Deep Neural Hashing for Medical Image Retrieval

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1 Abstract

Content-based image medical retrieval (CBMIR) is the method of finding images from a gallery which are similar to a query image. It employs similarity of their visual appearance characterised by image features instead of using a set of categorical labels defining image attributes. The process of extracting such analytically defined image features viz. shape signature, textures with co-occurrence matrix or local binary pattern are computationally expensive. Subsequently similarity between features is computed using distance measures viz. Bhattacharyya distance, cosine similarity, Euclidean distance, etc. In order to reduce this cost of computing similarity between image features, hashing-based distance measures have evolved. Coupled with recent advances in deep learning, deep neural hashing (DNH) has evolved to become a dominant area of active research in the CBMIR community. As in the case of medical images, they are characterised by modality, organ, and pathology. Retrieval is expected on a priority or user preference of either of these characteristics viz, and if there is an X-ray image of lungs available and the user is excepting say similar X-ray image but not CT image of the lung, then an option is expected to be able to specify such a requirement in the hash code in order to facilitate this priority in image retrieval. Such kind of preferential retrieval is desired in order to implement evidence-based medicine (EBM). While generally used DNH for natural images feature similarity search, they are not yet developed to incorporate such multi-lateral search preference. This research focuses on (i) designing DNH, which can extract such rich multi-lateral attributes in the images, and (ii) developing appropriate structured hash codes to retrieve images under such multi-lateral preference of similarity efficiently.

2 Problem Statement and Proposed Approach

This research work aims to build a state-of-the-art neural hashing architecture addressing some of these current challenges in order to develop a full-scale deep hashing neural network that can be used retrieve medical images with multiple characteristics. We evaluate each proposed model's retrieval performance using two metric mean average precision, and normalized discounted cumulative gain. The details of evaluation process can be found here. The problem statements are described below.

Objective 1: Organ and pathology retrieval using deep neural hashing The previous state-of-the-art methods only focuses on semantic similarity ($s_{i,j}$) and unable to prioritise retrieval specific to organ and their associated pathology. We introduce relational similarity ($r_{i,j}$) along with semantic similarity ($s_{i,j}$) to understand medical images better than the state-of-the-art-method. The proposed CBMIR system receives images from the medical database with similar evidence to a query image of known ground truth, which helps clinicians and radiologists to prescribe treatments to these patients based on the treatment of the query image.

Objective 3: Decision making under uncertainty hashing for multimorbidity medical image interval One organ can be affected by multiple symptoms or pathology in our human body. For example, Edema, Infiltration, and Effusion are the symptoms that can be found in a patient's chest. Clinicians need to identify multiple pathologies in the same organ and provide appropriate treatment to the patient. Understanding a model's input images is crucial for dealing with different diseases in a single organ. A fuzzy inference system (FIS) can be applied to images for our model to understand the input images better, allowing the proposed model to create the most authentic hash code for images. FIS consists of three steps Fuzzification, Knowledge base, and Defuzzification.

Objective 4: Medical image retrieval of untrained characteristic combination In this work, we want to retrieve images to a query image with a given untrained combination where the model has not been trained during the training procedure. For example, if our model is trained with Breast ultrasound and Brain MRI images, then we want to retrieve images with breast MRI. In objective 2, three sub-hash codes are generated from three sub-networks, which originated from one base network. So, there is a dependency between sub-hash codes for three characteristics. Here, We design a DNH that generates three independent sub-hash codes for three characteristics., which helps us to retrieve images with untrained characteristics combination.

References