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DenseHyper: an automatic recognition system for detection of hypertensive retinopathy using dense features transform and deep-residual learning

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Abstract
High blood pressure and diabetes are associated with a retinal abnormality known as Hypertensive Retinopathy (HR). The severity-level and duration of hypertension are straightly related to the incidence of HR-eye disease. The HR damages the pathological lesions of eyes such as arteriolar narrowing, retinal hemorrhage, macular edema, cotton wool spots, and blood vessels. In the early stages, it is important to detect and diagnose HR to prevent eye blindness. Currently, there are few computerize systems developed to recognize HR. However, those systems focused on extracting features through hand-craft and deep-learning models (DLMs) based techniques. As a result, the complex image processing algorithms are required in case of hand-crafted features and it is difficult to define generalized features by DLMs to recognize HR. Moreover, the classification accuracy is not up-to-the-mark even though by using deep-feature techniques as observed in state-of-the-art HR diagnostics systems. To solve these problems, a novel hypertensive retinopathy (DenseHyper) system is developed to detect the HR based on a proposed trained features layer (TF-L) and dense feature transform layer (DFT-L) to the deep residual learning (DRL) methods. The DenseHyper system consists of different multi-layer dense architecture by integrating of TF-L by convolutional neural network (CNN) to learn features from different lesions, and generate specialized features by DFT-L. To develop DenseHyper system, a learning based dense feature transform (DFT) approach was integrated to increase classification accuracy. Three online sources besides one private data are gathered to test and compare the DenseHyper system. To show the performance of the DenseHyper system, the statistical analysis is also performed on 4270 retinal fundus images through sensitivity (SE), specificity (SP), accuracy (ACC) and area under the receiver operating curve (AUC) metrics. The significant results were achieved compare to state-of-the-art methods. On average, the SE of 93%, SP of 95%, ACC of 95% and 0.96 of AUC values were obtained through a 10-fold cross-validation test. Experimental results confirm the applicability of the DenseHyper system to accurately diagnosis of hypertensive retinopathy.

Keywords Hypertensive retinopathy · Retinal fundus images · Features selection · Deep-neural network · Convolutional neural network · Transfer learning · Residual neural network