

COMPUTER SOFTWARE TO ASSESS WELD THICKNESS LOSS IN OFFSHORE PIPELINES: PEDS

André Luiz Silva Germano, andregermano.inf@gmail.com

Samanda Cristine Arruda Correa, scorrea@nuclear.ufrj.br

Centro Universitário Estadual da Zona Oeste (CCMAT/UEZO)

Avenida Manuel Caldeira de Alvarenga, 1203, 23070-200, Rio de Janeiro, RJ, Brasil.

Edmilson Monteiro de Souza, emonteiro@nuclear.ufrj.br

Ademir Xavier da Silva, ademir@nuclear.ufrj.br

Ricardo Tadeu Lopes, ricardo@lin.ufrj.br

Programa de Engenharia Nuclear, COPPE, Universidade Federal do Rio de Janeiro (UFRJ)

Ilha do Fundão, Caixa Postal 68509, 21945-970, Rio de Janeiro, RJ, Brasil.

***Abstract.** The purpose of this work is to present an initial vision about a computer software named PEDS to assess weld thickness loss in offshore pipelines through digital radiography. This software calculates the thickness loss through a data bank obtained using computational modeling based on Monte Carlo MCNPX code. In order to give users more flexibility, the computer software was written in Java, which allows it to run on Linux, Mac OS X and Windows. Furthermore, tools are provided to image display, select and analyze specific areas of the image (measure average, area of selection) and generate profile plots. Applications of this software in the offshore area are presented.*

***Keywords:** MCNP, PEDS, offshore, pipelines, thickness loss.*

1. INTRODUCTION

Pipelines are very important means of conveying liquid and gaseous substances. In recent decades, their logistic and economic significance in the oil industry is increasing due to an increase in subsea oil-drilling.

Offshore pipes are usually large-diameter steel tubes that are welded to one another to form a long pipeline. They are designed to support high pressures, both internal and external, and to be resistant to degrading processes such as corrosion, which is prevalent in the sort of environment where these pipes are commonly placed.

Degradation processes such as corrosion have a substantial bearing on the security and reliability, mainly in petroleum plants, causing leakages, fires, expensive non-programmed stops and even environmental disasters of great proportions (Correa et al., 2009). In order to guarantee the structural integrity of petroleum plants it is crucial to monitor the amount of weld thickness loss in offshore pipelines.

Considering that, a methodology for calculation of weld thickness loss using Monte Carlo MCNPX code and digital radiography was developed by our group (Correa et. al, 2009) and it has been used to obtain a data bank in order to calculate the thickness loss.

The aim of this work is to present an initial vision about a computer software named PEDS to assess weld thickness loss in offshore pipelines, where the data bank previously mentioned was implemented. Moreover, PEDS also provides the main tools for image manipulation in non-destructive assay (NDA) applications.

2. JAVA LANGUAGE

The PEDS is a computer software written in Java language. Java is currently one of the most popular programming languages in use, and is widely used to develop web and desktop applications.

The development environment used in this work was the NetBeans IDE version 6.9. NetBeans is a modular and extensible application framework for the development of Java desktop applications. It contains several application programming interfaces (API), thus providing the functionality that every programmer would have to write themselves, including: window management, saving state, connecting actions to menu items, toolbar items and keyboard shortcuts. It allows the developer to focus on the problem domain and save a huge amount of time and work. Figure 1 shows the NetBeans IDE platform.

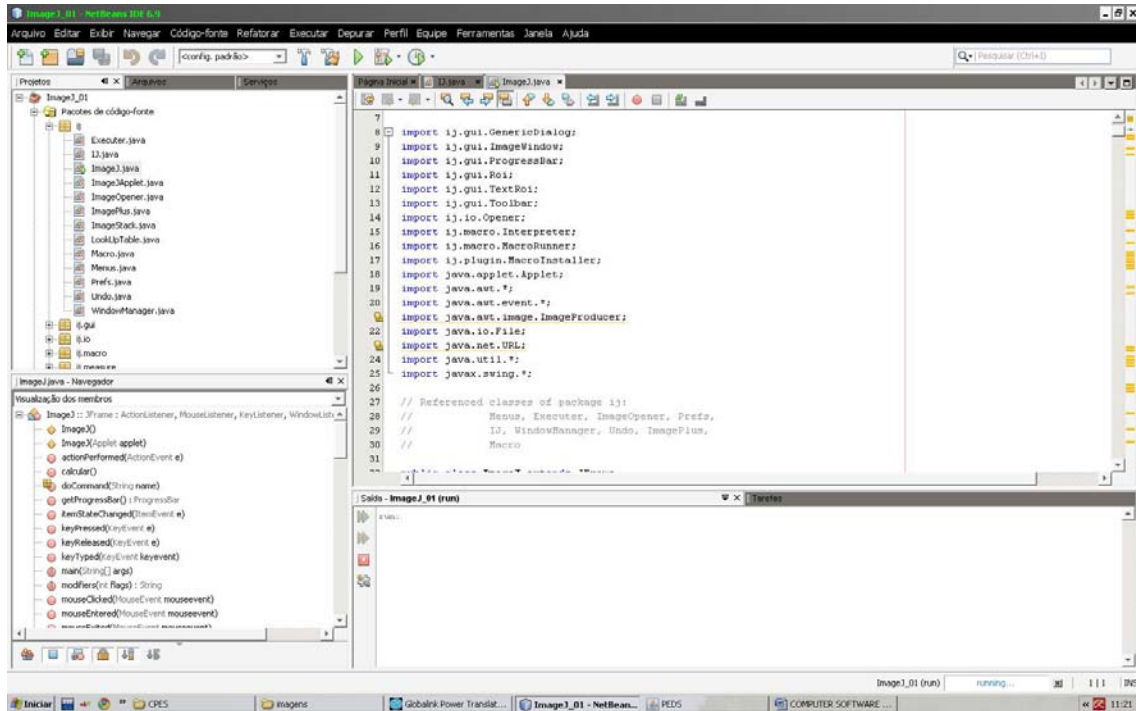


Figure 1. NetBeans IDE platform

3. PEDS

The PEDS is a program to assess weld thickness loss in offshore pipelines. It calculates the thickness loss thanks to a data bank obtained with computational modeling based on Monte Carlo MCNPX code (Correa et. al, 2009).

This program, up to the present moment, allows the estimate of weld thickness loss through digital radiography images obtained using image plate (BaFBr) detector, radiography technique of double wall single image (DWSI), and Iridium 192 (192Ir) source. It allows calculations for inspection of 0.5-in wall thickness offshore pipelines with 10, 12 and 16-in diameter.

The radiographic system used in order to obtain the data bank implemented in the PEDS, also considers 0.05-cm thick polyurethane (used to promote adherence between the pipe and the detection system), 0.2-cm thick weld, and 0.005-in thick lead screen.

PEDS calculates the weld thickness loss through the ratio between the pixels's average intensity in the region of the discontinuity and the pixels's average intensity in the neighborhood of the discontinuity. Figure 2 shows the PEDS.

In order to give users more flexibility, the PEDS also provides the main tools for image manipulation in non-destructive assay (NDA) applications. This program can read many image formats such as TIFF, GIF, JPEG, BMP and DICOM, besides display, edit and analyze 8-bit, 16-bit and 32-bit images.

Moreover, PEDS can calculate area and pixel value statistics of user-defined selections, and create density histograms and profile plots. It also supports standard image processing functions such as contrast and brightness manipulations.

Additionally, in the PEDS the image can be zoomed up to 32:1 and down to 1:32, and all analysis and processing functions are available at any magnification factor. The program also supports any number of windows (images) simultaneously, limited only by available memory.

In order to implement the tools for image manipulation in the PEDS, was considered the class structures of the ImageJ (public domain Java image processing program) available through tutorial (Bailer, 2006).

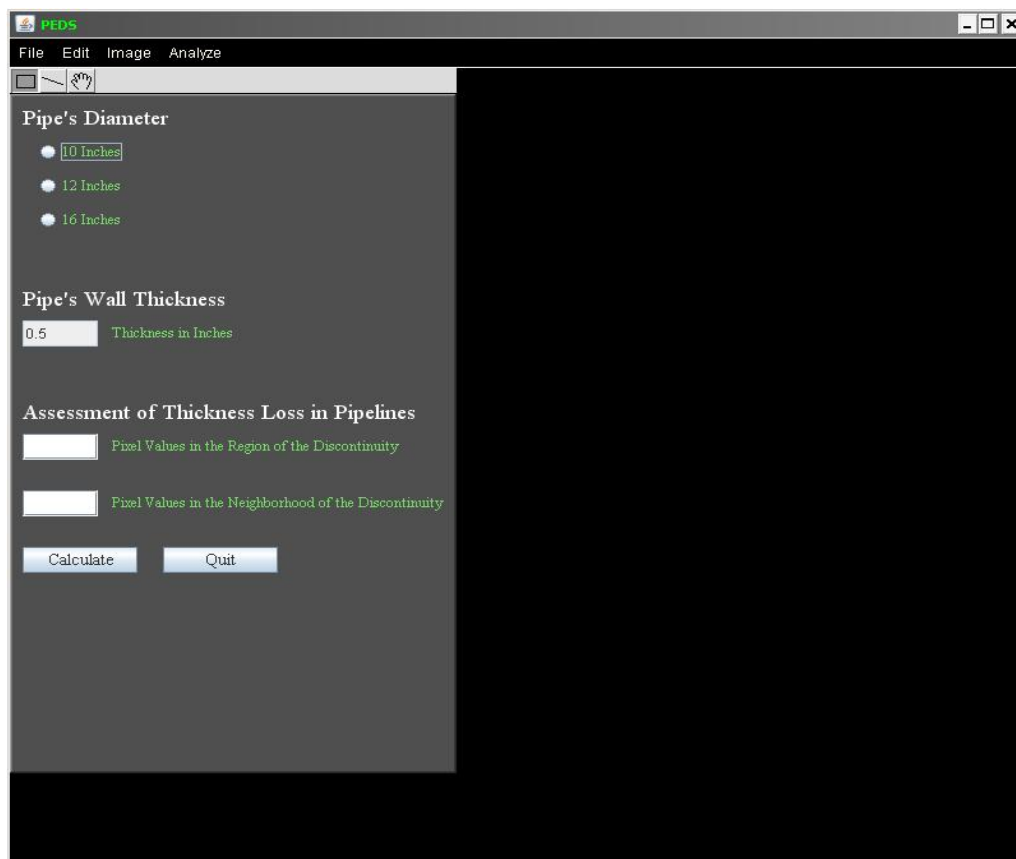


Figure 2. PEDS

4. APPLICATIONS OF THE PEDS

A demonstration of calculation weld thickness loss in offshore pipelines and some image manipulations are presented.

For this, it was used experimental digital images obtained using a GEIT's computed radiography system CR50P and a 36 Ci 192Ir source. The radiography technique applied in test was the double wall single image (DWSI). PEDS was tested using offshore pipe with known defect in its weld.

4.1 Reading image file

In order to open an image file in the PEDS, the menu command "File/Open" should be selected. Afterwards, the user should select the image file and click the open button ("Abrir"), as shown in the Figures 3 and 4. TIFF, GIF, JPEG, BMP and DICOM formats can be supported by the PEDS by default. The image file is opened automatically.

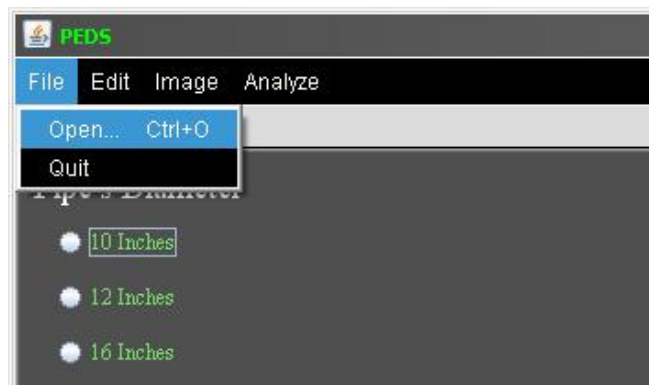


Figure 3. Opening a image file in the PEDS

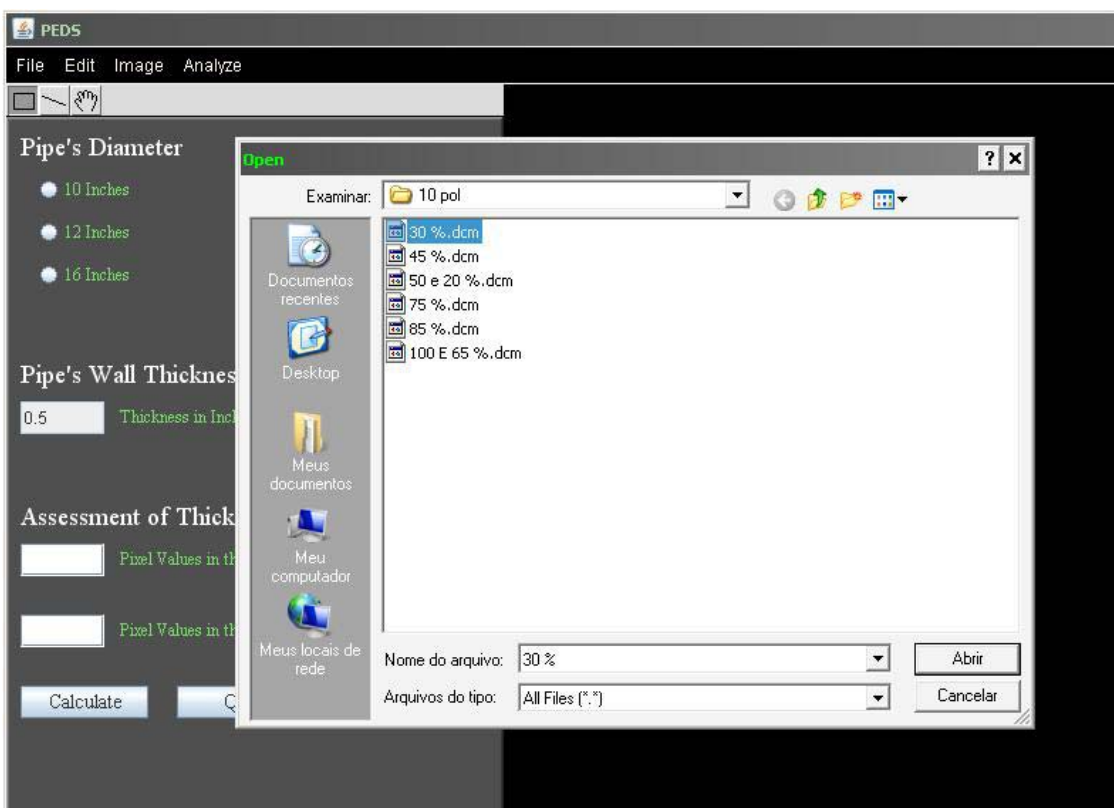


Figure 4. Selecting an image file to open in the PEDS

4.2 Brightness and contrast

To improve the visualization of the image, the displayed brightness and contrast can be adjusted with “Image/Adjust/Brightness-Contrast”. Figure 5 shows how to access the brightness and contrast function, and Figure 6 shows the brightness and contrast window.

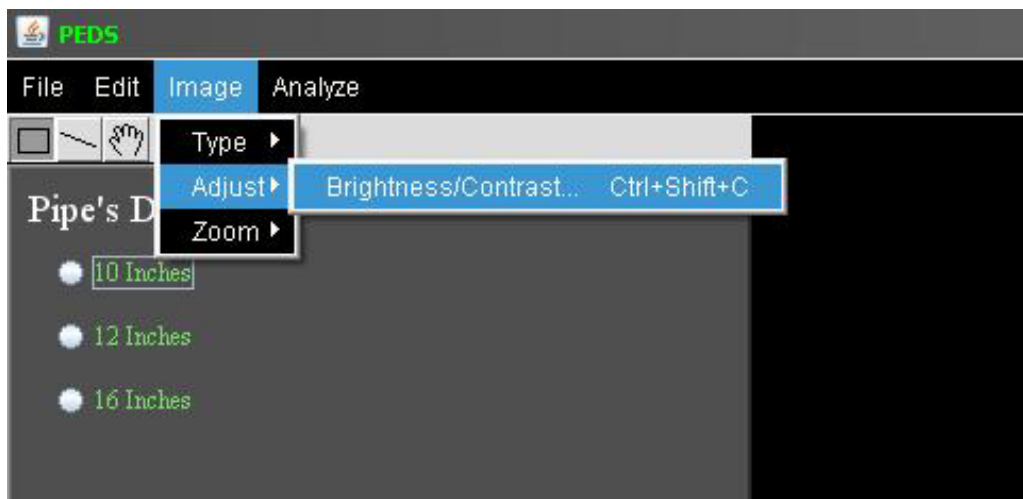


Figure 5. Brightness and contrast

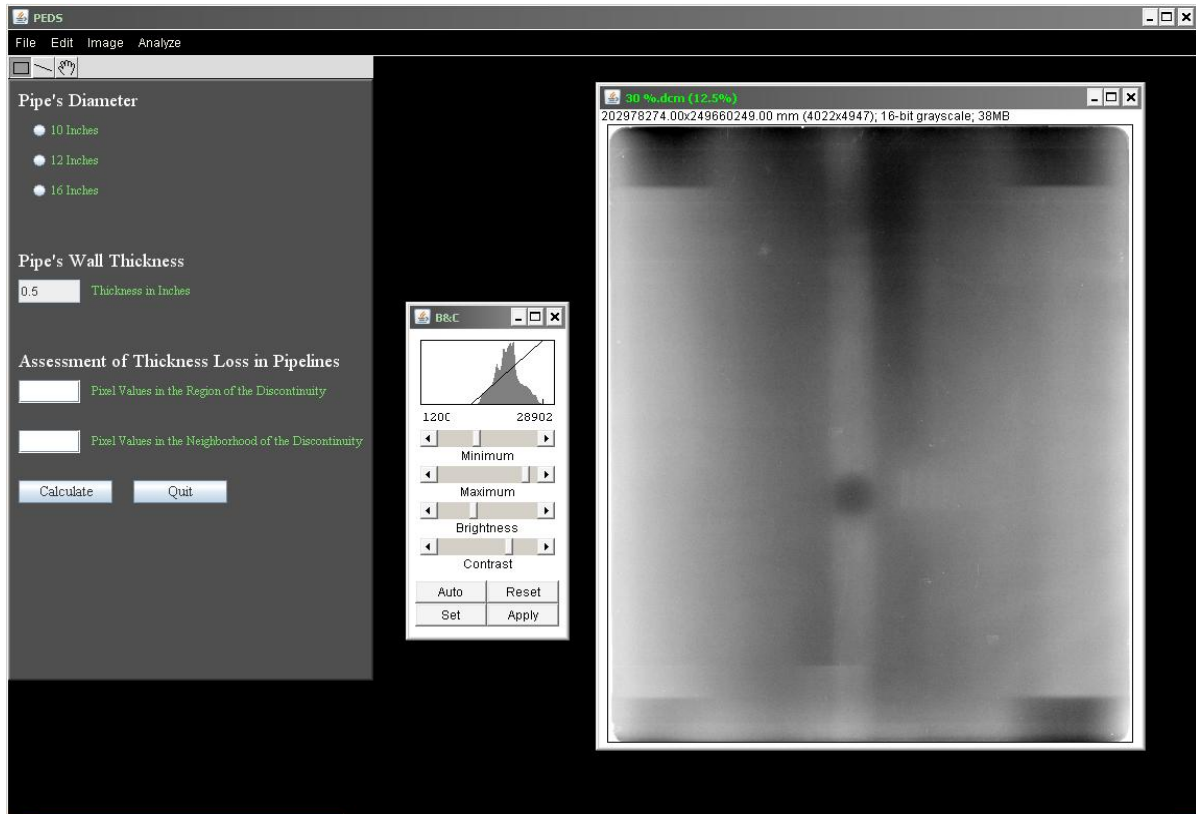


Figure 6. Brightness and contrast window

In the Figure 6, “*Minimum and Maximum*” sliders control the lower and upper limits of the display range, and “*Brightness and Contrast*” sliders increase or decrease the brightness and contrast, respectively, by moving the display range.

The “*Auto*” applies an intelligent contrast stretch to the way in which the image is displayed. The brightness and contrast are adjusted based on an analysis of the image's histogram.

“*Reset*” restores the original brightness and contrast settings, the “*Set*” allows to enter the minimum and maximum display range values in a dialog box, and the “*Apply*” applies the current display range mapping function to the pixel data.

4.3 Histogram plot

To obtain the image histogram in the PEDS, “*Analyze/Histogram*” should be selected. This function also allows the plot of relative frequency histogram from the data of a chosen column of the image. Besides that, it is possible to save the histogram data in a specific file. Figure 7 shows how to access the histogram plot, and Figure 8 shows the histogram window.

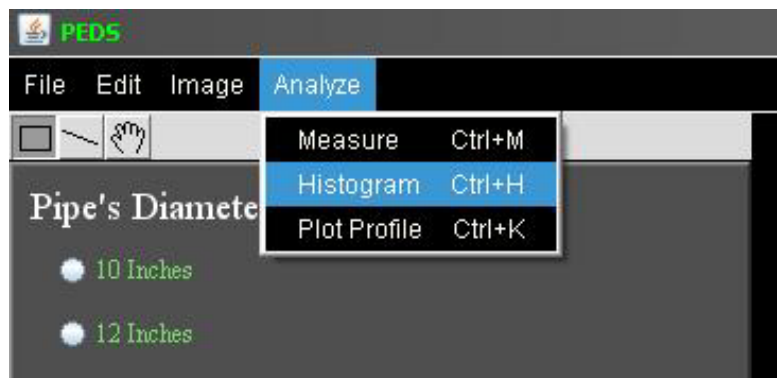


Figure 7. Histogram plot

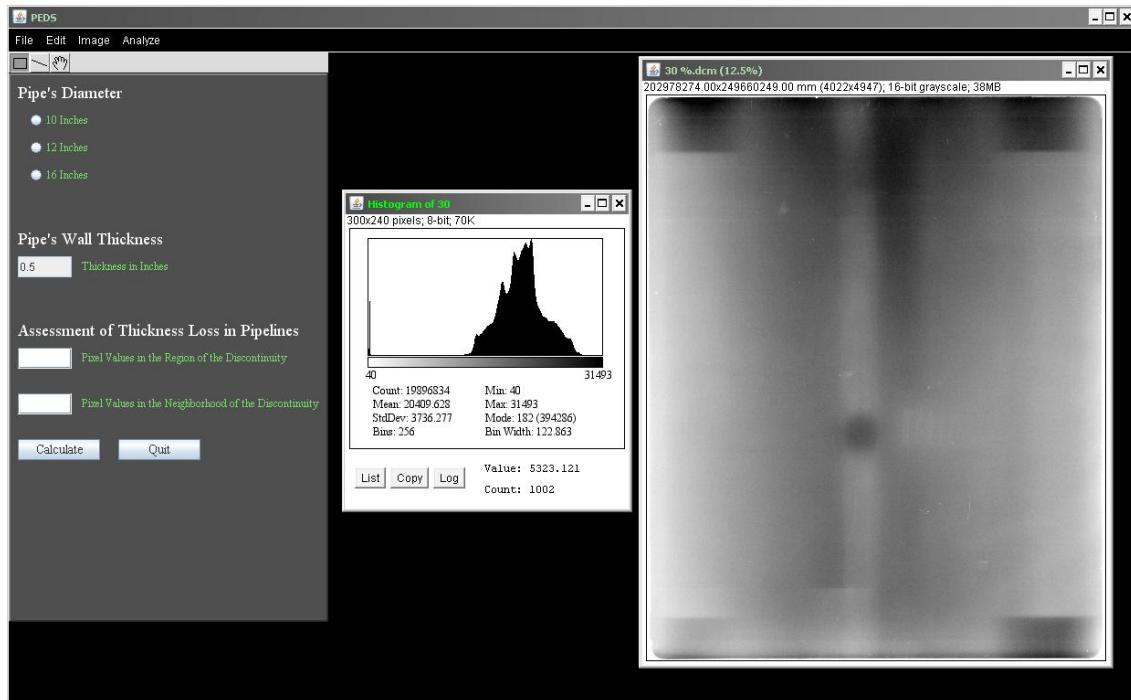


Figure 8. Histogram window

4.4 Profile plot

The program also displays a two-dimensional graph of the intensities of pixels along a line within the image (profile). The x-axis represents distance along the line and the y-axis is the pixel intensity. Moreover, in the profile plot window there are the “List, Save and Copy” buttons to view and save the profile data. To access this function “Analyze/Plot Profile” should be selected, and a line must be created through the line selection tool. Figure 9 shows how to access the profile plot, and Figure 10 shows the profile plot window.

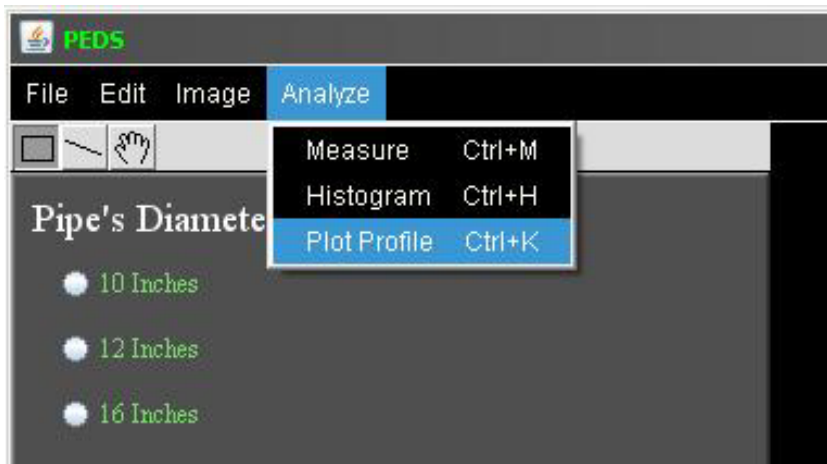


Figure 9. Profile plot

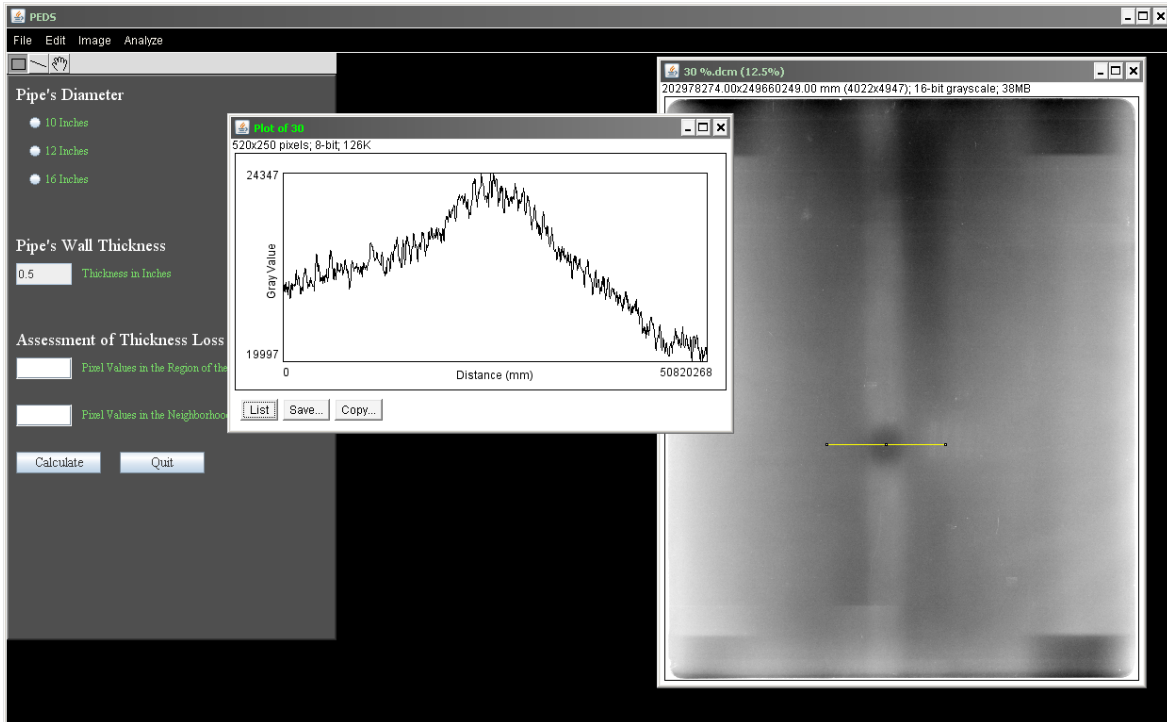


Figure 10. Profile window

The rectangular selection tool can also be used for profile plot. When it happens, x-axis represents the horizontal distance through the selection and the y-axis the vertically averaged pixel intensity.

4.5 Measurements

PEDS also allows the user obtain ordinary measurements such as average gray value within the selection, area of selection in square pixels, and maximum and minimum pixel values within the selection. To access measurement function, “*Analyze/Measure*” should be selected and a rectangular selection must be created. Figure 11 shows how to access the measurement function, and Figure 12 shows the measurement window.

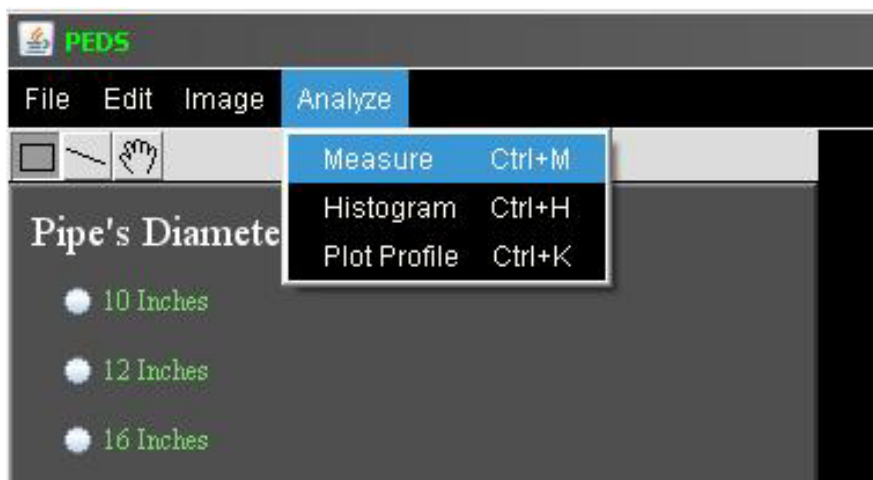


Figure 11. Measurement

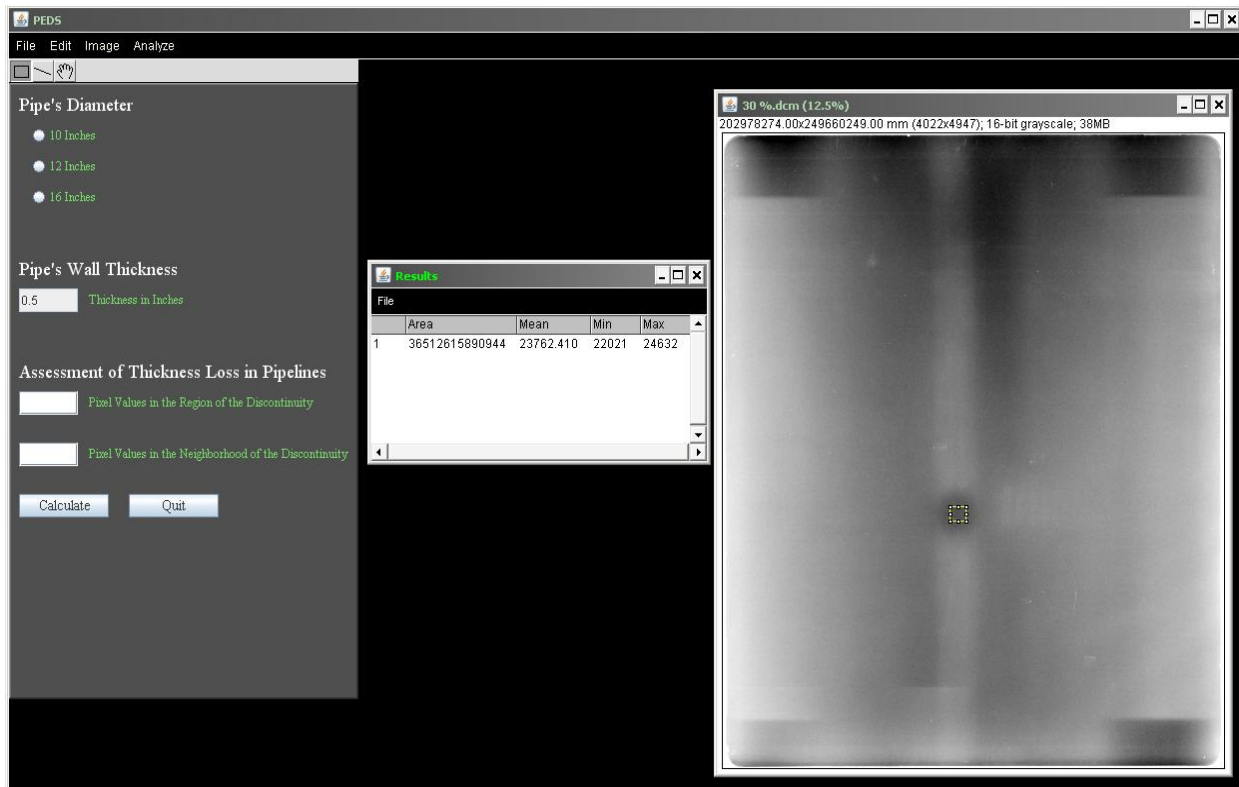


Figure 12. Measurement window

4.6 Assessment of thickness loss in pipelines

In order to assess the weld thickness loss, the first step is to choose the diameter of the pipeline. Afterwards, it is necessary to inform the pixels's average intensity in the region of the discontinuity and the pixels's average intensity in the neighborhood of the discontinuity. Those values can be obtained using the measurement function. The last step is the selection of the calculate button. The Figure 13 shows the weld thickness loss value.

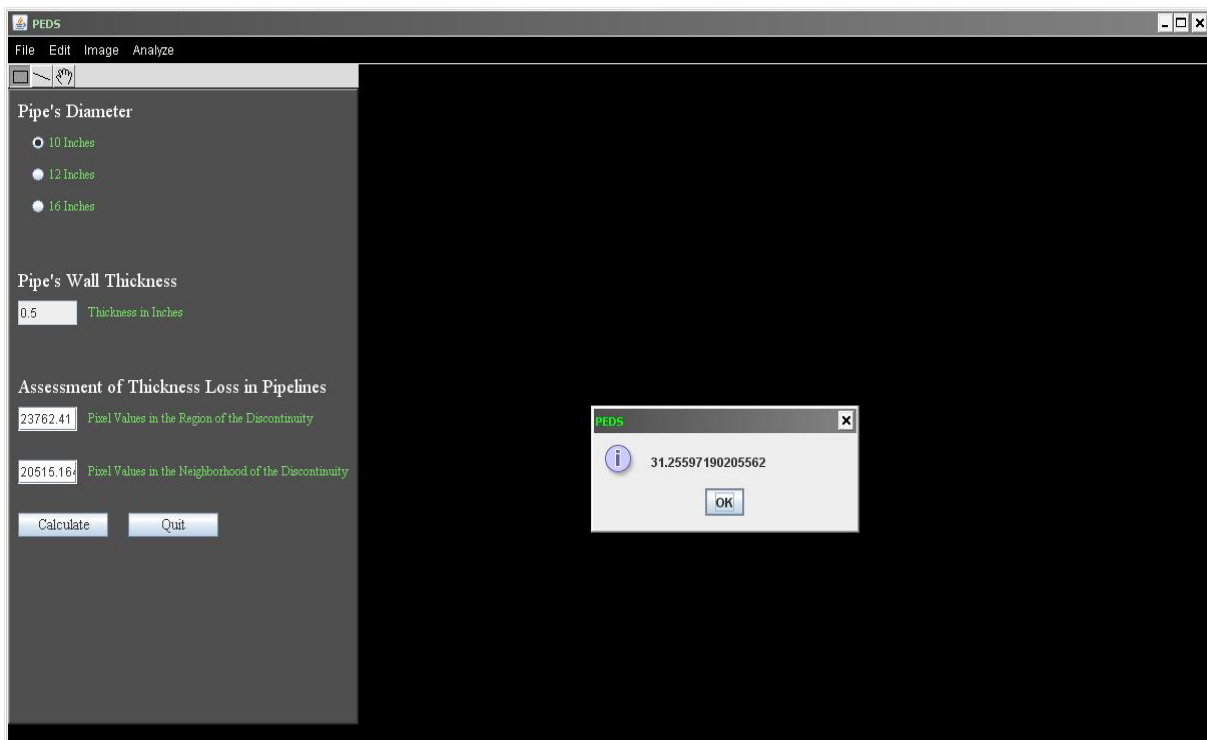


Figure 13. Weld thickness loss value

PEDS presents 31.26% of weld thickness loss. The real weld thickness loss was of 30%. Therefore, a difference of 4.2% was observed between real and calculated value, what shows good agreement between the results.

5. PERSPECTIVES

As mentioned previously, the aim of this work is to present an initial vision about PEDS. As future perspectives, our group wants to increase the data bank for calculation of thickness loss and include more radiography configurations.

5. ACKNOWLEDGEMENTS

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