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Original

State recognition scheme using feature vector and geometric area ratio techniques

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Abstract

The state recognition based on the image processing can identify whether or not the target is in normal state. In this paper, there are three creative works in our scheme. Firstly, the improved threshold segmentation (ITS) method can obtain the optimal parameters of the foreground and the background, and it will be favorable for the feature extraction. Secondly, we construct the geometric area ratio (GAR) feature vector to intensify the patterns to simplify the successive state recognition. Thirdly, a novel state recognition algorithm (NSRA) can correctly classify the states of the unknown patterns. Experiments demonstrate the ITS has a best edge effect than the Wavelet method. The proposed GAR feature vector is effective to reflect the similarity of the samples in same Log operator method. The presented NSRA is suitable for the state recognition of the target in an image. In the other words, the proposed algorithm can recognize effectively and correctly the unknown patterns.

Keywords: State recognition; Feature extraction; Image processing; Geometrical area ratio

1. Introduction

State recognitions were widely used in intelligent systems (Shi & Xu, 2007; Li et al., 2012; Sun et al., 2011). It could identify whether the interested object in normal state or in abnormal state. Meanwhile, image processing can enhance the useful information and remove the useless information (Avilés et al., 2011; Cruz et al., 2010). Therefore, the state recognition based on the image processing can recognize if the target of an image is in normal state or in abnormal state. The addressed problem of this paper is how to extract the features from medical images and implement the state recognitions. Aiming at the problem, an algorithm of the state recognition of geometric area ratio (GAR) was developed for the target of a medical image. So the works of this paper had great theoretical importance and practical significance.

Because of the limits of the imaging mechanism of imaging devices, the acquisition condition, the display equipment and other factors can sometimes lead to a misunderstanding when people view the image. In this situation, a computer were employed to process the image and make the computer-aided decision.

The computer-aided decision involves mainly the two fields of feature extraction and pattern recognition. That is to find the state features and classify the state to the normal class or the abnormal class. Then feature extraction and pattern classification based on the image processing have become the focus of the state recognition. The computer-aided decision can judge the target of the image whether or not in a normal state. The classification result can be a reference for the state judgment.

For the target volume estimation, Chang et al. (2010) used the radial basis function neural network to classify the region into the object area and uninterested area. Although the target volume estimation were promising based on the approach, it is difficult to choose the scaling parameter of the radial basis kernel function.

In order to extract the textural features of the target, the fuzzification of the local binary pattern approach was used to make the feature robust (Keramidas et al., 2008). However, it is difficult to determine a proper fuzzy membership parameter. Then scientists (Chang et al., 2011) used neural network for the target segmentation and volume estimation.

In a different way, the local intensity variance (Chen et al., 2009) at each pixel position is compared to a threshold to determine all pixels belonging to foreground region or background region. Those statistical features are estimated from the histogram of the local intensity variance of all pixels by maximizing the likelihood function. However, the choice of a proper threshold is usually difficult. Besides, statistical models (Corcoran et al., 2011) are commonly used approaches for background modeling and foreground segmentation. Nevertheless, computing such statistics of an image is sometimes not enough to achieve a good discrimination.

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In order to determinate the parameters of foreground-background, the block means of the brightness distortion and lightness distortion were used to updates the codebook to segment the foreground (Li et al., 2010). However, this approach is only a framework and the detailed works should be completed.

For the image recognition, Xuan and Shen (2009) presented a cognition algorithm based on the difference of the subspaces. The algorithm utilizes sufficiently the relativity of principal component analysis eigen-subspaces of the total samples and individual sample spaces, so that it improved efficiently the recognition rate.

Ito et al. (2005) presented a robust recognition algorithm using phase-based image matching. In this algorithm, the 2-dimensional discrete Fourier transformation was used. Furthermore, Xu and Lei (2008) proposed an algorithm with the combination of skeleton and moment invariants. A two-layer generalized regression radial basis neural network is adopted to do machine self-learning and target-identifying. In order to solve the small sample problem of neural network, support vector machines (Zou, 2009) are used to analyze the characteristics of roadbed diseases, and the general purpose register echo signal recognition algorithm is brought up.

Different from the above algorithms or methods, this paper developed an improved threshold segmentation (ITS) method to obtain the optimal parameters of the foreground and the background, and it will be favorable for the feature extraction. In addition, the geometric area ratio (GAR) technology was established to construct the feature vector. Finally, a novel state recognition algorithm (NSRA) was proposed to classify the states of the unknown patterns. In section 1, we stated the meaning and the actuality of this study. In section 2, we described the relative works which include feature selection, feature extraction and iterative threshold segmentation. In section 3, ITS, GAR algorithm, the decision rule, the classifier structure, the generation of the clusters, and NSRA were developed. In section 4, the experiments and comparison analyses were given to demonstrate the ITS, GAR, and NSRA. Finally, the conclusions are in section 5.

2. Feature extraction and image segmentation

Feature selection and feature extraction are the most important parts in pattern recognition because they influence dramatically the final classification correctness. Therefore, a proper feature space determination is one of vital tasks in a pattern recognition system. Feature selection is to choose the features from the original data. Feature extraction is to transform the original data to obtain the features which can reflect the essential differences of different classes. In a normal case, the ratio of the sample number N and the feature number n should be large enough. Typically, N is about 5 to 10 times of n (Chen & Chung, 2011).

2.1. Feature selection

The first stage of the image recognition design is features selection. How to select a set of features that can improve maximally the classification effect is the key work. In general, the large number of features that are related to each other will result in the duplication and the waste of information. Moreover, it is difficult to calculate the large number of data. In order to simplify the calculation, the number of feature should be reduced by feature selection or feature compression.

Assuming $F = \{f_1, f_2, \ldots, f_d\}$ is a d-dimensional feature space, feature selection means to delete some features from the original d-dimensional feature space, and a new feature space R is obtained. Because R is a subset of F, each element r_i of R has a corresponding element f_i of F, $r_i = f_i$. In the process of classifier design, the feature choice is very important to describe an object. Feature selection gives up some features which have little contribution to classification meanwhile some features which can reflect the classification essence are kept.

2.2. Feature extraction

Assuming $F = \{f_1, f_2, \ldots, f_d\}$ is a d-dimensional feature space, feature extraction means to extract some of features from the original d-dimensional feature space. The samples of the new concise feature space R is described by n features.

$$R = \{r_1, r_2, \ldots, r_n\}, n < d \tag{1}$$

Feature extraction is to find a mapping relationship M.

$$M : F \rightarrow R \tag{2}$$

The above mapping relationship should make the dimension small than the original dimension (Bag & Sanyal, 2011). Every component r_i of R is a function of the components of the original feature vector.

$$r_i = M(f_1, f_2, \ldots, f_d) \tag{3}$$

2.3. Iterative threshold segmentation

The traditional iterative threshold segmentation algorithm (Martinez et al., 2011; Li & Kim, 2010) is based on the approximation thinking. Firstly, an initial threshold value S_0 should be select as the follow.

$$S_0 = (g_{\max} + g_{\min}) / 2 \tag{4}$$

where $g_{\max}$ and $g_{\min}$ are the maximum gray value and the minimum gray value of the image respectively. Secondly, the image is segmented to the foreground area R_1 and the background area R_2 according to S_0. Thirdly, calculate the new segmentation threshold S_1.

$$S_1 = (g_1 + g_2) / 2 \tag{5}$$

where g_1 is the mean gray value of the area R_1 and g_2 is the mean gray value of the area R_2.