Abstract

As healthcare facilities and medical centres proliferate, biomedical images relevant to patient pathology are also rising rapidly. Effective bio-medical image search and retrieval in a database is crucial for proper patient diagnosis and bio-medical research. Also, addressing current clinical expectations requires radiologists to evaluate multiple images each minute. This highlights the absolute need of state-of-the-art medical image classification systems. Biomedical artificial intelligence is becoming more important as medical imaging collections grow. This thesis is organized into three major chapters that address many problems relevant to biomedical image comprehension issues, such as bio-medical image classification and retrieval.

Our first objective is to integrate distinctive multi-dimensional arbitrary-shaped sampling structures into the bit-plane domain via local bit-plane decomposition, which facilitates the acquisition of image details from extremely fine to very coarse levels. To achieve this, we initially investigated the implementation of a 2-D arbitrarily shaped sampling structure with multiscale support to resolve the current challenges associated with existing LBP-based variants and local bit-plane based descriptors. Subsequently, we have extended the notion of 2-D arbitrary shaped sampling structures to multi-orientational 3-D arbitrary shaped scanning structures to ascertain the relationship between the reference and its surrounding neighbours in the bit-plane domain. Our multi-orientational 3-D arbitrary-shaped scanning structures, unlike other current scanning systems, provide more continuous angular variation across sampling points, enabling enhanced capture of irregular local textures. We have shown that the use of proposed multidimensional arbitrarily shaped sampling structures, in conjunction with standard circular sampling, significantly enhances the characterization of both uniform and non-uniform textures.

Second, we investigate the possibility of enhancing the COVID-19 detection procedure from chest X-ray images by combining deep features from a variety of models. The observation has been made that the appropriate combination of deep features has the potential to make the features more generous. We have also shown that the deep features derived from hand-engineered bit-plane based pattern maps may provide supplementary information compared to those obtained from direct raw spatial input images. We utilized the multiscale information calculated in each bit-plane, coupled with inter-scale features, to produce the final bit-plane based pattern maps.

Third, we have endeavored to enhance the efficacy of three existing pre-trained convolutional neural network models for precise skin lesion categorization from dermoscopic pictures. Our modified models and the original models display distinct misclassification errors, so a robust ensemble of both the original and our modified deep models is developed to enhance the categorization of skin lesions using dermoscopic pictures. The modified models have shown superior performance compared to their original counterparts, and the ensemble framework yields competitive results relative to current methodologies.

Keywords: Image retrieval, image classification, bit-plane, arbitrary scanning, COVID-19 detection, chest X-ray image, convolutional neural networks, deep learning, dermoscopy images, skin-lesion classification, image augmentation, transfer learning