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Optoelectronic Hardware Architecture for Recurrent Learning Algorithm in Image Processing

Authors : Abdullah Bal, Sevdenur Bal

Abstract : This paper purposes a new type of hardware application for training of cellular neural networks (CNN) using optical joint transform correlation (JTC) architecture for image feature extraction. CNNs require much more computation during the training stage compare to test process. Since optoelectronic hardware applications offer possibility of parallel high speed processing capability for 2D data processing applications, CNN training algorithm can be realized using Fourier optics technique. JTC employs lens and CCD cameras with laser beam that realize 2D matrix multiplication and summation in the light speed. Therefore, in the each iteration of training, JTC carries more computation burden inherently and the rest of mathematical computation realized digitally. The bipolar data is encoded by phase and summation of correlation operations is realized using multi-object input joint images. Overlapping properties of JTC are then utilized for summation of two cross-correlations which provide less computation possibility for training stage. Phase-only JTC does not require data rearrangement, electronic pre-calculation and strict system alignment. The proposed system can be incorporated simultaneously with various optical image processing or optical pattern recognition techniques just in the same optical system.

Keywords : CNN training, image processing, joint transform correlation, optoelectronic hardware
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