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Multimod Data Manager: A tool for data fusion

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ABSTRACT

Nowadays biomedical engineers regularly have to combine data from multiple medical imaging modalities, biomedical measurements and computer simulations and this can demand the knowledge of many specialised software tools. Acquiring this knowledge to the depth necessary to perform the various tasks can require considerable time and thus divert the researcher from addressing the actual biomedical problems. The aim of the present study is to describe a new application called the Multimod Data Manager, distributed as a freeware, which provides the end user with a fully integrated environment for the fusion and manipulation of all biomedical data. The Multimod Data Manager is generated using a software application framework, called the Multimod Application Framework, which is specifically designed to support the rapid development of computer aided medicine applications. To understand the general logic of the Data Manager, we first introduce the framework from which it is derived. We then illustrate its use by an example—the development of a complete subject-specific musculo-skeletal model of the lower limb from the Visible Human medical imaging data to be used for predicting the stresses in the skeleton during gait. While the Data Manager is clearly still only at the prototype stage, we believe that it is already capable of being used to solve a large number of problems common to many biomedical engineering activities.

1. Introduction

The work of the biomedical engineer is increasingly based on the simultaneous use of data sets that have come from disparate sources. It is common to use data from multiple medical imaging modalities, and to combine these with biomedical measurements and results from computer simulations. This poses a number of technical problems including the interpretation of different storage formats, spatial and temporal registration, feature extraction, classification and segmentation, interactive visualisation, etc.

There are specialised tools that may help to solve each of the individual problems, but this implies that we routinely have to use a large number of software tools that are, in general, expensive, demanding to learn, and difficult to combine into a smooth or semi-automatic workflow.

Examples of the various software categories are commonly referred to in the literature. AVS/Express [1], OpenDX [2], and SCIRun [3] are general-purpose scientific visualisation environments organised around the data flow paradigm. Amira [4], 3D Doctor [5], and Mimics [6] are 3D visualisation applications that excel in image processing activities such as segmentation.

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3D Slicer [7] is an application mostly focused on neurosurgery problems. Other programs, such as OsiriX [8] are specialised in the visualisation of medical images only. There are some solutions that provide an integrated environment, e.g. Analyze [9], but they are limited to medical and geometric imaging. A promising environment still under development, the Julius framework [10], aims to provide a more integrative approach but it mainly focuses on medical imaging and computer-aided surgery.

The present study describes a new application, the Multimod Data Manager (hereafter simply called the Data Manager), which is distributed as freeware. The Data Manager provides the end user with a fully integrated environment for the fusion and manipulation of all biomedical data and does not necessarily demand any knowledge of programming from the user.

2. Description of the Data Manager

The Data Manager is an application developed using a software application framework called the Multimod Application Framework (MAF), which is specifically aimed at providing a supportive environment for the rapid development of computer aided medicine applications. A detailed description of MAF and its capabilities is presented in [11]. MAF is currently being developed through the OpenMAF Open Source collaborative development initiative [12], and distributed under a BSD-like license, which allows the use of MAF for the royalty-free development of commercial applications.

Although MAF is a cross-platform software environment that can be compiled under multiple operative systems, the Data Manager is currently developed only for Microsoft Windows operating systems. All examples in this paper were produced using a standard personal computer equipped with an Intel P5 processor running at 2.8 GHz, 1 GB of RAM, a 120 GB hard disk, and a Radeon 9200 Pro graphic board, running at a screen resolution of 1024 × 768. We used Data Manager v1.2.1 running under Microsoft Windows XP SP2.

At launch, the Data Manager exposes a relatively simple user interface (Fig. 1). A menu bar is placed at the standard position in the upper part of the screen, while a message area is positioned at the foot. On the right of the screen, there are four tabbed frames, named Tree, View, operation and VME. These correspond to the four fundamental concepts that one needs to master to use the Data Manager effectively. The remainder of the screen is left free for the various Views that the user can open while using the program.

An essential feature of the Data Manager is its ability to import virtually any type of biomedical data into a hierarchical data structure in which each data block is called a Virtual Medical Entity (VME). Each VME contains a dataset, a pose matrix that defines the position and orientation of the dataset, and a number of metadata attributes (textual information associated with the data themselves). Both the pose matrix and the dataset can be time varying.

The Data Manager can import 3D volumes generated from almost any medical imaging modality (CT, MRI, PET, SPECT, 3D Ultrasound) and written in DICOM format, the interna-

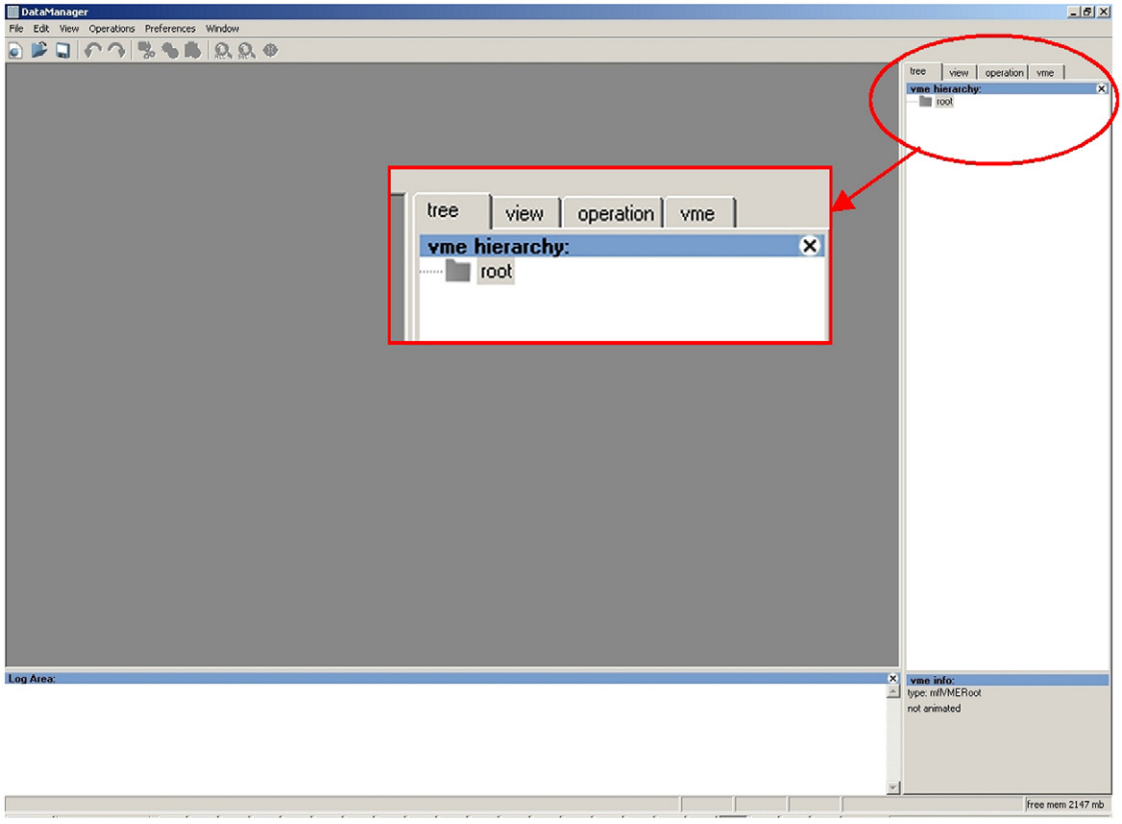

Fig. 1 – The Data Manager launch interface; the four tabbed frames are shown enlarged.