensitive HP memristors will result in an energy-efficient bionic vision system, paving the way for future artificial machine vision design.