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Region based segmentation and analysis of carpal bones using fuzzy c means algorithm

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ABSTRACT

Image segmentation plays a crucial role in many medical-imaging applications, by automating or facilitating the delineation of anatomical structures and other regions of interest. We present a novel framework for segmentation of 2-D image of a subject at articulated positions. During this process, Fuzzy Cluster Means Algorithm is used in an iterative refinement of the segmentation of the bone. As the subject is segmented, the model is updated, improving the accuracy of successive segmentations. The evaluation result also shows that our purposed framework achieved more efficient segmentation than Grow Cut Algorithm with the error of 0.10±0.20. Current segmentation approaches are then reviewed with an emphasis on the advantages and disadvantages of these methods for medical imaging applications. We conclude with a discussion on the future of image segmentation methods in biomedical research.

Key words: Articulated joint, carpal bones, 2-D image segmentation, wrist.

INTRODUCTION

Diagnostic imaging is an in valuable tool in medicine. Magnetic resonance imaging (MRI), computed tomography (CT), digital mammography, and other imaging modalities provide an effective means for noninvasively mapping the anatomy of a subject. These technologies have greatly increased knowledge of normal and diseased anatomy for medical research and are a critical component in diagnosis and treatment planning. The growing size and number of these medical images have necessitated the use of computers to facilitate processing and analysis. In particular, computer algorithms for the delineation of anatomical structures and other regions of interest are becoming increasingly important in assisting and automating specific radiological tasks.

A. Bone: Bones are rigid organs that constitute part of the endoskeleton of vertebrates. They support and protect the various organs of the body, produce red and white blood cells and store minerals. Bone tissue is a type of dense connective tissue. Bones come in a variety of shapes and have a complex internal and external structure, are lightweight yet strong and hard, and serve multiple functions.

B. Carpel Bones: Carpal bone, any of several small angular bones that in humans make up thewrist (carpus).It is the anatomical assembly connecting the hand to forearm. The main role of the carpus is to facilitate effective positioning of the hand and powerful use of the extensors and flexors of the forearm, but the mobility of individual carpal bones increase the freedom of movements at the wrist.

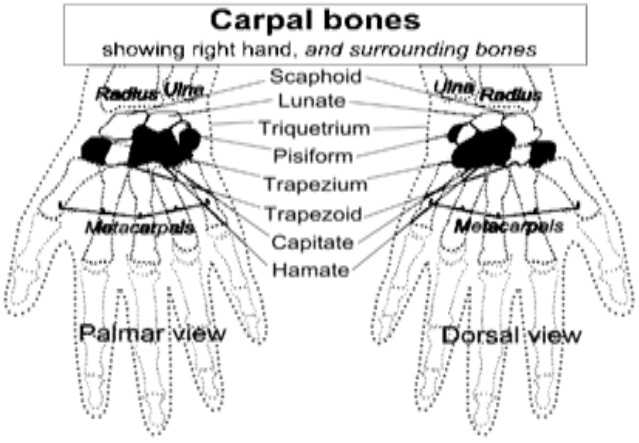

Figure.1.Carpal bones

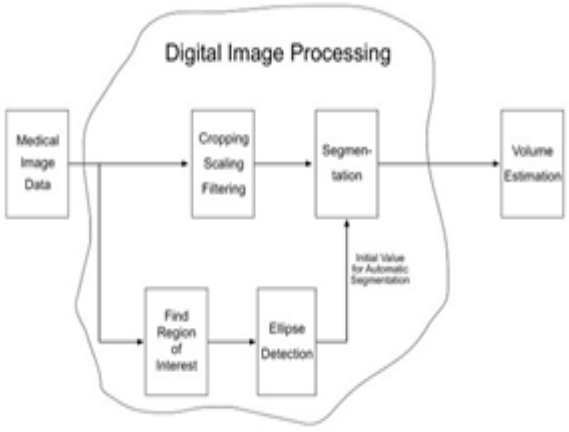

Figure.2.Block diagram of image segmentation

Image segmentation: In computer vision, image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

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Clustering method: Clustering algorithms essentially perform the same function as classifier methods without the use of training data. Thus, they are termed unsupervised methods. To compensate for the lack of training data, clustering methods iteratively alternate between segmenting the image and characterizing the properties of each class. In a sense, clustering methods train themselves, using the available data. Three commonly used clustering algorithms are the K-means or ISODATA algorithm, the fuzzy c-means algorithm, and the expectation maximization (EM) algorithm. The K-means clustering algorithm clusters data by iteratively computing a mean intensity for each class and segmenting the image by classifying each pixel in the class with the closest mean. The fuzzy c-means algorithm generalizes the K-means algorithm, allowing for soft segmentations based on fuzzy set theory. This lack of spatial modeling, however, can provide significant advantages for fast computation. Work on improving the robustness of clustering algorithms to intensity inhomogeneities in MR images has demonstrated excellent success.

Region based segmentation: Region based methods are based on the principle of homogeneity - pixels with similar properties are clustered together to form a homogenous region. The criteria for homogeneity is most of the time gray level of pixels and this criteria can be specified by following conditions. This is as per the set theory of homogeneity.

Region based segmentation is further divided into three types based on the principle of region growing,

- Region merging
- Region splitting
- Split and merge

Region merging: In this method some seeding points are required to initialize the process, the segmentation results are dependent on the choice of seeds. Regions are grown iteratively by merging the neighboring pixels depending upon the merging criterion. This process is continued until all pixels are assigned to their respective regions as per merging criterion.

Region splitting: Its principle is just opposite to region merging and whole image is continuously split until no further splitting of a region is possible.

Split and merge: This is the combination of splits and merges utilizing the advantage of the two methods. This method is based on quad quadrant tree representation of data whereby image segment is split into four quadrants provided the original segment is non-uniform in properties. After this the four neighboring squares are merged depending on the uniformity of the region (segments). This split and merge process is continued until no further split and merge is possible.

The algorithm for split and merge follows the following steps:

- Define homogeneity criterion. Break image into four square quadrants.
- If any resultant square is not homogeneous split it further into four quadrants.
- At each level merge the two or more neighboring regions satisfying the condition of homogeneity.
- Continue the split and merge until no further split and merge of region is possible

Apart from the above-mentioned techniques watershed segmentation based on the concept of topography and hydrography is also a region-based segmentation.

CONCLUSION

In view of the fact, the initially developed FCM makes use of the squared-norm to determine the similarity between prototypes and data points, and it performs well only in the case of clustering spherical clusters. Furthermore, several algorithms are developed by numerous authors based on the FCM with the aim of clustering more general dataset. During the survey, we also find some points that can be further improvement in the future using advanced clustering technique to achieve more efficient accuracy in the result and reduce the time taken for data and/or information retrieval from large dataset. Future research in the segmentation of medical images will strive toward improving the accuracy, precision, and computational speed of segmentation methods, as well as reducing the amount of manual interaction.

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