ECGViewer

Release Notes

Software version: 2004/02/22 Interim Release for OpenSCG Programming Competition

Document version: 2004/02/22

Changes.

Since the initial submission for the competition, the following changes in response to a request from the judging committee have been made:

- User control of scaling of both amplitude and time, as well as the height of each lead.

- Default scaling values that allow an entire 10-second 12 lead ECG to fit on the screen.

- Improved drawing performance to reduce sluggishness.

- Text dump of decompressed data in order to check quantitative accuracy of extracted SCP-ECG data (not part of the *com.pixelmed.displaywave.ECGViewer* application, but rather accessible to the user by supplying a third argument after the raw data output file to *com.pixelmed.scpecg.SCPECG*; see the javadoc).

In addition, the following changes have been made:

- Improved line drawing consistency and quality across multiple platforms by using a line width of 1.5, using a *GeneralPath* and anti-aliasing.

- Fixed bug that failed to add reference ECG beats when bimodal compression not in use

Abstract.

The freely available source code pure Java PixelMed Publishing DICOM toolkit has been extended to include support for the display of ECGs and the reading of DICOM ECG waveforms and SCP-ECG waveforms.

The primary purpose of the inclusion of this capability is to provide toolkit support for others developing applications. The toolkit is not primarily intended to contain clinically useful applications in their own right. However, for testing purposes, some basic applications to exercise the toolkit have been developed that may prove useful to others.

The *com.pixelmed.displaywave.ECGViewer* application is a self-contained application that will open a single DICOM or SCP-ECG file and display both the attributes of the object (including any measurements or results contained therein) as a tree, and the entire waveform data, in scrollable windows.

The *com.pixelmed.displaywave.ECGPanel* class can be used as a test application that will open a single raw binary, DICOM or SCP-ECG file and display subsets of the waveform data, in a specified layout of tiles in a window.

Limitations, Testing, Future Work.

The ECGViewer has no concept of a patient directory, or local database, cannot yet read DICOMDIR files, and cannot transfer files over the network. Very likely in the future it will be extended to include such capabilities, or be folded into the com.pixelmed.display.DicomImageViewer application that does.

The toolkit and display application have been tested with a limited range of DICOM and SCP-ECG waveforms, specifically those available from the OpenECG web site, those produced by the OpenECG SCP-ECG to DICOM on-line conversion tool, and the 12 lead ECG available from the Excel Medical web site.

This limited set of test objects does not exhaustively test the toolkits ability to handle all permutations and combinations of either standard's waveforms. Indeed, the current release of the software essentially supports only signed 16 bit short single multiplex group simultaneously acquired waveforms, which the available test material exemplifies. More robust support for other forms of data is an area in which further work is anticipated.

No quantitative analysis of the reconstruction of the highly decompressed SCP-ECG waveforms has been performed. Since the toolkit does not currently perform interpolation or filtering, the decompressed results may well exceed acceptable clinical limits, or limits specified by the standard. This is also an area in which further work is anticipated.

The validation performed on SCP-ECG is limited to ensuring that the data stream is well formed and performing specific checks for particularly egregious or obvious malformations. This validation is performed as the data is read and logged to the console.

The validation performed on DICOM waveforms is limited to the integrity of the DICOM bit stream. The toolkit incorporates a considerably more extensive validation mechanism for DICOM objects, based on an XML representation of the standard, but the waveform objects have not yet been included in that representation.

Additional capabilities planned include the ability to annotate the waveform with measurements in the files and users measurements, as well as the ability to read HL7 V3 observations containing ECGs, and to convert into DICOM waveforms and HL7 V3 observations.

Support for ISO 2022 and other character sets is included only for DICOM and not yet for SCP-ECG.

Copyright and Restrictions.

The BSD-style copyright notice and additional disclaimers on fitness for use that accompanies the software is included verbatim here.

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-- end inclusion --

Installation and Operation.

The supplied *pixelmedjavadicom_binaryrelease.yyyymmdd.tar.bz2* distribution should be decompressed to an appropriate location.

For Windows users, a batch file *ECGViewer.bat* is supplied, which when double-clicked will use the locally-installed JRE to run the application

For Unix and Mac OS X users, a shell script *ECGViewer.sh* is supplied which will do the same.

For Mac OS X users, a double-clickable bundled application, *ECGViewer*, is provided separately.

Regardless of how the application is invoked, once started it will prompt the user for a DICOM file to load before continuing, which will then be parsed and display.

The user may also invoke the application using the appropriate Java command-line syntax with a single additional parameter that is the name of the file to be loaded.

The application is contained within and dependent upon only the *pixelmed.jar* file. Should other components of the PixelMed toolkit than the ECG applications be used, there may be other dependencies that are documented separately.

The *ECGViewer* application does not currently make use of any properties file.

Building From Source.

The supplied *pixelmedjavadicom_sourcerelease.yyyymmdd.tar.bz2* distribution should be decompressed to an appropriate location.

A Makefile is supplied that will allow the *pixelmed.jar* file to be rebuilt using the locally installed javac compiler. However, all the various dependent libraries will be required to perform such a build, even though they are not required at run time for ECG functionality. See the *README* file for details of what is necessary and where to get them (they are all free, are not restricted for commercial use, and source code is available).

Documentation.

The supplied *pixelmedjavadicom_javadocrelease.yyyymmdd.tar.bz2* distribution should be decompressed to an appropriate location.

The Javadoc describes the public and protected interfaces of the entire toolkit, including the *com.pixelmed.displaywave* and *com.pixelmed.scpecg* packages that are directly relevant.

Doxygen generated documentation is also available, and the graphical depictions of the class hierarchy may be useful to developers using the toolkit.

Competition themes

This contribution for the OpenECG programming contest is submitted for evaluation in the following categories:

1. **SCP-Tester:** *the application should be able to evaluate/check any part of an scp record not regarding proprietary/custom part or sections; i.e. global and/or Section CRC; global and/or Section Header; Section 0 pointer coherence; etcetera.*

   The PixelMed submission is intended to fall within this category, providing as it does validation of the SCP-ECG in terms of compliance with the standard and internal consistency as records are read. The *ECGViewer* application performs this automatically as the file is read; in addition, the *com.pixelmed.scpecg.SCPECG* class can be invoked as a command line application to provide validation as well as create a raw binary output file and dump and display the fields of the record.

2. **SCP-Converter:** *the application should be able convert an SCP-ECG file to and from another documented structure; FDA proposed XML format and DICOM supplement 30 waveform standard are strongly encouraged; but other solutions will be evaluated;*

   The PixelMed submission is not intended to fall within this category at the present time.

3. **SCP-Viewer:** *the application should be able to display the content of an SCP-ECG file in its alphanumeric and signal parts;*

   The PixelMed submission is intended to fall within this category, specifically the *ECGViewer* application.

4. **SCP-Writer:** *starting from an ECG signal stored in 16 bits binary interlaced Little Endian form with an associated info file, this application should be able to produce an SCP record (with or without high compression);*

The PixelMed submission is not intended to fall within this category at the present time.

5. **SCP-Meter:** *the application should be able to analyze the ECG to locate the complexes and to define the reference beats, the fiducial points and the reserved areas for each beat;);*

The PixelMed submission is not intended to fall within this category at the present time.

6. **Other:** *The OpenECG consortium will evaluate well-documented applications able to suggest new interoperability or viewing tools related to Electrocardiography and the SCP-ECG standard.*

The PixelMed submission may fall within this category, since it provides a toolkit with sufficient functionality to allow application developers to build new applications as well as to convert and exchange forms of waveforms without them having to dwell on the low level details of the DICOM or SCP-ECG encoding. The support for XML that is readily available for Java will likely allow this support to be readily extended to the HL7 V3 observation encoding.