Automated Quality Assurance System for Clinical CT Systems

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BSAC: Sam Brenny

Overview

Client Information

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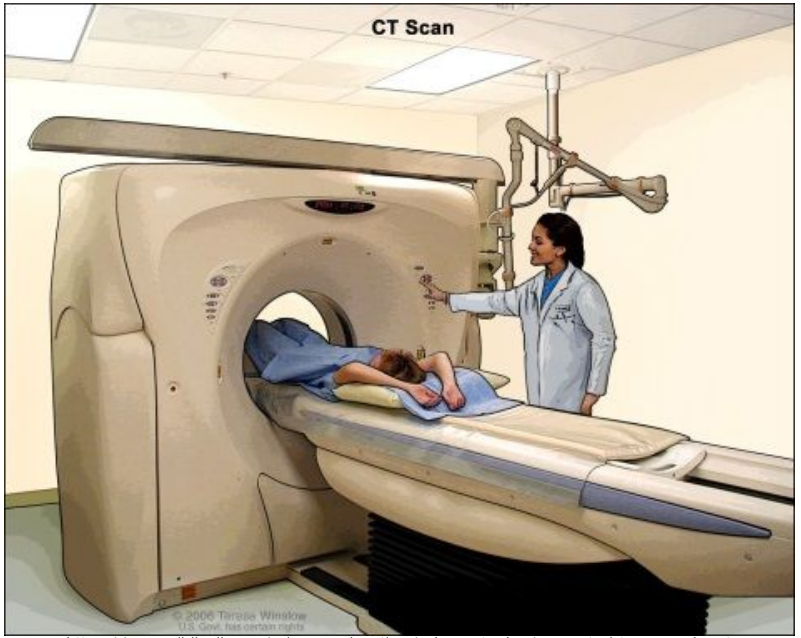
Future Work



https://www.nibib.nih.gov/science-education/science-topics/computed-tomography-ct

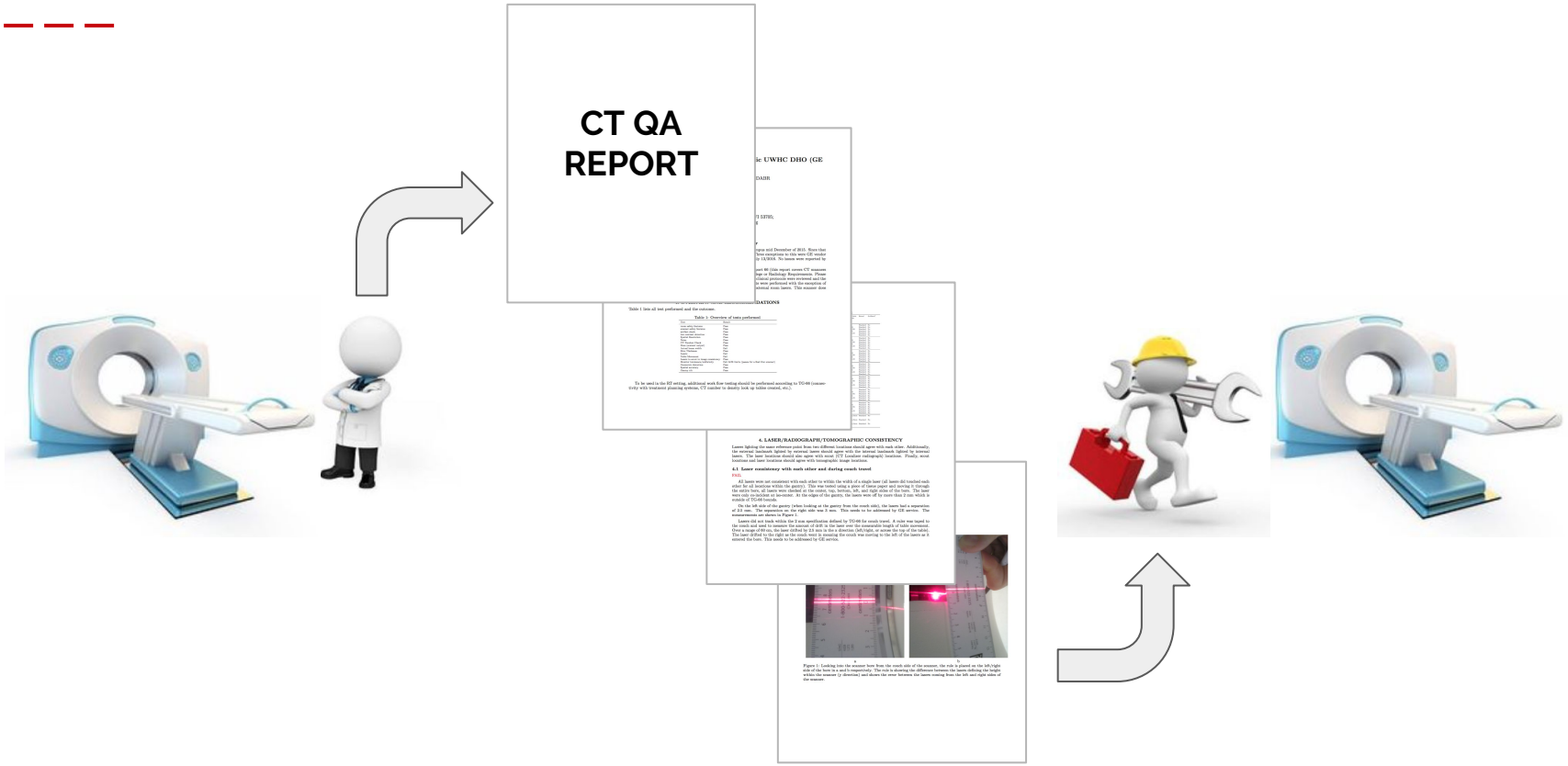
Client Information

Dr. Tim Szczykutowicz

- Assistant Professor
  - UW School of Medicine, Radiology, Medical Physics, Biomedical Engineering
- Undergrad in physics, Masters and Ph.D. in medical physics
- Research activities include
  - Optimizing CT scan protocols, patient dose monitoring, and developing protocol management methodologies [1]

https://www.radiology.wisc.edu/people/facultyContent.php?vaultID=552

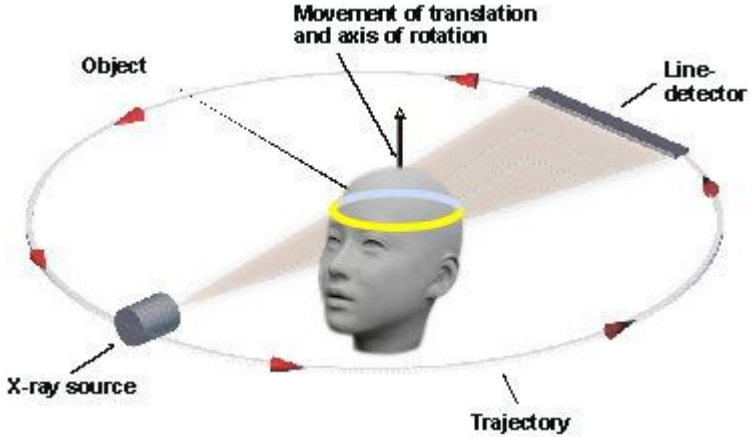
Problem Statement



Background

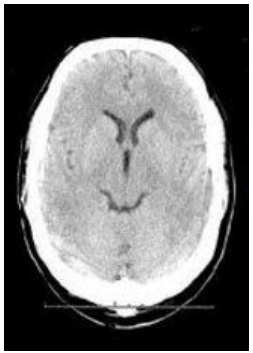
Computed Tomography (CT)

- Narrow x-ray beam rotated around patient
- Sensor opposite of x-ray picks up signals
- Cross-sectional images (slices) are created from signals [2]



Quality Assurance (QA) Testing

- Scanner is tested daily, monthly, yearly basis
- QA testing ensures the scanner is functioning properly
- Multiple tests conducted to measure individual functions
- Reports generated from testing, sent to technicians for repair [3]



http://doctorspiller.com/Dental%20radiology/ct_scans.htm

Motivation

- To expedite testing and optimize the reporting process
- To create a universal and standard reporting system
- Improve communication between QA and service technician
- CT needs to be properly working so that the right dose can be applied
- Create database & view scanner trends

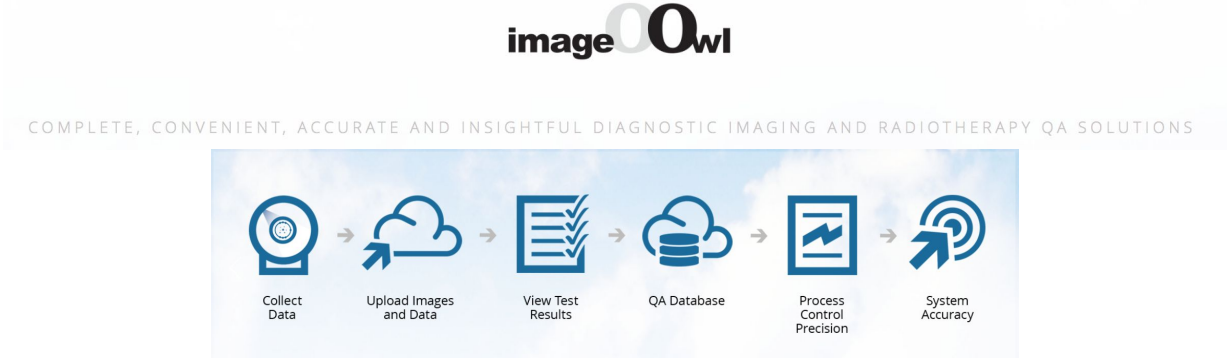
Design Specifications

- Performance:
  - Process CT images
  - Create PDF reports using LaTeX
  - Write to database/view trends
- Accuracy:
  - No crashes/bugs
  - Pop-up windows to verify calculations
- Ergonomics:
  - Intuitive user-interface
- Program Format:
  - Well-commented
  - Modular
- Universal Distribution:
  - Packaged into executable
- Standards:
  - Outline testing procedures

Commercially Available Competing Designs

Image Owl [4]

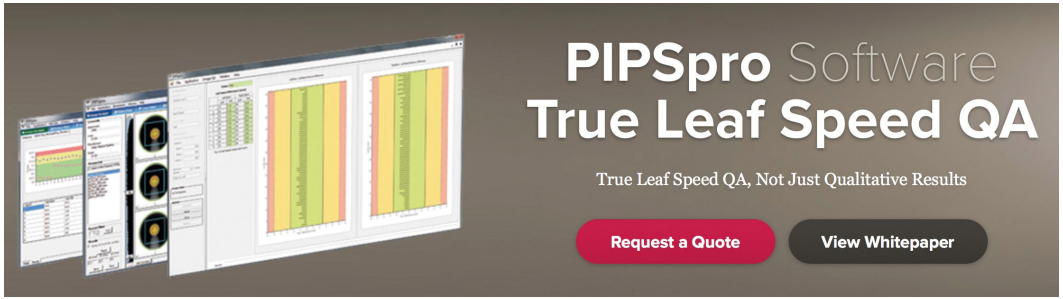
- ✔ QA database & trending
- ✔ Cloud-based service
- ✔ Mobile App
- ✖ High cost
- ✖ Expensive Customization



http://www.imageowl.com/

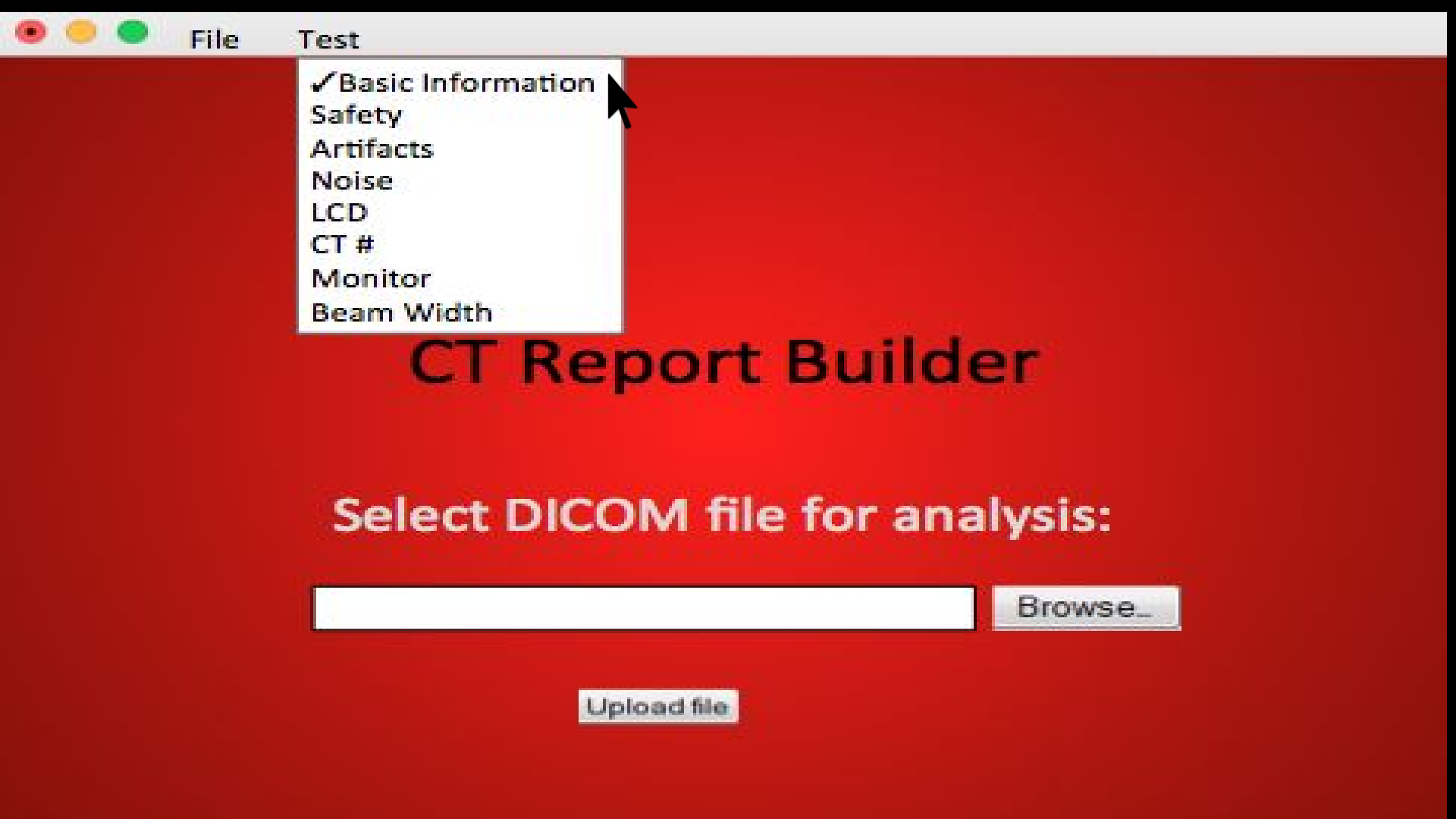
PIPSpro [5]

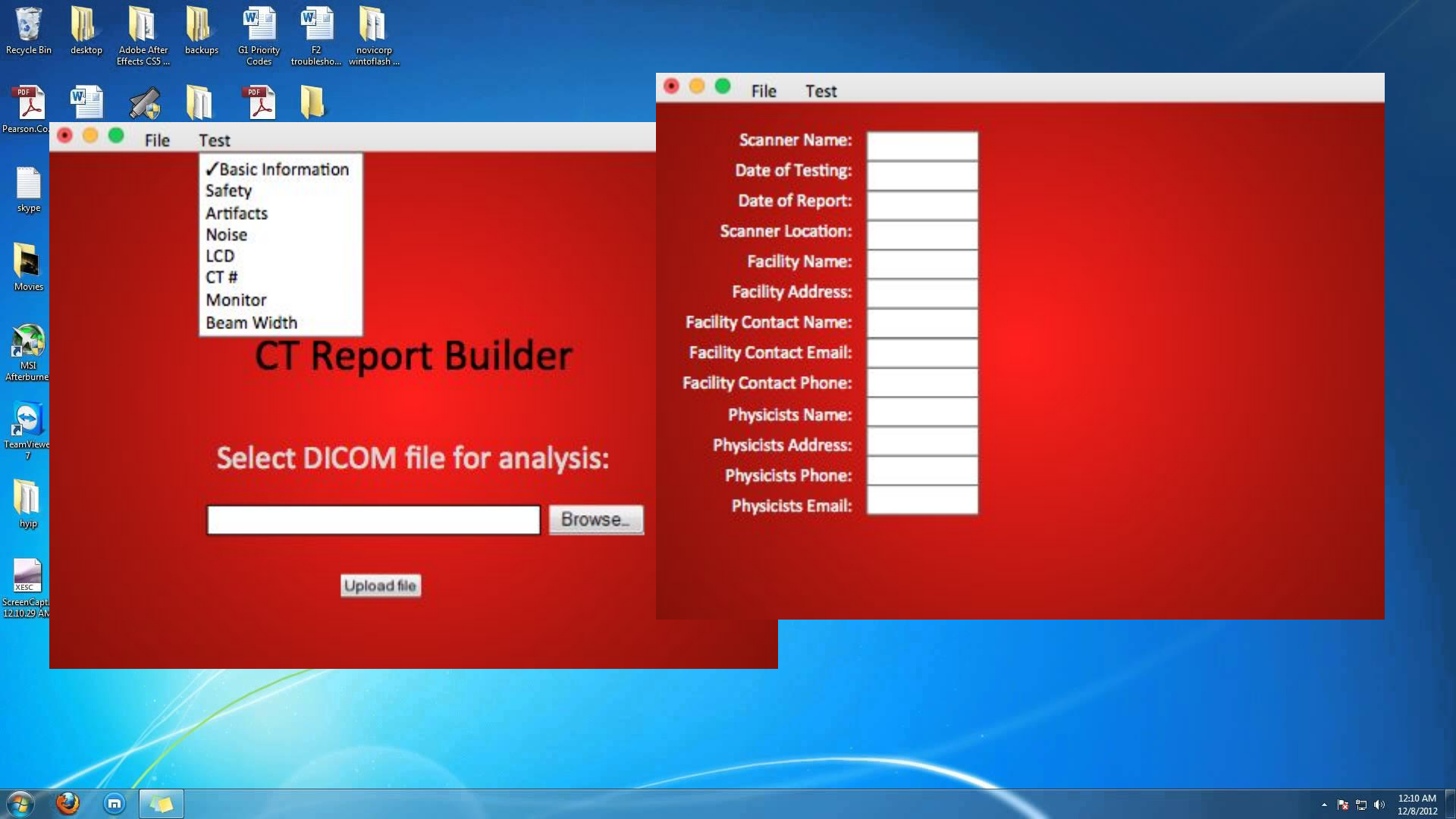
- ✔ Performs image analysis & calculations
- ✔ QA database & trending
- ✔ Provides quantitative analysis of scanner
- ✖ High cost
- ✖ Complexity requires training to use
- ✖ Testing protocols not included in reports



http://www.standardimaging.com/qa-software/pipspro-software/

Design 1: The Multi-Graphical User Interface (GUI)


File
Test
✓Basic Information
Safety
Artifacts
Noise
LCD
CT #
Monitor
Beam Width
CT Report Builder
Select DICOM file for analysis:
Browse...
Upload file


Recycle Bin
desktop
Adobe After Effects CS5 ...
backups
G1 Priority Codes
F2 troublesho...
novicorp wintoflash ...
Pearson.Co...
skype
Movies
MSI Afterburne
TeamViewe 7
hyip
ScreenCapt 12.10.29 AM
File
Test
✓Basic Information
Safety
Artifacts
Noise
LCD
CT #
Monitor
Beam Width
CT Report Builder
Select DICOM file for analysis:
Browse...
Upload file
File
Test
Scanner Name:
Date of Testing:
Date of Report:
Scanner Location:
Facility Name:
Facility Address:
Facility Contact Name:
Facility Contact Email:
Facility Contact Phone:
Physicists Name:
Physicists Address:
Physicists Phone:
Physicists Email:
12:10 AM
12/8/2012

Design 2: Text Document

CT Report Builder

Please fill out the below information on each CT image

Section 1: Basic Information

Scanner Name....._____

Date of Testing....._____

Date of Report....._____

Scanner Location....._____

Facility Name....._____

Facility Address....._____

Facility Contact Name....._____

Facility Contact Email....._____

Facility Contact Phone....._____

Physicists Name....._____

Physicists Address....._____

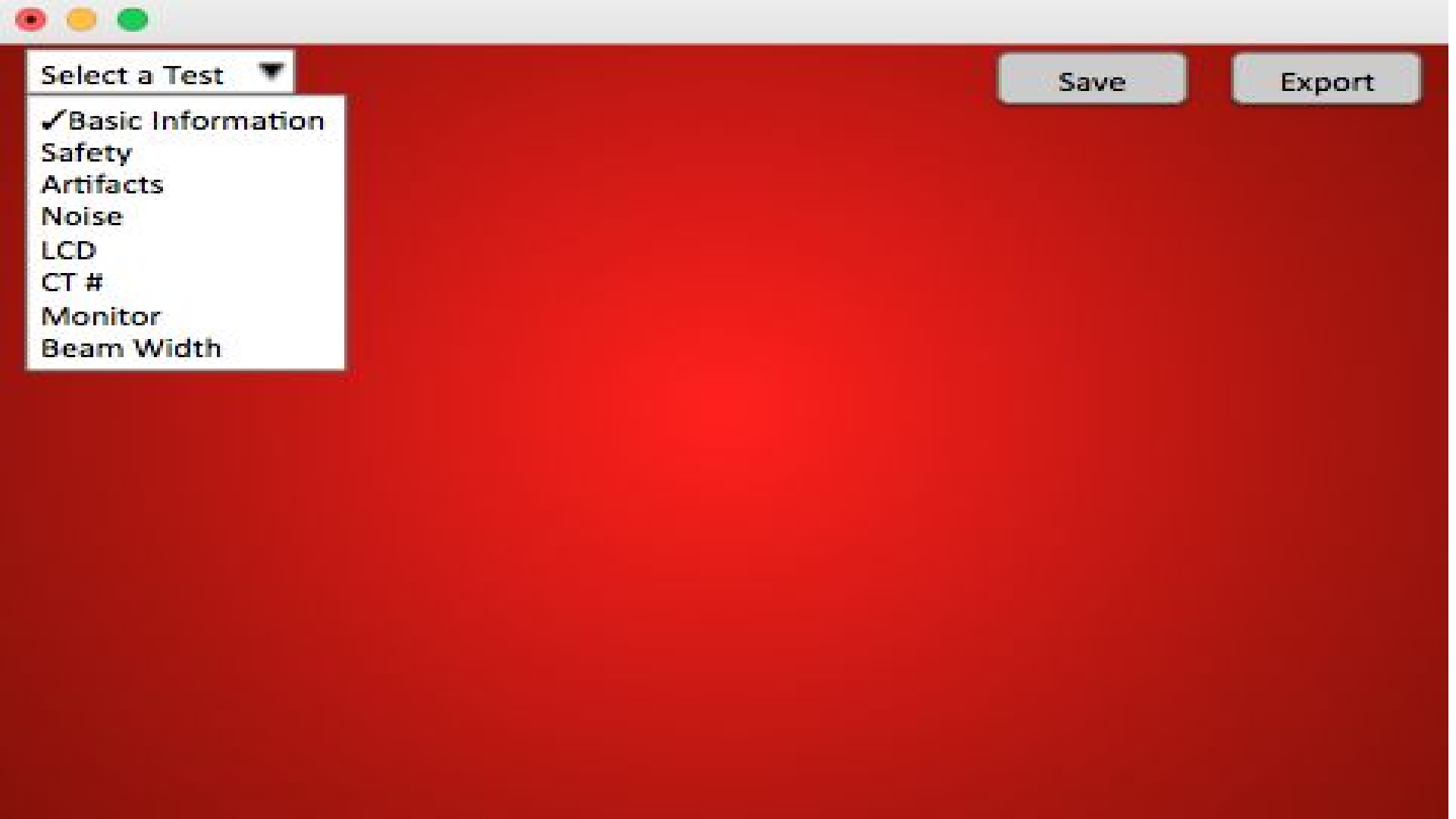
Physicists Phone....._____

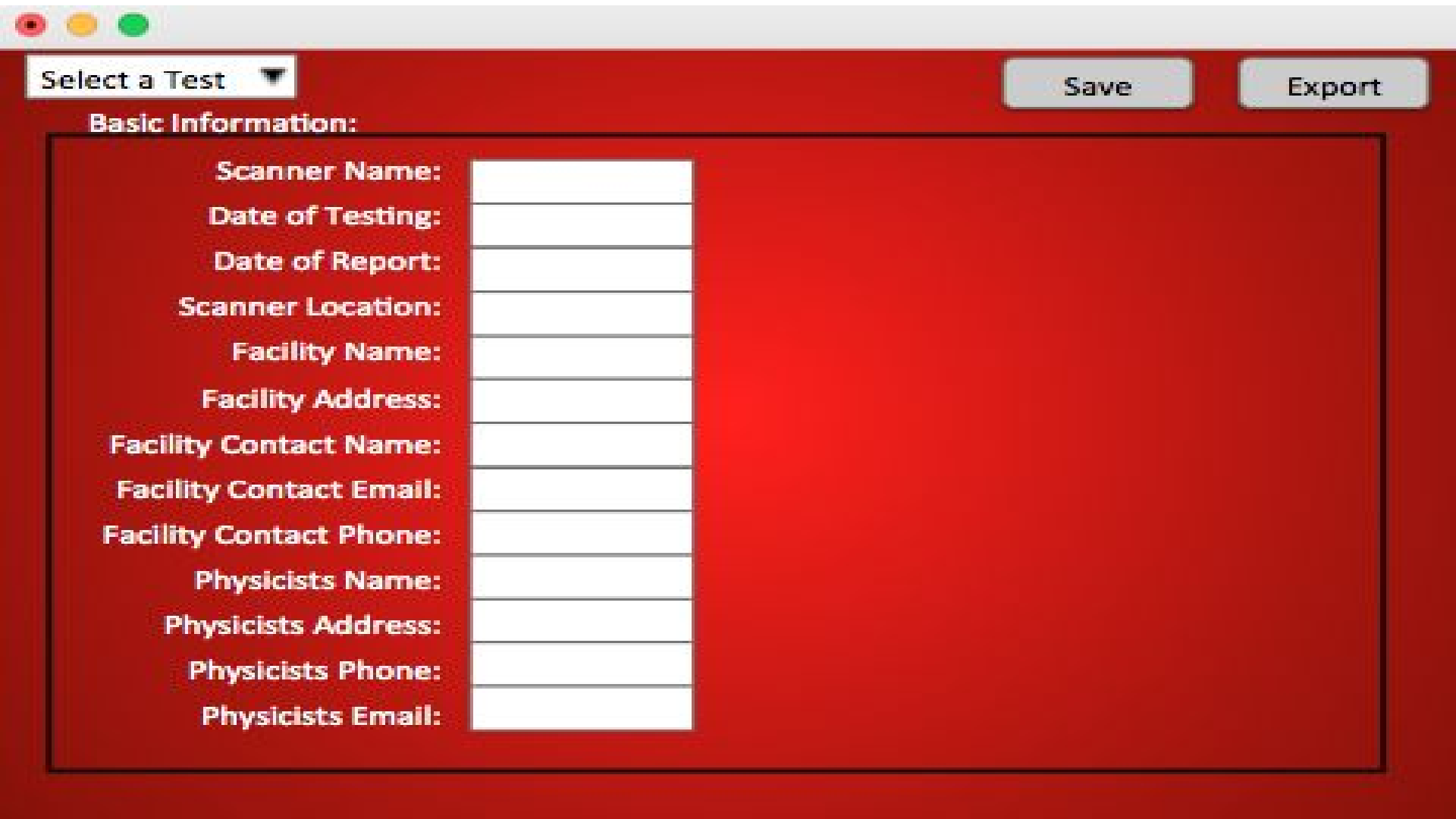
Physicists Email....._____

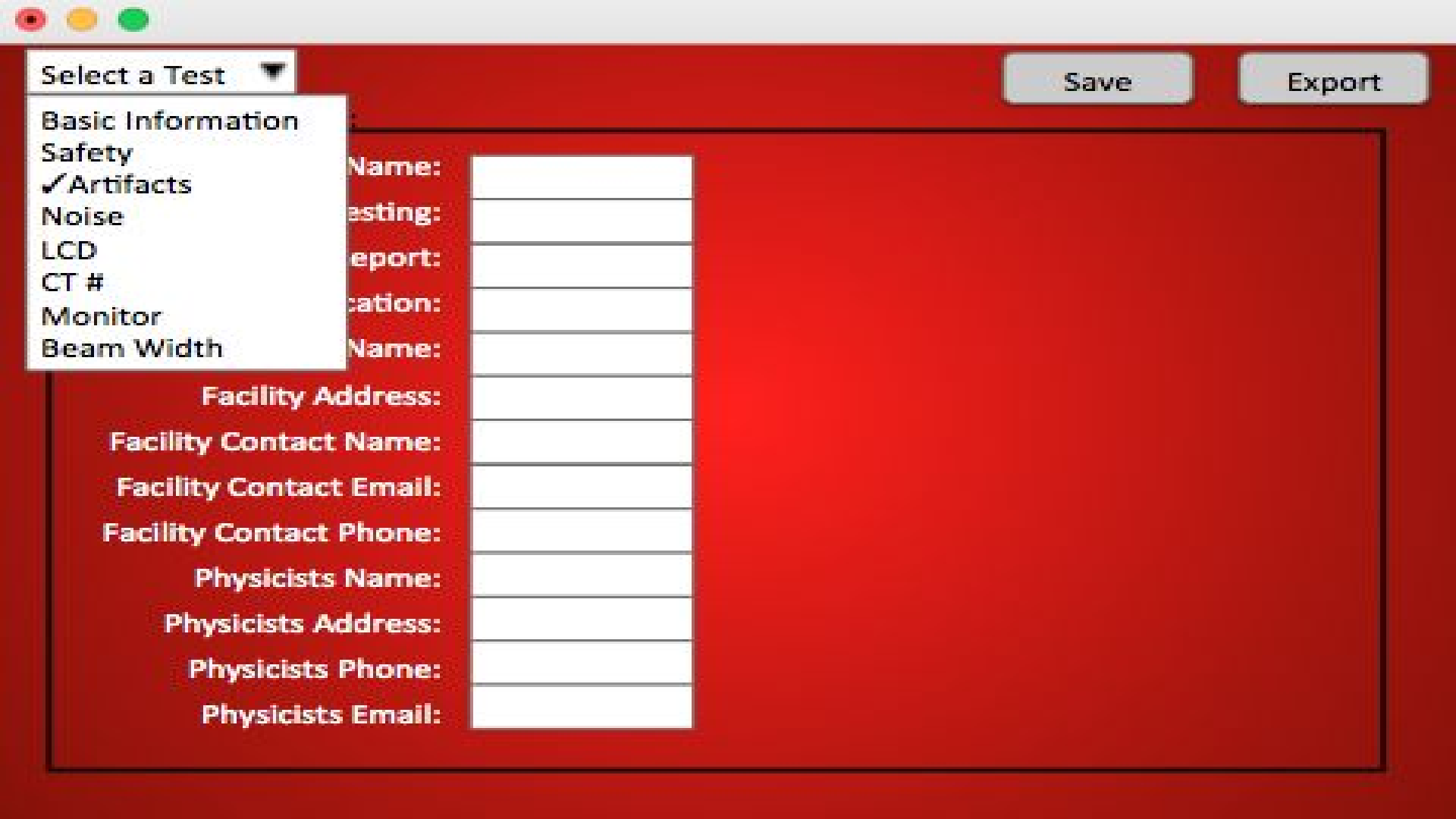
Section 2: Safety

	yes	no	N/A
1.Scanner speakers allow you to hear patient lying on couch?	☐	☐	☐
2.Intercom works and has a volume set to allow patients to hear coaching instructions?	☐	☐	☐
3.X-ray warning labels present in control room?	☐	☐	☐
4.X-ray warning label present on scanner?	☐	☐	☐
5.X-ray on light works on control panel?	☐	☐	☐
6.X-ray on light works on scanner?	☐	☐	☐
7.X-ray on light works outside room?	☐	☐	☐
8.Scatter information is available to staff working with scanner?	☐	☐	☐
9.Disable couch movement button works?	☐	☐	☐
10.When disable couch movement button is pressed, couch is left in a state movable by hand?	☐	☐	☐

Design 3: The Master GUI

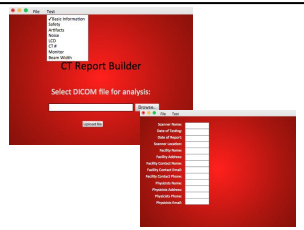
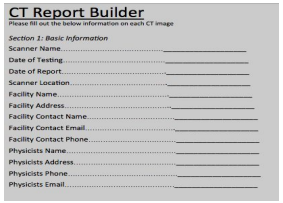
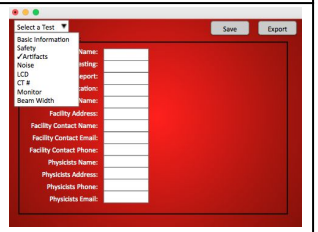

Select a Test
✓Basic Information
Safety
Artifacts
Noise
LCD
CT #
Monitor
Beam Width
Save
Export


Select a Test
Save
Export
Basic Information:
Scanner Name:
Date of Testing:
Date of Report:
Scanner Location:
Facility Name:
Facility Address:
Facility Contact Name:
Facility Contact Email:
Facility Contact Phone:
Physicists Name:
Physicists Address:
Physicists Phone:
Physicists Email:


Select a Test
Basic Information
Safety
✓Artifacts
Noise
LCD
CT #
Monitor
Beam Width
Save
Export
Name:
esting:
eport:
cation:
Name:
Facility Address:
Facility Contact Name:
Facility Contact Email:
Facility Contact Phone:
Physicists Name:
Physicists Address:
Physicists Phone:
Physicists Email:

Select a Test
Save
Export
Artifacts:
Select a DICOM image:
Browse...
Pitch:
Scan mode:
mA:
Rotation time:
Effective mAs:
Denoising level:
Kernel:
SFOV:
RFOV:
slice thickness:
Comments:

Design Matrix

Design	Design 1		Design 2		Design 3	
						
Criteria (Weight)	Multi-GUI		Text Document		Master GUI	
Ease of Use (30)	4/5	24	3/5	18	5/5	30
Degree of User Interaction (25)	5/5	25	0/5	0	5/5	25
Modularity (20)	2/5	8	0/5	0	4/5	15
Speed (15)	3/5	9	0/5	0	5/5	15
Safety (5)	5/5	5	5/5	5	5/5	5
Cost (5)	5/5	5	5/5	5	5/5	5
Total (100)		76		28		95

Proposed Design: Master GUI

Ease of Use & Speed

- Easy to switch between tests
- User friendly, intuitive

Degree of User Interaction

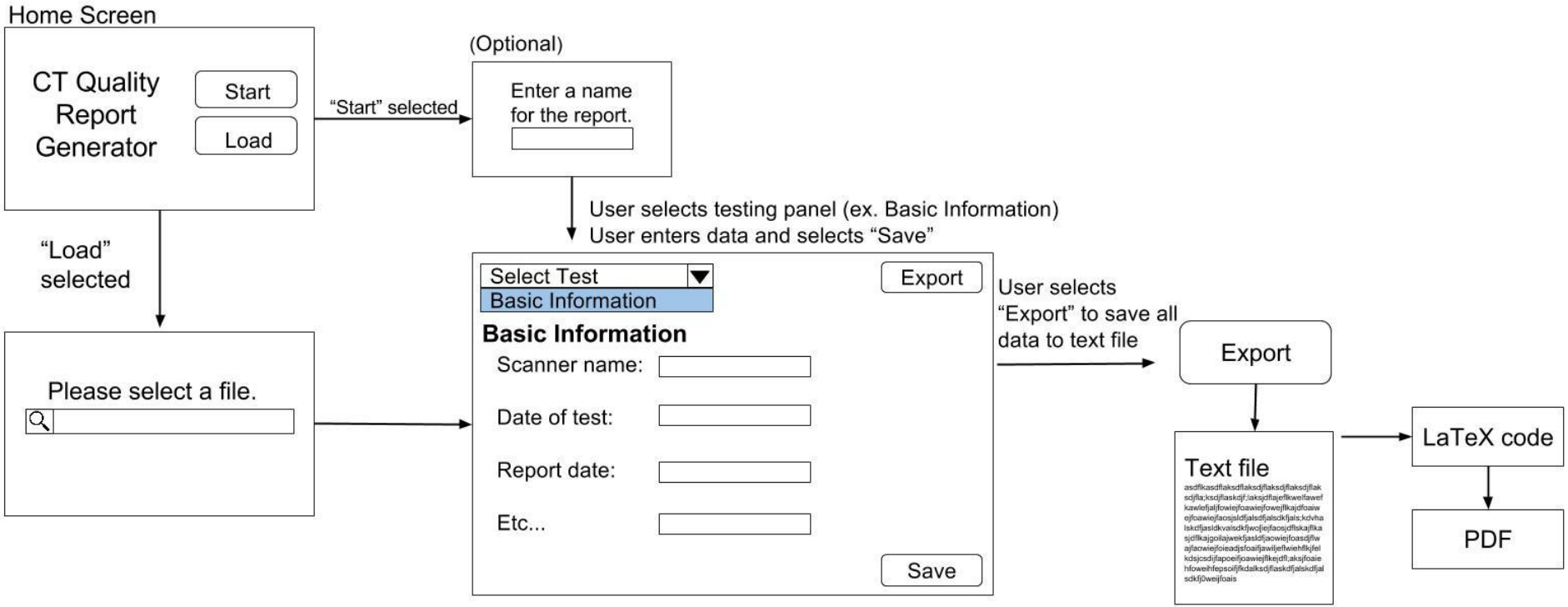
- Automatic calculations
- Text file exportation

Modularity

- Future adjustments all in same GUI

Additional Features

- Easy to package & distribute software
- Database for scanner trending


Home Screen
CT Quality Report Generator
Start
Load
"Start" selected
(Optional)
Enter a name for the report.
User selects testing panel (ex. Basic Information)
User enters data and selects "Save"
"Load" selected
Please select a file.
Select Test
Basic Information
Export
Basic Information
Scanner name:
Date of test:
Report date:
Etc...
Save
User selects "Export" to save all data to text file
Export
Text file
LaTeX code
PDF

Future Work

- Continue to add functionality to GUI
  - Develop back-end code to input and manipulate images and data
- Improve look and user interface
- Improve ergonomics
- Standardize testing protocols with client
- Work with LaTeX
- Trial runs with client
- Packaging for distribution

Acknowledgements

We would like to thank:

- Prof. Tim Szczykutowicz
- Prof. John Webster
- Assistant Prof. Jess Miller

Questions?

References

1. “Faculty and Staff,” University of Wisconsin School of Medicine and Public Health. [Online]. Available: https://www.radiology.wisc.edu/people/facultyContent.php?vaultID=552
2. “CT Scan,” Mayo Clinic [Online]. Available: http://www.mayoclinic.org/tests-procedures/ct-scan/basics/definition/prc-20014610
3. T.P. Szczykutowicz. “CT Scanner Annual Testing: East Clinic UWHC DHO,” UW-Madison Dept. of Radiology. Madison, WI. July, 2016.
4. “Comprehensive QA Services in the Cloud,” Image Owl, Inc. [Online]. Available: http://www.imageowl.com/. [Accessed: 09-Oct-2016].
5. “PIPSpro Software,” Standard Imaging, Inc.. [Online]. Available: http://www.standardimaging.com/qa-software/pipspro-software/. [Accessed: 09-Oct-2016].