YACTA

a software system for analyzing lung CT images
supporting Big Data Analytics

Quick Start Guide

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1 Introduction

The YACTA Quick Start Guide is an introduction for the complete newcomer to a few essentials for getting off to a quick start with YACTA. Before you read on, verify that this guide matches your YACTA version.

1.1 What is YACTA?

YACTA is an acronym for *Yet Another CT Analyzer*. The aim of the software system YACTA is to support the user evaluating medical images – focus is on lung CT images. YACTA works with images in the DICOM file format (.dcm) - MetaImage format (.mhd) is also supported. The software system consists of two main parts:

- Yacta: tool for image processing.

- Process manager: tool for organizing the image processing tasks.

Main modules so far integrated in Yacta are:

- Module for parenchyma analysis in MDCT images.

- Module for airway analysis in MDCT images.

Lung CT scans can be analyzed with YACTA via:

- Windows Explorer context menu.

- Batch files.

- DICOM transfer using TCP\IP.

- GUI modus for more specific tasks.

The default quantification procedures work without any user interaction. Quantification results are pushed in a database. That means that YACTA is very suitable for Big Data Analysis and can support you in Big Data Analytics.

1.2 Who can use YACTA?

You are allowed to use the software if you get it directly from the developer's team. YACTA is a free CT analyzing system, but "free" does not meant that everything is permitted. You can use YACTA freely if you are in a university and use it for publishing, studying or teaching, but not if you are in the industry — in that case, please reach for the wallet. It is not allowed to redistribute the software.

1.3 Acknowledgements

Many people have contributed to the development of YACTA. In particular, I would like to thank: Tobias Achenbach, Craig J. Galbán, Claus Peter Heußel, Hans-Ulrich Kauczor, Terry E. Robinson and Mark Wielpütz.

YACTA is not perfect. Bug reports, suggestions for improvements, requests and questions to: weinheimer@uni-heidelberg.de .

2 Installing YACTA

2.1 System requirements

YACTA needs:

- Microsoft Windows 10 64bit (Win 7 and 8 may also work, but are not tested).

- recommended are at least 16 GB of RAM.

Known issues: 1) Using YACTA on a virtual machine can cause the software to crash, most likely due to graphic card issues. 2) Remote control of YACTA works with TeamViewer or VNC but not with RDP triggered by insufficient OpenGL support.

2.2 Installation

The installer YACTA_v2.8.x.y_setup.exe installs YACTA on your system. Make sure you run the installer as Administrator (i.e. right-click on the executable and choose "Run as Administrator") or you may run into permission problems later. The installer includes installers of the database system Firebird

and of the Microsoft Visual C++ 2012 and 2015 Redistributable packages.If you install YACTA the first time on your system and no Firebird server is installed then you can skip the first two points of the following recipe:

1. Backup YACTA database (default name is YCTDATABASE.FDB).

2. Uninstall YACTA and Firebird (if installed version < 3.0.4) via Windows Settings > Apps or Windows program menu entries.

3. Start YACTA_v2.8.x.y_setup.exe as administrator.

4. Install Firebird when prompted and set password for SYSDBA to "masterkey" (without quotation marks). See section 6.1 if you want to use a different password.

5. Install Microsoft Visual C++ 2012 Redistributable when prompted. The installer will recognize if it is already installed.

6. Install Microsoft Visual C++ 2015 Redistributable when prompted. The installer will recognize if it is already installed.

By default two desktop icons and a program menu entry YACTA are generated.

YACTA can be configured via the ini files yacta.ini and yactascp.ini, both files are located in Users\UserName\AppData\Roaming\yacta64. In Yacta yacta.ini can be opened via Help→Open ini-File ... yactascp.ini can be opened in the process manager under the tab Options→Open ini-File ...

Furthermore, various command line parameters are defined, see section 6 .

2.3 About YACTA Development

YACTA is written in C++, the development environments are Embacadero's C++Builder Rio 10.3[1] (Clang based compiler[2]) and Microsoft's Visual Studio C++ 14.0[3] on a 64bit Win10 system. Following libraries are used by source code:

- Visualization ToolKit (VTK)[4], version 7.1.1: VTK is an open source, freely available software system for 3D computer graphics, image processing, and visualization.

- Insight Segmentation und Registration Toolkit (ITK)[5], version 4.10.1: ITK is an open-source software toolkit for performing registration and segmentation.

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[1]http://www.embarcadero.com/
[2]http://clang.llvm.org/
[3]http://www.visualstudio.com/vs/cplusplus/
[4]http://www.vtk.org
[5]http://www.itk.org

- OFFIS DICOM Toolkit (DCMTK)[6], version 3.5.4: DCMTK is a collection of libraries and applications implementing large parts the DICOM standard.

- Clipper library[7], version 6.4.2: The Clipper library performs clipping and offsetting for both lines and polygons.

- Libmorpho[8] version 1.3: libmorpho is a free software library written in ANSI C that implements several basic operations of mathematical morphology.

- Dinkumware C++ Library (STL) 2018 edition [9]: Standard C and Standard C++ libraries.

- Boost C++ Libraries[10], version 1.68: Set of libraries for the C++ programming language that provide support for tasks and structures such as linear algebra, pseudorandom number generation, multithreading, image processing, regular expressions, and unit testing. It contains over eighty individual libraries..

Binary version of following software are used:

- Firebird[11], version 3.0.4 : Firebird is an open source SQL relational database management system.

- elastix[12], version 4.8 : elastix is a toolbox for rigid and nonrigid registration of images.

3 Using YACTA

3.1 First Steps

To check whether YACTA is successfully installed on your system, proceed as follows:

- Copy a lung/chest CT volume to a directory.

- Start Process Manager (the tool for organizing the image processing tasks, fig. 1) via double-click on the desktop icon or by the Windows Start Menu button, entry *YACTA > yactascp64 - lung processing.*

- Perform a right mouse button click on the directory containing the CT images in the Windows Explorer. Choose *Yacta: Process dir via yactascp.*

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[6]http://dicom.offis.de/dcmtk
[7]http://sourceforge.net/projects/polyclipping/
[8]http://orbi.ulg.ac.be/handle/2268/121494
[9]http://www.dinkumware.com/
[10]http://www.boost.org/
[11]http://firebirdsql.org/
[12]http://elastix.isi.uu.nl/

- A new line will be added to the Process Manager in the Tab Processes representing a new Yacta task, status will be *not started*, line background color is white. If a computation slot is free, the status turns to *running* and the background color of the line turns to yellow, see fig. 1.

- After finalization of the image processing task and if everything succeeded the line background turns to green (status finished), results as PDFs can be found in the directory containing the images and in the connected (default) database.

This method should be used if only a few CTs are to be evaluated. Multiple folders can be selected in the Windows Explorer and sent to the YACTA Process Manager at the same time. Tasks not started immediately are stored in a list with status *not started*. The number of allowed simultaneous running processes can be set in the options of the YACTA Process Managers, see section 4.

3.2   Analysing CTs located on HD or SSD

The method described in the following is useful if you want to evaluate many scans. Every CT scan should be located in a separate directory, all scans should be organized in a tree like structure, there should be one single root directory.

- Start Yacta (the tool for image processing, fig. 2) via double-click on the desktop icon or by the Windows Start Menu button, entry *YACTA > yacta64*.

- If not already open, open the Volume Manger (see fig. 3) form via *File > Search Volume ...*[13]. You can choose a drive in the drop-down-list in the left upper of the *Volume Manager* form, Yacta's current working directory can be changed by selecting a directory in the directory-list-box below the drive drop-down-list. Choose the root directory of your CT scan collection as current working directory.

- Mark the check box *Include Subdirectories*. Click on button *Search Volume(s)* button. Yacta will search for contiguous DICOM volumes in the entire directory tree structure. The found volumes will be displayed in a list-box below the *Search Volume(s)* button. This step may take some time depending on the size of the tree structure (seconds, minutes, hours).

- The found volumes can be sorted by clicking on the header of the columns. Any unnecessary rows can be marked and deleted. By clicking on the button *Generate all *.dcvs* for every DICOM volume a *.dcv file containing all the associated files DICOM files will be generated. Click on the button *Export Volume List* and a *.bat file containing one line for every task (volume) will be generated. Quit Yacta.

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[13] All menu items followed by dots will open another window.

Figure 1: Process manager. Tasks are displayed under the tab Processes. Background color depends on the status of the tasks.

- Start Process Manager. Load previously generated *.bat file via File > Load bat-file ... . All scans in the directory tree structure will be analyzed. If you have paired inspiratory/expiratory scans take care that the inspiratory scans will be analyzed first. If you analyze hundreds or thousands of scans this my take some time (minutes, hours, days) depending on the size of the tree structure.

3.3 YACTA as DICOM node

3.4 YACTA in GUI mode

4 Process Manager

The Process Manager is the tool for organizing the image processing tasks. It contains 3 tabs:

- Processes,

- Options and

- Database.

Fig. 1 shows the Process Manager with selected Tab Processes.

4.1 Processes

Tasks can be added to the processes list by:

- Windows explorer, see section 3.1.

- Batch file, see section 3.2.
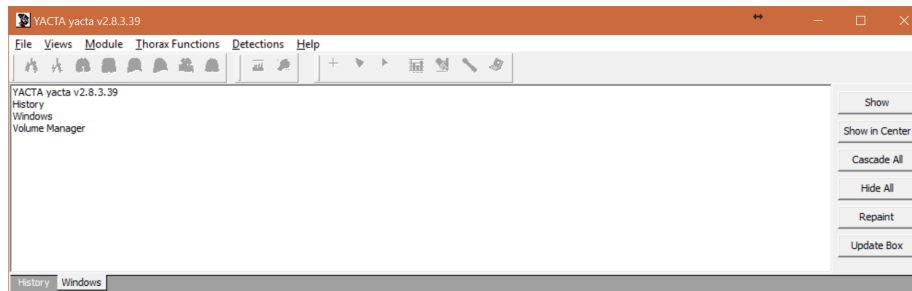
- DICOM transfer, see section 3.3.

Figure 2: Main form.

Newly added tasks are pushed to the end of the list:

- Initial status of a task is *not started*, white background.

- If a computation slot is available the status turns immediately to *running*, blue background.

- If Yacta calls external binaries e.g. image registration is done by calling the elastix toolbox the background turns to light blue, status *sleeping*.

- A technical successfully completed task receives status *finished*, background color green.

- Process *killed* by OS, background red.

- Process *stopped*, e.g. caused by access violation, background color ?.

- Process *terminated* orderly but no finished message was received, background purple.

4.2 Options

The number of allowed simultaneous running processes can be set in the options of the YACTA Process Managers. elastix uses per default all available logical CPU processors for registration tasks, this can be limited by setting the system variable ITK_GLOBAL_DEFAULT_NUMBER_OF_THREADS to the desired number of logical processors (threads) to be used.

4.3 Database

5 Yacta

5.1 Administration of DICOM volumes

The Volume Manager and the Volume Editor are tools for the administration of DICOM volumes. You can search for contiguous DICOM volumes with the Vol-
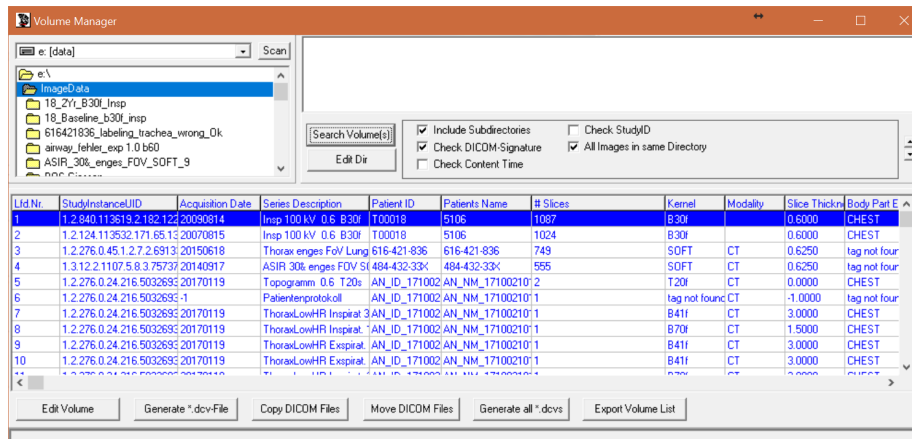
Figure 3: Volume manager.

ume Manager. The Volume Editor gives you a preview to the DICOM images. You can create partial volumes with the Volume Editor.

6 Configuration

6.1 Setting different firebird username and password

The user name and the password that are used by YACTA to connect to the firebird database can be configured via the ini files yacta.ini and yactascp.ini, both files are located in Users\UserName\AppData\Roaming\yacta64. UserNameDatabase and UserPasswordDatabase are the corresponding entries. Default combination is "SYSDBA" and "masterkey" for user name respectively password.

7 Trouble shooting

I am getting the error message: "Connection to database failed."

- Firebird user name and password incorrect: To adjust these values, see section 6.1.

- Firebird server not running: Start firebird server (Windows service).

- Database file does not exist: default location is ProgramData\yacta64\Temp\YCTDATABASE.FDB .

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