Site:		**Survey Date**	
		Medical Physicist	
X-Ray Unit Manufacturer		**Contact**	
X-Ray Unit Model		**Email**	
Last QC Report Date		**Signature**	

I-ImaS

Intelligent Imaging Sensors for

Industry, Health and Security

RIEDS – Radiographic Imaging Evaluation & Documentation System

version 1.2.3

Documentation set:

- Form A: X-ray Equipment Specifications Assessment
- Form B: Image Acquisition – Experiment Settings
- Form C: Image Acquisition – Experiment Logging
- Form D: Image Quality Evaluation – Technician's QC
- Form E: Image Quality Evaluation – Physician's QC – Mammo
- Form F: Image Quality Evaluation – Physician's QC – Dental
- Experiment Planning (logging sheet)

Results:

Images Acquired: _____

Image Resolution (pixels): _____

Graylevel Depth (bits): _____

Detailed Equipment Description: ☐ YES ☐ NO

RIEDS – Radiographic Imaging Evaluation & Documentation System

version 1.2.3

I-ImaS

Intelligent Imaging Sensor for Industry, Health and Security

Workpackage-3

Contact: Harris Georgiou, xgeorgio@di.uoa.gr

1. Introduction

As part of the I-ImaS project, the RIEDS prototype (Radiographic Imaging Evaluation and Documentation System) is the basic tool for planning and executing a series of radiological experiments for image sets acquisition. It contains a package of template documents in the form of data sheets that are to be filled before, during and after the image acquisition process.

The main goals for having a detailed set of documentation and logging templates are related to quality control, backtracking information and explicit image annotation, all necessary for the construction of images that employ high quality and detailed descriptions.

The RIEDS prototype includes a total of 6 template sheets for documenting various aspects and parameters of the equipment, the data acquisition environment and the retrieved images. Specifically, these sheets are:

- Form A: X-Ray Equipment Specifications Assessment
- Form B: Image Acquisition – Experiment Settings
- Form C: Image Acquisition – Experiment Logging
- Form D: Image Quality Evaluation – Technician's QC
- Form E: Image Quality Evaluation – Physician's QC (Mammo)
- Form F: Image Quality Evaluation – Physician's QC (Dental)

The system is concluded with additional electronic data container files that are filled after processing the data, as well as a prototype experiment planning chart that is constructed after defining the goals of the experiments and the specifications of the equipment.

2. Identification Codes

The RIEDS uses a detailed set of unique identifiers for all the elements involved in the experiment. Specifically, codes are applied for the project name, the equipment, the target used as the X-ray subject, the experiment runs and the image sets acquired. There are no strict rules on naming conventions for these identifiers, however the naming rules should be applied consistently and provide uniqueness.

For I-ImaS, the following naming conventions could be used:

- Project ID: "I-ImaS" (common name used throughout the documents)
- Machine ID: Lxx (latin letter identifying location + two-digit numeric code)
  - UCL: L="U", xx=10...19
  - Trieste: L="T", xx=20...29
  - ACTA: L="A", xx=30...39
- Target ID: zz (location-specific X-ray subject identifier)
- Experiment ID: zzz (numeric identifier specifying a particular machine configuration and a particular target)
- Test Set ID: NNN (set of images acquired under similar equipment settings)
- Image ID: nnnn (unique image identifier within the current test set)

Based on these naming conventions, the combined Unique Image Identifier (UID) can be constructed as follows:

< ProjectID . MachineID . ExperimentID . TestsetID . ImageID >

For example: "I-ImaS.U10.001.003.0023" can be translated as image No 23 of set No 3, done using the settings for used in experiment #1 on equipment No 10 at UCL.

All the UID codes should be accompanied with accurate timestamps, containing at least date information. For compatible date/time representation, the ISO 8601 standard format can be used for date-only representation, e.g. the "YYYY-MM-DD" format can be used.

3. Phase A – Experiment Planning

Before conducting the experiment, several properties have to be identified and documented, in order to log the exact characteristics of equipment and to plan the required experiment settings.

Form A is used to record the equipment specifications. There are specific fields for logging the tube potential (kVp) and tube current (mA or mAs) ranges, usually required distribute the acquisition parameters and plan the experiment. Other equipment-related parameters include focal spot sizes, filtering properties, grid properties, detector specifications, etc. Output image characteristics are described

by pixel size, spatial resolution and graylevel depth. Finally, there additional fields for recording AERC settings available, optical density modes, etc.

After the equipment characteristics are recorded in every detail, Form B can subsequently be used to record the exact settings of these equipment-related parameters that are involved in the experiment. These settings are considered fixed and common throughout the entire experiment, thus there is no need to include them along with every single image set that is acquired but instead record them once for the entire experiment.

Using the information from Form A and Form B, specifically the data related to the tube capabilities in kVp and mAs ranges, the exact settings can be planned and noted in the corresponding Experiment Planning Chart.

4. Phase B – Image Acquisition

During the experiment, acquired images are annotated using Form C. The fields contain information about the initial exposure settings set by the technician, the true values used (may differ slightly from the initial), as well as dose measurements. The same sheet can be used to record multiple images or entire test sets.

As the full UID naming convention might be too lengthy for the actual file names, the acquired images can be stored with a shorter abbreviation of the UID, for example using the “TestsetID.ImageID” part as the file name and the rest of the UID as a hierarchical directory structure for organizing the storage of the complete set. Image format should be chosen carefully for lossless and optionally compressed storage, as it may affect future work on data quality and software development.

5. Phase C – Image Evaluation

After the images are acquired and stored, they are evaluated by trained radiologists, as well as expert physicians of the specific medical field.

Form D contains technical measurements on the acquired image, specifically related to image quality. Resolution is considered through spatial resolution (SR), high-contrast resolution (Hi-CR) and low-contrast resolution (Lo-CR). True intensity if the projected target is measured via optical density values inside (OD1) and outside (OD2) the disc. Finally, there is also a subjective evaluation of noise level

(rms%), as well as beam quality measurements (HVL – Half Value Length). The same sheet can be used to record multiple images or entire test sets.

Forms E and F are used by the expert physicians on the specific field of study, specifically mammograms and dental images, in order to produce a detailed image quality evaluation with regard to various clinical aspects and content-related features of the image. Integer ranking grades are noted in a symmetric range between -5 and +5. If less detailed ranking is needed, the active range can be limited accordingly, e.g. between -2 and +2. Due to the extent of the ranking tables needed for detailed image quality characterization, one sheet is used per image.

6. General Guidelines

All documents included in the RIEDS prototype were created in accordance with standard quality control assessment procedures, employed in periodic equipment validations in real clinical environments [1]. Although RIEDS is focused on image quality evaluation, rather than quality control for the equipments, the same rules apply with regard to consistency in using it as an annotation tool.

For maximum integrity and usability of the resulting data, as well as the acquired X-ray images, it is recommended that properly trained personnel are used when conducting and documenting the experiments.

References

[1] RANZCR Mammography QC Manual – Physicist's Test Sheets

RIEDS / FORM A: X-Ray Equipment Specifications Assessment

Machine ID[2]:		**Project ID[1]:**	
Site:		**Survey Date**	
		Medical Physicist	
X-Ray Unit Manufacturer		**Contact**	
X-Ray Unit Model		**Email**	
Last QC Report Date		**Signature**	

Tube Potential		**Minimum Setting**	**Maximum Setting**	**Step Setting**	**Nominal Setting**
	kVp				
Tube Current		**Minimum Setting**	**Maximum Setting**	**Step Setting**	**Nominal Setting**
	mA				
	mAs				
Focal spot size		**Minimum Value**	**Maximum Value**	**Nominal Value**	
	µm				
Magnification factor		**Minimum Value**	**Maximum Value**	**Nominal Value**	
Filter types available		**Mo/Mo**	**Mo/Rh**	**Rh/Rh**	**W/Re**	**Other (specify)**
		Y N	Y N	Y N	Y N	
Filter thickness	mm					
Grid types available		**Configuration 1**	***Configuration 2***	***Configuration 3***	
Grid thickness	mm				
Detector type					
Detector size		**Configuration 1**	***Configuration 2***	***Configuration 3***	
	cm x cm				
Pixel size	µm				
Number of Pixels	p x p				
Spatial Resolution	lp/mm				

Scan time	sec	**Minimum Value**	**Maximum Value**	**Nominal Value**
Effective Exposure Time	msec	**Minimum Value**	**Maximum Value**	**Nominal Value**
Matrix size	p x p	**Setting 1**	***Setting 2***	***Setting 3***
Graylevel depth	bits/pixel			
AERC modes available		**Configuration 1**	***Configuration 2***	***Configuration 3***

Optical Density modes	**Minimum Setting**	**Maximum Setting**	**Step Setting**	**Nominal Setting**

Comments	

RIEDS / FORM B: Image Acquisition – Experiment Settings

Project ID[1]:		**Target ID[3]:**	
Machine ID[2]:		**Experiment ID[4]:**	
Site:		**Survey Date**	
		Medical Physicist	
Contact		**Signature**	
Email			

Tube Potential		**Minimum Setting**	**Maximum Setting**	**Step Setting**	**Nominal Setting**	
	kVp					
Tube Current		**Minimum Setting**	**Maximum Setting**	**Step Setting**	**Nominal Setting**	
	mA					
	mAs					
Focal spot size		**Setting Used**				
	µm					
Magnification factor						
Filter type used		**Mo/Mo**	**Mo/Rh**	**Rh/Rh**	**W/Re**	**Other (specify)**
	☑	☐	☐	☐	☐	
Filter thickness	mm					
Grid type		**Configuration Used**				
Grid thickness	mm					
Detector type						
Detector size		**Configuration Used**				
	cm x cm					
Pixel size	µm					
Number of Pixels	p x p					
Spatial Resolution	lp/mm					
Matrix size	p x p					
Graylevel depth	bits/pixel					

AERC mode	Default: OFF	
Optical Density mode (AERC: on)	Default: OFF	
Target Used		
Target model		
Target type		
Target diameter	mm	
Target thickness	mm	
Comments		

RIEDS / FORM C: Image Acquisition – Experiment Logging

Machine ID[2]:		**Project ID[1]:**		**Target ID[3]:**	
Site:		**Survey Date**		**Experiment ID[4]:**	
		Medical Physicist		**# of Images**	
Contact		**Signature**		**Current Page**	
Email				**Total Pages**	
				Test Set ID[5]:	

EMULSION		SETTINGS				RESULTS					
		Values Set				True Values				Air Kerma	MGD
Image ID[6]	**Filename**	**kVp**	**mA**	**sec**	**mAs**	**kVp**	**mA**	**sec**	**mAs**	**mGy**	**mGy**

RIEDS / FORM D: Image Quality Evaluation – Technician's QC

Machine ID[2]:		**Project ID[1]:**		**Target ID[3]:**	
Site:		**Survey Date**		**Experiment ID[4]:**	
		Medical Physicist		**# of Images**	
Contact		**Signature**		**Current Page**	
Email				**Total Pages**	
				Test Set ID[5]:	

EMULSION		IMAGE QUALITY EVALUATION								
		Resolution			Intensity				Noise	Beam Quality
Image ID[6]	**Filename**	**SR**	**Hi-CR**	**Lo-CR**	**OD1**	**OD2**	**Diff(2-1)**	**Diff (%)**	**rms (%)**	**HVL**

RIEDS /FORM E: Image Quality Evaluation – Physician's QC Mammography Template

Project ID[1]:		**Target ID[3]:**	
Machine ID[2]:		**Experiment ID[4]:**	
Site:		**Survey Date**	
		Medical Physicist	
Contact		**Signature**	
Email			

Test Set ID[5]: **Image ID[6]:**

Image Quality Property	Scale										
	–5	–4	–3	–2	–1	0	+1	+2	+3	+4	+5
Typical Measurements											
Contrast Estimation											
Spatial Resolution Estimation											
Noise Estimation (%)											
Normal Elements											
Background / Tissue Discrimination											
Structural Details (veins, etc)											
Fatty Tissue (compressed+uncompressed)											
Dense Tissue (fibro-granular)											
Pectoral Muscle											
Main Boundary Edges (breast)											
Overall Quality on Normal Elements											
Abnormal Elements (if present)											
Masses											
Spiculate Formations											
Micro-calcifications											
Stellate Lesions											
Asymmetric Density											
Asymmetric Ducts											
Axillary Nodes											
Lymphoadenoma Patterns											
Other: _____											
Overall Quality on Abnormalities											

RIEDS /FORM F: Image Quality Evaluation – Physician's QC Dental Template

Project ID[1]:		**Target ID[3]:**	
Machine ID[2]:		**Experiment ID[4]:**	
Site:		**Survey Date**	
		Medical Physicist	
Contact		**Signature**	
Email			

Test Set ID[5]: **Image ID[6]:**

Image Quality Property	Scale										
	–5	–4	–3	–2	–1	0	+1	+2	+3	+4	+5
Typical Measurements											
Contrast Estimation											
Spatial Resolution Estimation											
Noise Estimation (%)											
Background / Tissue Discrimination											
Intraoral Elements											
Teeth Enamel and Dentine											
Caries Lesion											
Periodontal Lesions											
Periapical Lesions											
Bone											
Bone Lesions											
Soft Tissues											
Restoration Materials											
Overall Quality on Intraoral Elements											
Extraoral Elements											
Bone											
Teeth											
Soft Tissues											
Sharpness											
Slice Thickness											
Other: _____											
Overall Quality on Extraoral Elements											

RIEDS: Experiment Planning Chart

Page ☐ of ☐

mAs \ kVp															