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Brillouin fiber lasers and their applications in fiber sensing

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Several fiber lasers based on stimulated Brillouin scattering are reported including multi-wavelength lasers, single longitudinal-mode multi-wavelength lasers and short-cavity length single longitudinal-mode lasers. A hybrid multimode fiber laser is proposed to realize simultaneous measurement of strain and temperature based on radio-frequency demodulation. The hybrid lasers include a Brillouin erbium fiber laser (BEFL) with dual Brillouin peaks and an erbium-doped fiber laser (EDFL), which is incorporated in a simple and compact ring laser cavity. The injection of Brillouin pump excites first-order stimulated Brillouin scattering in two sections of fibers with different Brillouin stokes frequencies. The simultaneous measurement of strain and temperature are achieved by monitoring the self-beating signals of the BEFL and EDFL. The maximum measurement errors of strain and temperature obtained are within ±20.3 με and ±0.5°C. Simultaneous temperature and strain measurement is demonstrated by using hybrid EDF/Brillouin lasers. The EDFL can be switched to BEFL by injecting the Brillouin pump into the laser cavity. Longitudinal mode beat frequency and Brillouin frequency shift are monitored to discriminate strain and temperature. The longitudinal modes beat frequency is measured by observing the self-beating signals of the EDFL, while the Brillouin frequency shift is measured by monitoring the heterodyning signal of the BEFL. The simultaneous measurement errors of strain and temperature are within ± 25.8 με and ± 0.8°C.

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Neural networks based on memristor crossbars and bridges

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Hardware implementation of a neural network requires a lot of memory for storing the weight matrix of the neurons layer and is expensive. Solving this problem is simplified by using device as the memory cell called memristor. The memristor has many advantages such as non-volatile storage media, low power consumption, high density integration and excellent scalability. Unique ability to retain traces of the device excitation makes it an ideal candidate for the implementation of electronic synapses in neural networks. The present contribution reports for programming memristor array (crossbar). An algorithm for mapping weight matrix of the neuron layers onto memristor crossbar is proposed. LTSPICE model of WTA ("Winner Takes All") neural network implementation on the memristor crossbar and CMOS transistors is developed for binary images recognition. The resistor bridges containing memristors are used for LTSPICE simulation of tunable weights in electronic associative memories, a bi-directional associative memory and an associative memory based on the Hopfield network, which can be implemented as networks of coupled phase oscillators. The experiments using LTSPICE models show that for the reference binary images with size 3x3 the oscillatory Hopfield network converges to the reference images (accordingly, to their inversion) with a random uniform distribution of the binary pixel values in the input images.

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