Medical Imaging Mammography Project

ClearView Imaging Members: Andrew Guzman, Jasmine Garcia, Abiha Fatima

Introduction

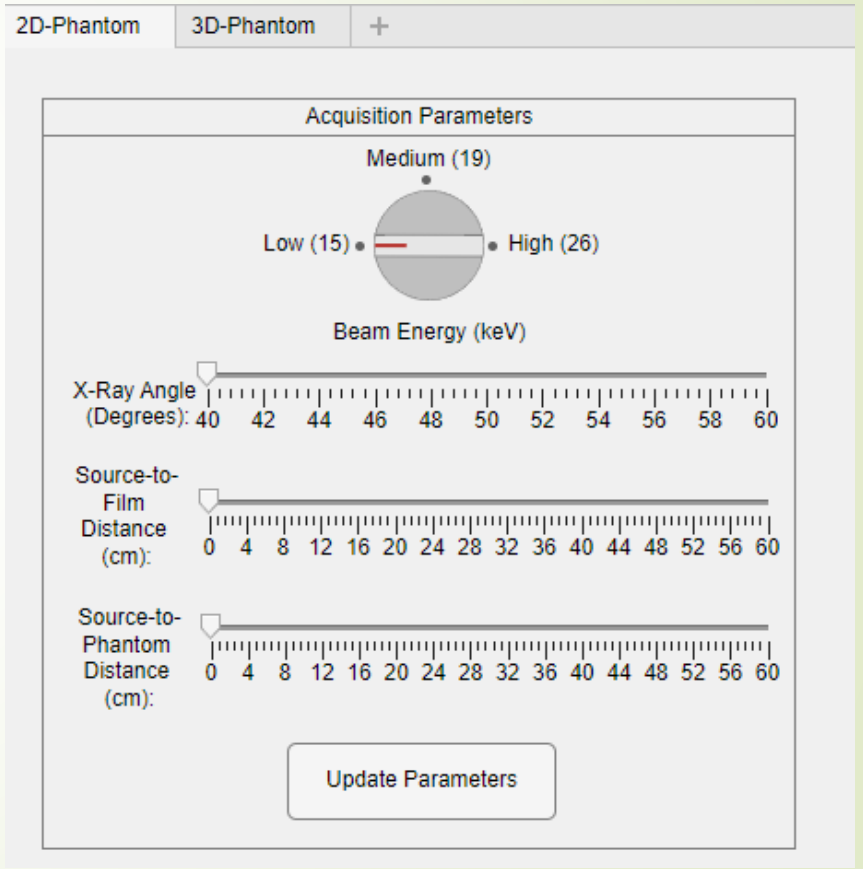
- Breast cancer is a significant concern for women worldwide, with early detection playing a crucial role in improving survival rates. Advancements in medical imaging have enhanced the ability to detect and treat breast cancer early, saving lives. However, the development and testing of imaging techniques often involve expensive, time-consuming processes and require state-of-the-art equipment.
- Now that we've highlighted the significance of early breast cancer detection and the challenges associated with current imaging techniques, let's move on to the specific objective of our project.

Objective

- The objective of this project that we were tasked with is to develop software with MATLAB that simulates a conventional film-based X-ray machine using a graphical user interface (GUI). The software allows users to modify acquisition parameters, view reconstructed images, and perform basic analysis. It incorporates a 2D phantom for validating algorithms and analyzing parameter effects, a 3D phantom designed to mimic anatomical structures like a breast and cancerous lesion for Mammography Imaging, and finally, a function to produce a 2D mammogram from the 3D phantom using user-defined parameters.

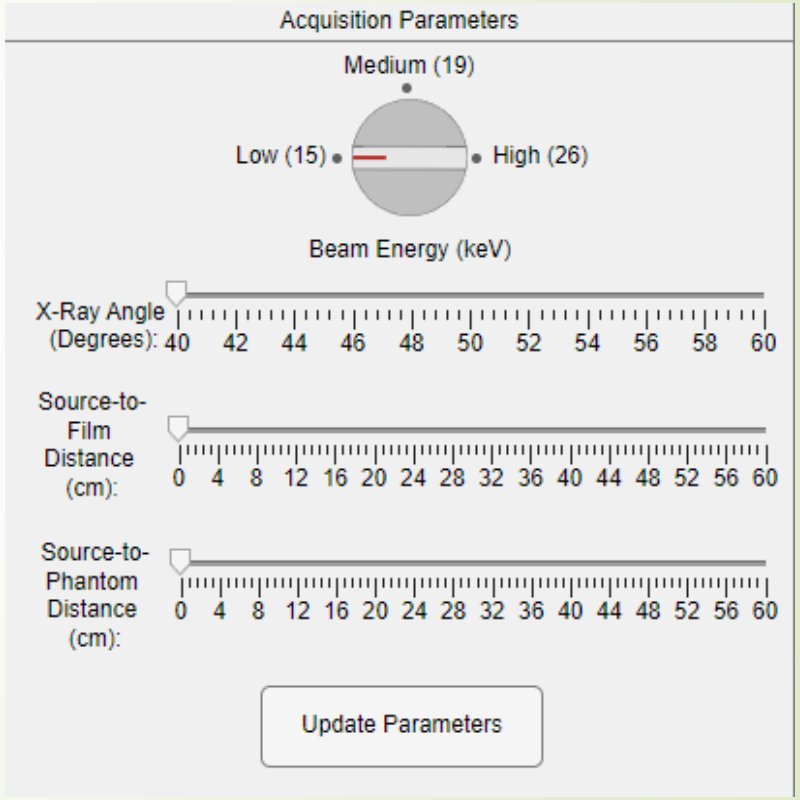
GUI

- Following is the GUI that the user can interact with. It has 2 views, each for the 2D and 3D Phantoms it produces.
- It involves 4 parameters:
  - Beam Energy: Choices of 15, 19, and 26 keV.
  - X-Ray Angle: From 40-60 deg.
  - Source-to-Film Distance: From 0-60 cm.
  - Source-to-Phantom Distance: From 0-60 cm.
- Each parameter can be adjusted to the user's liking.



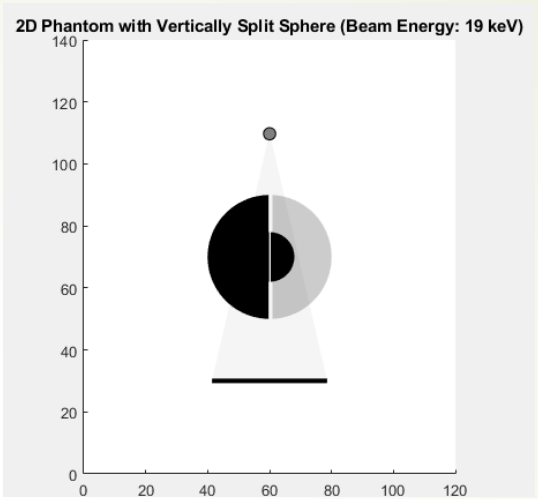
Parameters

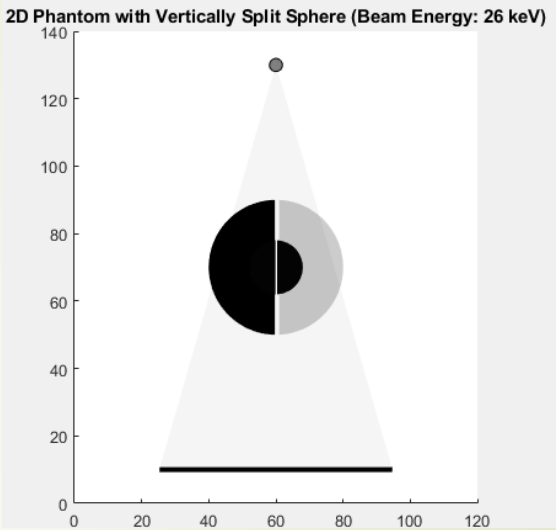
- Beam Energy: Affects the brightness and contrast of the phantoms generated.
- X-Ray Angle: Adjusts the cone width and exposure on the phantoms.
- Source-to-Film Distance: Adjusts the height between the film and phantoms.
- Source-to-Phantom Distance: Adjusts the height between the source and phantoms.

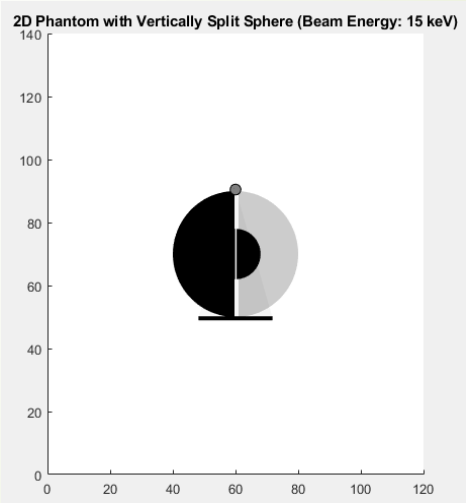


2D-Phantom

- The phantoms generated have varying parameters adjusted.
- The phantoms are split in half to show the effects of the outer layer while also being able to see the effects of the inner layer.
- Due to an increase in beam energy, there is some difference in the contrast between each variation of outputs.

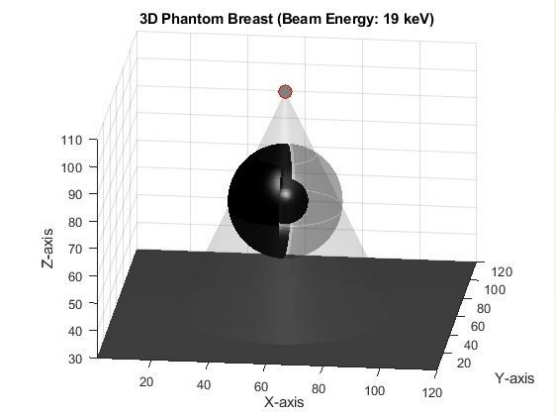


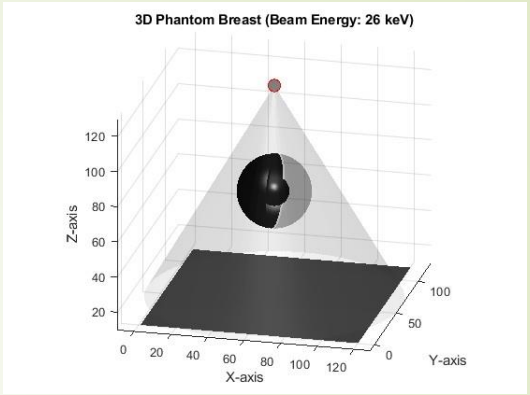


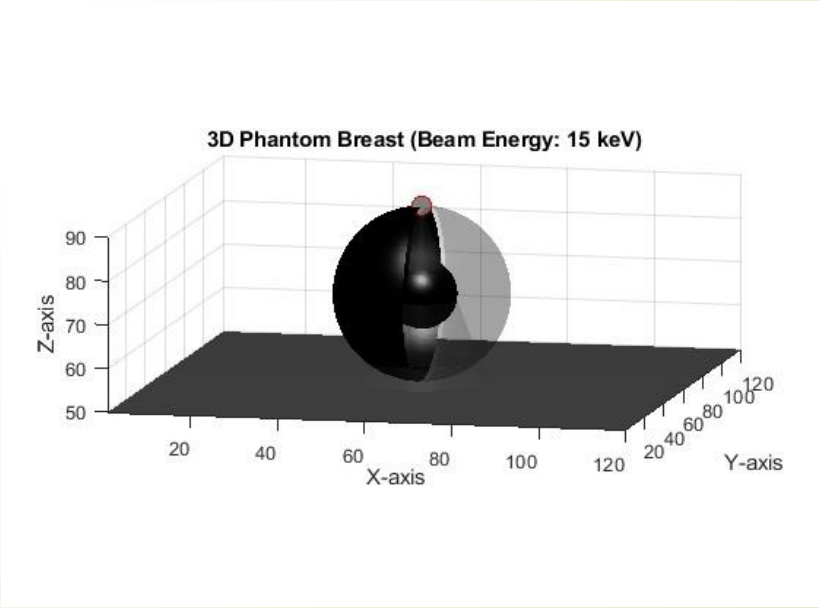


3D-Phantom

- The phantoms generated have varying parameters adjusted.
- The phantoms are split in half to show the effects of the outer layer while also being able to see the effects of the inner layer.
- Due to an increase in beam energy, there are some notable differences in each output. It is difficult to tell completely, primarily due to the very slight contrast in attenuation between the lesion and healthy breast tissue.

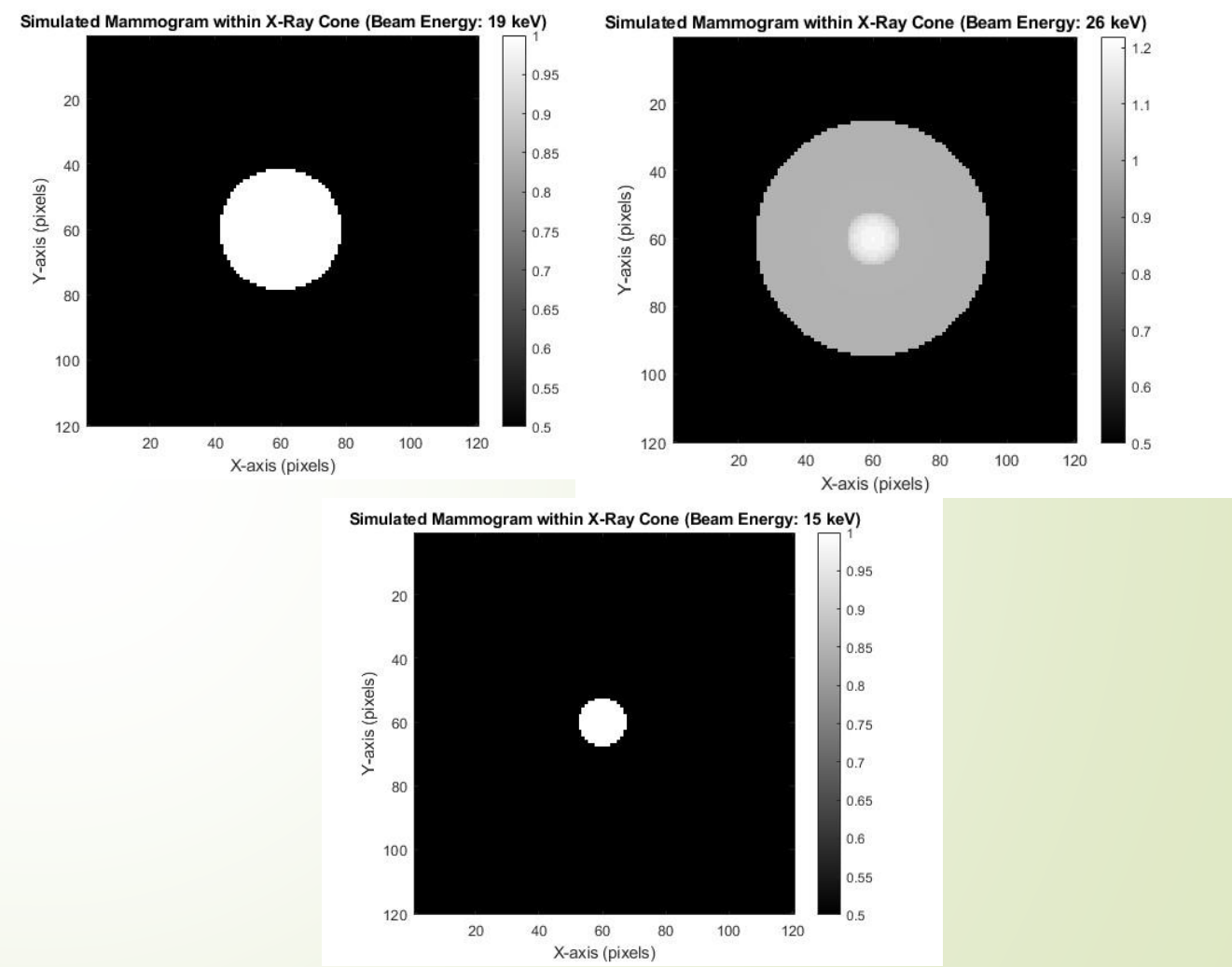






Mammogram Generated by 3D Phantom

- The mammograms generated here are all taken from the 3D phantoms used in the previous slide.
- Each mammogram has different visibility based on the user-defined parameters of the 3D phantom.
- The beam energies allowed for the user are chosen based on current literature defining the proper attenuation coefficients for different beam energies.



Results

- The results seen in the different mammograms taken suggest that the best beam energy to use for mammography is 26keV. This is due to the high contrast between the healthy and diseased tissue at this specific energy.
- The best parameters for visibility are: 60 degrees X-Ray angle, 60cm film-to-phantom distance, and 60cm phantom-to-source distance.

Challenges

- One of the main challenges we faced in this project was finding the most plausible parameters to use and set in our GUI, which we solved with the help of current literature.
- We also had a bit of trouble figuring out our attenuation coefficients and how to translate each factor in to signal intensity, but we also overcame that by informing ourselves of the current literature.
- There is still difficulty in visualizing the lesion in a mammogram with the low and medium beam energies, and perhaps with different incident intensities, the lesion would be easier to see. However, we chose to stick to what has been documented with regards to intensities and attenuations in order to make this project as realistic and informative as possible.