

## REVIEW ARTICLE

**RESEARCH ON REALIZATION METHODS OF DIAGNOSTIC IMAGING IN SPORTS MEDICINE**Xu Lifa<sup>a\*</sup> and Zhang Chao<sup>b</sup><sup>a</sup>National Institute of Education, Nanyang Technological University (NIE NTU), Singapore<sup>b</sup>Department of Biochemistry, Medical College of Anhui University of Science & Technology, Huainan 232001, P.R. China

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## ARTICLE DETAILS

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## ABSTRACT

In this paper, medical images are used to realize the computer-aided diagnosis (CAD) system which develops targeted solutions to existing problems. Relying on the MiCOM platform, this system has collected and collated cases of all kinds, based on which a unified data model is constructed according to the gold standard derived by deducting each instance. Afterwards, the object segmentation algorithm is employed to segment the diseased tissues. Edge modification and feature extraction are performed for the tissue block segmented. The features extracted are classified by applying support vector machines or the Naive Bayesian classification algorithm. From the simulation results, the CAD system developed in this paper allows realization of diagnosis and treatment and sharing of data resources.

## KEYWORDS

CAD, aided diagnosis system, DICOM, medical imaging.

**1. INTRODUCTION**

In order to ease the highly concentrated energy of medical staff in admissions and treatment, help improve doctors' judgments of diseases, reduce their diagnostic error rates, and heighten the degree of sharing various cases (original medical images, typical medical cases, data storage formats and forms, process data for realizing aided diagnosis, etc.) in the medical industry, medical and research communities are striving to develop a complete set of medical systems allowing computer-aided medical diagnosis, namely the CAD system (Thomas et al., 2005). This system is mainly to segment original medical images located in the diseased tissue, and this segmentation is carried out based on the symptom characteristics of various types of diseases. A variety of image segmentation methods are used to segment the target diseased tissue as per its structural constitution and make a comparison between the diseased tissue segmented and the features from the medical library features. Extract the tissue characteristics and finally classify similarities and differences between the features. This is a computer-aided diagnosis process performed by the CAD system using medical images, and also a hotspot of research.

Research into CAD can be traced back to the 1980s when some countries began to construct CAD systems applicable to various illness conditions, which aimed to help medical workers work in a better and more convenient way (Elon et al., 2015). Among them, most works are about CAD systems for diagnosing breast cancer by using the principles of X-ray imaging, and this technology development has been mature relatively. Some countries have applied aided diagnosis systems for breast cancer in clinical diagnosis and treatment and received significant effects. However, a complete set of CAD systems should have covered other various diseases to support diagnosis and treatment of universally available objects. Nevertheless, currently CAD systems still cannot be used in all clinical

diagnoses mainly for the following reasons:

First, there is much research on CAD algorithms, but virtually it is difficult to collect test samples to verify algorithm experiments and it is impossible to conduct further research on algorithms. Here are some of the challenges (Xiangrui et al., 2011): (1) CAD simulation experiments require a large number of medical imaging data, and these data are costly to acquire and the experiments need massive images. In the current stage, such factors as limits on the number of cases and high research costs have limited the development of CAD research. (2) With respect to segmenting diseased tissues in videos and images, the difficulty lies in how to distinguish between normal and diseased tissues, such as how to diagnose whether a tumor is benign or malignant after segmenting tumor images. Here the distinguished boundary is called a "gold standard" for diagnosing medical cases. Visibly, great difficulty to set gold standards and construct gold standard models for all kinds of diseases has impeded existing research.

Second, it is unable to unify resource sharing and research standards. Research on CAD will involve numerous medical videos and images, as well as subsequent segmentation, feature extraction and data set generated by classification. At present, there is a lack of sharing and communication platforms, so researchers and medical staff are unable to interact and spread test samples, experimental data and reviews, which result in narrow-minded data integration and a lot of repeated experiments and are un conducive to help solve common difficulties encountered by new teams.

Finally, currently there have not been internationally recognized specifications for gold standards regarding all types of diseases and all teams develop their "gold standard" depending on their own experimental samples, without making effective comparisons at the horizontal level (Gatta et al., 2015). All team improve algorithms and evaluate their effects in accordance with their respective standards, which are not generalized

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or persuasive. Therefore, in terms of accelerating CAD research, there are urgent needs to develop an internationally recognized “gold standard” for unified model and experimental database.

According to some contents and problems existing in the current CAD system development process, a data sharing platform is presented that can harmoniously use various resources targeting at collection of medical cases, development of the “gold standard”, resource sharing of research processes and results, and lastly evaluation of system effectiveness. In addition, the Oracle database (Shuqun et al., 2008) and VC++ software development platform are adopted for system simulation, while simulation experiments are conducted to successful study and judge MRI evaluation of gliomanature and CT scanning for auxiliary diagnosis of lung cancer (Allen et al., 2015).

## 2. DATA PLATFORM NEEDS ANALYSIS

### 2.1 The use of shared data

The development of CAD systems will involve a large number of research data, encompassing image data of various medical cases, sample data for constructing a “gold standard” model, intermediate data generated during experiments and reference data provided by routine clinical diagnoses.

In order to construct a set of functional CAD systems suitable for medical cases of all kinds, possessing a wide variety of original images and diagnostic models for different medical cases is the foundation. Currently, the medical field has set DICOM as a shared standard for data transfer and storage between medical imaging devices, so CAD construction schemes proposed in this paper must comply with the current DICOM standards (Mildenberger et al., 2014), support interface connections of various types of equipment and facilitate data reading and storage.

A premise of computer-aided medical treatment is to devise a “gold standard” so that there are unified evaluation criteria for some medical cases or measures in the current diagnosis and treatment system. The aim of developing this standard is to create unified labels of the diseased tissue during computer-aided medical treatment, while these processes and methods of labeling are accumulated by computer simulation and learning as per clinical works of multiple medical experts. During this process, if “creating a label” is seen as a division, then before it the computer globally detects and locks the target position, and after it the computer judges whether the diseased tissue is malignant or benign according to the label.

The key technology in CAD research lies in segmentation of diseased tissues and extraction of corresponding features. The data sets acquired after data extraction and integration serve as the basis and guarantee whether subsequent experiments can go smoothly. In this process, data storage should subject to the dynamic management philosophy, because the system’s use objects involve the diagnosis and treatment of multiple research teams and various diseases. The data storage form and content are complex, which involve not only the block size, shape and density of diseased tissues (Fedorov et al., 2013), but also the hybrid features of different diseases of the same form. Therefore, dynamic medical data management implemented on the CAD system can facilitate specific applications later.

### 2.2 Platform Business Modules

Figure 1 shows multiple business function modules involved in the CAD system development process in this paper, consisting of acquisition of various types of disease samples, development of the “gold standard”, segmentation and feature extraction of diseased tissues, algorithm classification of diseased tissues extracted and eventually mechanisms for evaluating the effectiveness of classification algorithms.

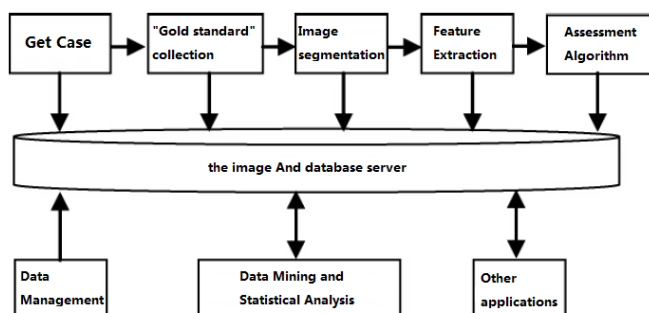


Figure 1: Business function modules CAD system involved

In this paper, simulation experiment data used in the CAD system are mainly from the operating PACS system (Dean et al., 2010) in current hospitals, diagnostic data of medical imaging collection business from various departments, and process data being researched by a number of fraternal teams. When using data from clinical sample images, it is necessary to remove patient information in addition to case information, and finally only DICOM original medical imaging, information of equipment that collects images, and image parameter setting information are imported into the database. Since the medical image storage has an excessively large capacity, only server address and extraction path of images are stored in actual data storage, as well as basic information such as folder names of images stored in the server.

When setting the diagnostic “gold standard” in CAD systems, it is necessary to label the collected original case images, and this process of labeling requires blending medical experience from a number of experts. Specialized medical imaging annotation tools are adopted to label the edge of diseased tissues with corresponding annotations. In order to make the processes of labeling and extraction more intelligent, labeling and extraction algorithms with a self-learning mode can be employed. Based on forms and trends of diseased tissues, label regions in a self-adaptive way according to some threshold value. Extract the target tissue in accordance with the marked trajectory and adjust the edge region of diseased tissues extracted in combination with expert remediation strategies.

When developing CAD systems, unifying the modes and storage formats for various types of data will conduce to smoothly carrying out subsequent experiments and making horizontal comparisons of research achievements among different research teams. Besides, evaluation systems provided by CAD involve multiple regards, including algorithm evaluation and evaluation of specificity of diseased lesions.

## 3. DATA MODEL

Fig.2 shows a standardized reference model defined by CAD systems, including the current system’s target user, experiments for diagnosing diseases, original medical imaging data, the “gold standard” strategies developed based on reality, operating results of classification algorithm, and the like. This model is applicable to study a variety of conditions, by which users can create one or more accounts in accordance with the actual needs, with each account corresponding to one patient’s diagnostic work.

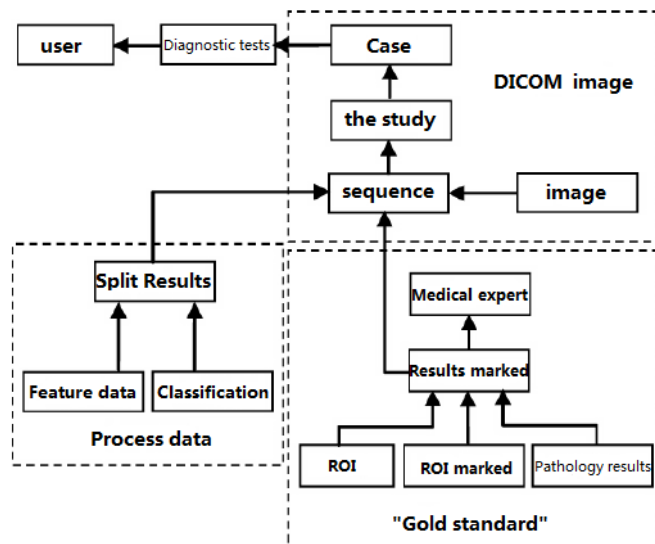


Figure 2: The standard model defined

From the DICOM standard, we know that sample data are stored in tune with some class and sequence. First, a storage sequence is composed by disease categories and some typical properties of patients, process data of one or more research carried out focusing on the current conditions, as well as a number of check indexes involved in a study. Then the sequence is stored in the DICOM hierarchical model data block.

According to the principles of ROI, feature extraction standards recognized in the medical field, and ROI data obtained by clinical surgical mobile phones, experts compare and verify these data in accordance with their work experience, correct unappropriated places and improve relevant operating standards in CAD systems.

The dynamic data management mechanism in CAD systems is targeted in terms of information storage. Store a plurality of classification results acquired from a segmentation algorithm and store different features extracted from the same feature extraction algorithm. In the same vein, store different diagnosis results acquired from using different classification algorithms<sup>[12]</sup>.

## 4. SYSTEM IMPLEMENTATION AND APPLICATIONS

### 4.1 Realization of the system platform

The development and realization of CAD system functions should be underpinned by a database with late extended and portable functions for storing medical image data, other related equipment information and experimental data. In addition, the data structure for this database is also applicable to DICOM's standardized format and XML Read/Write. With reference to DICOM's standardized format, this paper adopts OFFIS Company's toolkit DCMTK<sup>[13]</sup> for secondary database development and uses VC++ to realize software features of the data platform. By directly using a development toolkit to develop the data platform, we can sharply reduce the time cost for redevelopment, which is also in line with the extensibility concept in software design.

The CAD system developed in this paper enjoys great advantages in retrieving, consulting and annotating medical images in DICOM. In order to improve annotation accuracy and labeling efficiency, research and development staff have integrated diversified classification algorithms on the system platform. When performing appropriate operations, doctors can run the classification algorithm only by retrieving the corresponding function module. The platform supports both automatic and manual segmentation of target diseased tissues, as well as manually annotating, querying and browsing regional content. In addition, the platform is equipped with self-learning and management functions and can initiate self-organization and management following the machine learning way<sup>[14]</sup>.

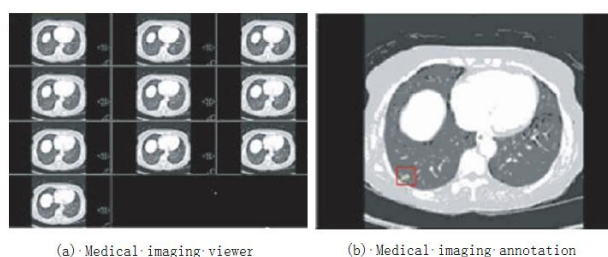


Figure 3: Marks in medical imaging

### 4.2 Diagnostic Applications

When doing simulation research of CAD systems, this paper studies and judges MRI evaluation of gliomas and evaluates CT scanning for diagnosing lung cancer in the chest by different grades. In diagnostic experiments on MRI evaluation of gliomas, 300 representative cases were selected; each case had clear pathological causes and corresponding severity grade. Further, a number of experts worked together to label the regions of diseased tissues and extract and segment feature positions for these 300 cases. Similarly, on the diagnosis of lung cancer using CT scans, a total of 400 cases were gathered in this paper and all the information has been input in the database system. The block size, density and severity of specific diseased tissues were attained from these conditions to build a "gold standard" model. This "gold standard" data model provides solutions to the diagnosis of similar diseases later. By employing the current system platform model, we can extract some tissue shape and regions of a particular size by using algorithms for the diagnosis and treatment of lung cancer.

## 5. CONCLUSION

In order to address the problem that data resources in current medical research, clinical diagnosis and treatment and computer-aided diagnosis

data in medical imaging cannot be shared, this paper has designed and developed a CAD system for sharing all kinds of materials, functional algorithms and tools in medical research.

Firstly, obtain conditions for diversified diseases through various channels like other medical imaging repository and diagnoses of clinical cases, attain process data from research progress and clinical diagnostic reports, analyze the above data by certain forms of organization, get the corresponding "gold standard" model, and use a database to store all kinds of resources and parameters of the "gold standard" model. Secondly, analyze and induce all kinds of cases acquired from the previous step, apply various parameters of the "gold standard" to diseased tissues, segment diseased tissues by blocks and extract their features, and then classify the extracted features by a suitable classification algorithm in order to complete a periodical "gold standard" data reference model. Finally, use DCMTK toolkit and VC++ programming software together to achieve the functions of the CAD system. The simulation treatment of both gliomas and lung cancer illustrates that the current system platform can be applied to computer-aided diagnosis in medical imaging.

The CAD system has blended functional modules of all of the above steps, which provides uniform, standardized application standards and auxiliary support for medical research and clinical diagnosis. Various types of segmentation algorithms, feature extraction algorithms and classification algorithms are loaded in the uniform system module in the form of components, which both ensure the unity of components, but also lay the foundation for expanding and transplanting the system later, thus largely saving time and effort on repeated development and improving the advancement extent of the present study.

The development and application of the CAD system has provided a unified, standardized data storage format for the medical system at this stage, pointed out direction for a new phase of research in this field, and provided a new way of thinking in specific medical imaging applications and large data retrieval, among others.

## REFERENCES

- Allen, R., Rafael S., John K. 2015. Computer-aided diagnosis in medical imaging diagnosis[J]. Health Vocational Education, Vol. 29, No. 19, Pp. 154-155.
- Fedorov, A., Clunie, D., Ulrich, E. 2013. Based on medical imaging scale space multi-feature fusion classification[J]. Computer application, Vol. 33, No. 4, Pp. 1108-1114.
- Gatta, R., Abeni, F., Buglione, M., Peveri, A. 2015. Current Situation and Prospect of medical image analysis[J]. Biomedical Engineering, Vol. 27, No. 2, Pp. 175-181.
- M. Elon, G., Daniel, R.G. 2015. Medical image acquisition and Standardization[J]. Electronics Engineer, No. 10, Pp. 410-412.
- Mildenberger, P., Wein, B., Bursig, H.P. 2014. Computer-aided diagnosis perfusion analysis model[J]. Application Research of Computers, Vol. 26, No. 3, Pp. 1189-1191.
- Shuqun, X., Donglan, Y., Xianli, W., Kuijian, W. 2008. Advances in computer-aided diagnosis of clinical research[J]. Modern doctors, Vol. 46, No. 21, Pp. 78-88.
- Thomas, T., Philipp, L. 2005. Medical image communication standard DICOM Principles and Applications[J]. Modern Medical Imaging, Vol. 9, No. 2, Pp. 84-87.
- W. Dean, B., Steven, C.H. 2010. The main method of computer-aided diagnosis technology research and application of image texture[J]. Tissue Engineering Research Clinical Rehabilitation, Vol. 13, No. 39, Pp. 7721-7727.
- Xiangrui, L., Paul, S.M., John, A., Jolinda, S. 2011. To explore the computer-aided diagnosis system of radiological emergency[J]. Medical equipment, Vol. 26, No. 11, Pp. 89-90.