Application of DICOM in Electrical Impedance Tomography

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Abstract: Medical imaging devices including EIT systems are required to be integrated in the clinical information systems. Combining DICOM industrial standard with Open EIT file format can lead to the result, appropriate both to clinical requirements and research community. Successful implementation of the DICOM format for data storage in real EIT system is described here.

1 Introduction

Any medical device pretending to be used in general practice rather than in marginal areas of medicine must be capable of being integrated in the clinical information systems. This supposes compliance with corresponding standards of the data exchange and storage. For the imaging devices such a standard is DICOM (Digital Imaging and Communications in Medicine) [1]. De facto DICOM is the only worldwide used medical data framework, which is adapted even for non-imaging modalities such as electrocardiography. EIT, which makes modest steps in clinical practice and frequently, suffers from lack of this compliance. Customers just refuse to buy equipment if it does not support at least export to the DICOM format. On the other hand, the scientific community needs some common data exchange facilities to share and interpret experimental data. Open EIT initiative is primarily aimed at this task, and the first version of the EIT data storage format is almost ready [2]. Combining industrial DICOM standard with Open EIT internal data arrangement can lead to the result, appropriate both to the requirements of the clinical applications and research community demands.

DICOM is a standard of processing, storage, printing and transmitting information in medical imaging systems. It includes a description of the file format and network protocol. Network protocol uses TCP/IP as the basis for communication among systems. Also systems that support reading and writing DICOM files can simply exchange files in this format. DICOM enables the integration of scanners, servers, workstations, printers, and network equipment of different manufacturers in a single system named PACS (picture archiving and communication system).

2 Methods

In response to many requests from medical community and authorities we have started development of a next software version for the Multifrequency Electrical Impedance Mammography system MEM to achieve DICOM compatibility. MEM is an EIT system with 3D visualization [3, 4]. Before this development the MEM data were stored in a proprietary format, which combines binary and xml data, readable only by the native software.

DICOM is considered sometimes as just a particular image storage format equal to jpeg, png and so on. In fact, the DICOM file is a specialized data base, which can store some mandatory text fields such as patient's social data, equipment and physician identifications, examination conditions as well as binary pixel data including series of images or multiple cross-sections. Every conventional DICOM viewer can extract and display these data. In addition**,** DICOM standard makes provision storing an arbitrary text or binary data in so-called raw data modules in the same file. Format of such raw data entries is wholly specified by the vendor. For example**,** they are used for storing MRI or CT raw measurements to make possible further image reconstructions with different parameters. EIT can use this possibility in the same way: we can store results of electrical measurements and other specific data in the raw data module inside a DICOM file. Certainly, this part of DICOM data is readable only by specialized software.

At the first stage we have implemented the DICOM export and import facilities inside existing MEM software. Corresponding procedures are coded as a dynamically loaded library using resources of DCMTK open source project [5]. The raw data storage part of the library is not device specific, so it can be used with other EIT systems. The next step is transition to using DICOM files instead of our native data storage format. This will make it possible to view and store EIT data in the clinical information system without export/import steps. The further development would be implementation of the DICOM network protocol for direct communication with the data storage servers.

3 Conclusions

DICOM data format has been successfully used in the commercial EIT application as for storage of the general patient data and reconstructed images as well as for EIT specific data storage, including raw measurement results. Because of flexibility of the raw data file module in DICOM format, it is possible to combine it with the Open EIT format suggested by the community. This supposes storing the reconstructed images and general information in the corresponding DICOM modules while encapsulating the rest of Open EIT data in the raw data module instead of zipping them in archive.

References

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