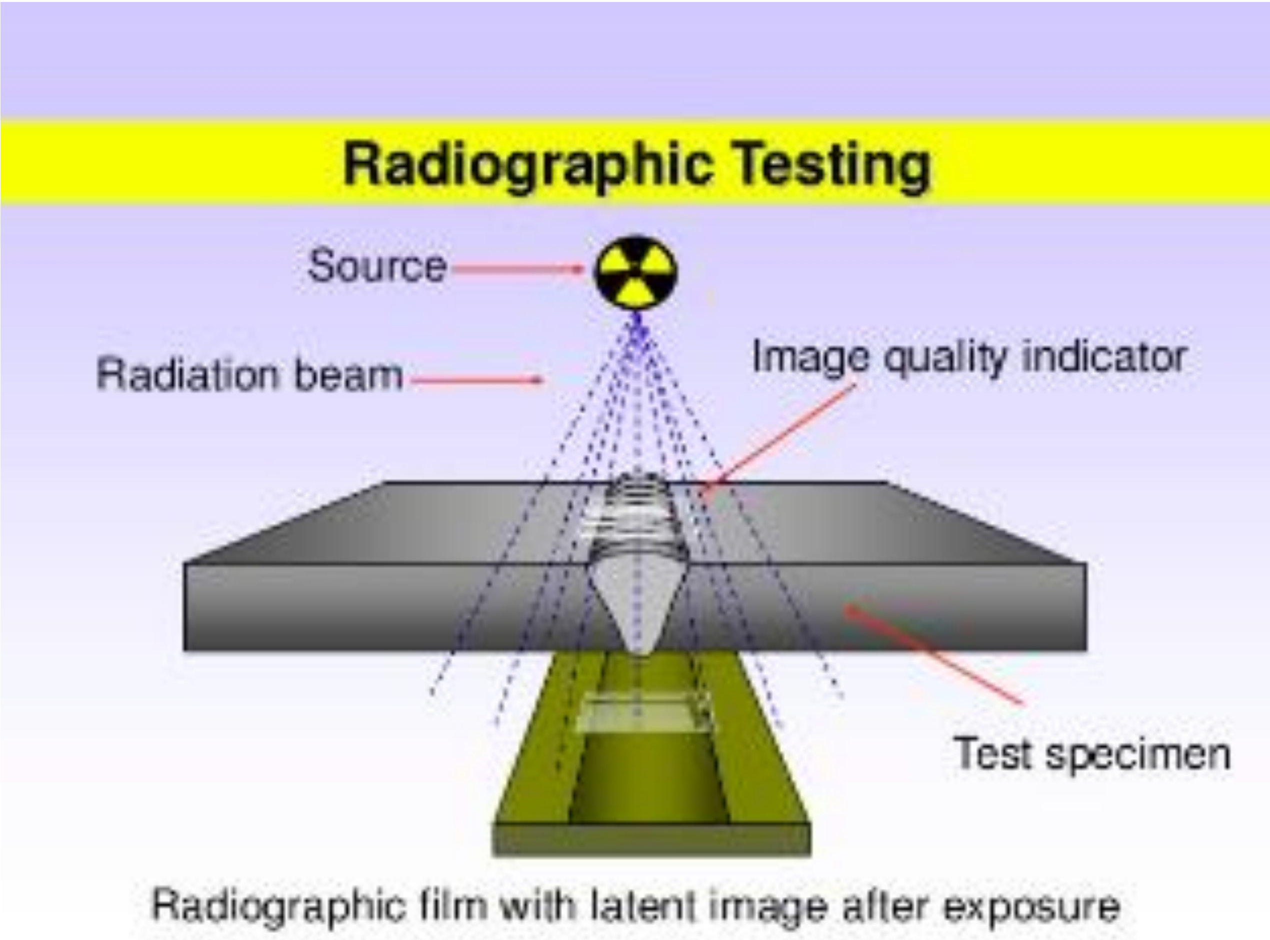
Radiographic Testing (RT) Simulation



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Project Overview:

In this project, I used MATLAB to simulate Radiographic Testing (RT) with X-rays to inspect the internal structure of materials. The simulation involved modeling X-ray propagation through a material and analyzing how internal defects, such as cracks or voids, affect the resulting radiographic image. The project demonstrated how variations in material thickness, defect size, and X-ray exposure influenced the quality of the radiographic images. By simulating different defect scenarios, I was able to analyze how effectively RT could detect internal flaws and enhance the understanding of material integrity.

Introduction:

Radiographic Testing (RT) is a non-destructive testing (NDT) technique used to examine the internal structure of materials using X-rays or gamma rays. It works by passing a beam of radiation through the material, and a detector captures the radiation that passes through. Differences in the material's density or structure, such as cracks or voids, absorb or scatter the radiation, leading to variations in the final image. RT is widely used in industries such as aerospace, manufacturing, and construction to detect internal defects without damaging the material.

This project focuses on simulating RT for detecting internal flaws in materials, specifically cracks and voids, using MATLAB. The goals were:

1. To simulate the propagation of X-rays through the material.
2. To model the effect of internal defects on the X-ray absorption.
3. To visualize the radiographic images and analyze how defects are represented.

Technical Parameters Used in the RT Simulation:

Material Properties:

Parameter	Value	Description
Density	7800 kg/m^3	Density of steel material
X-ray Attenuation Coefficient	0.2 cm^{-1}	X-ray attenuation coefficient for steel
X-ray Energy	100 kV	Energy of the X-rays used in the simulation

Defect Parameters:

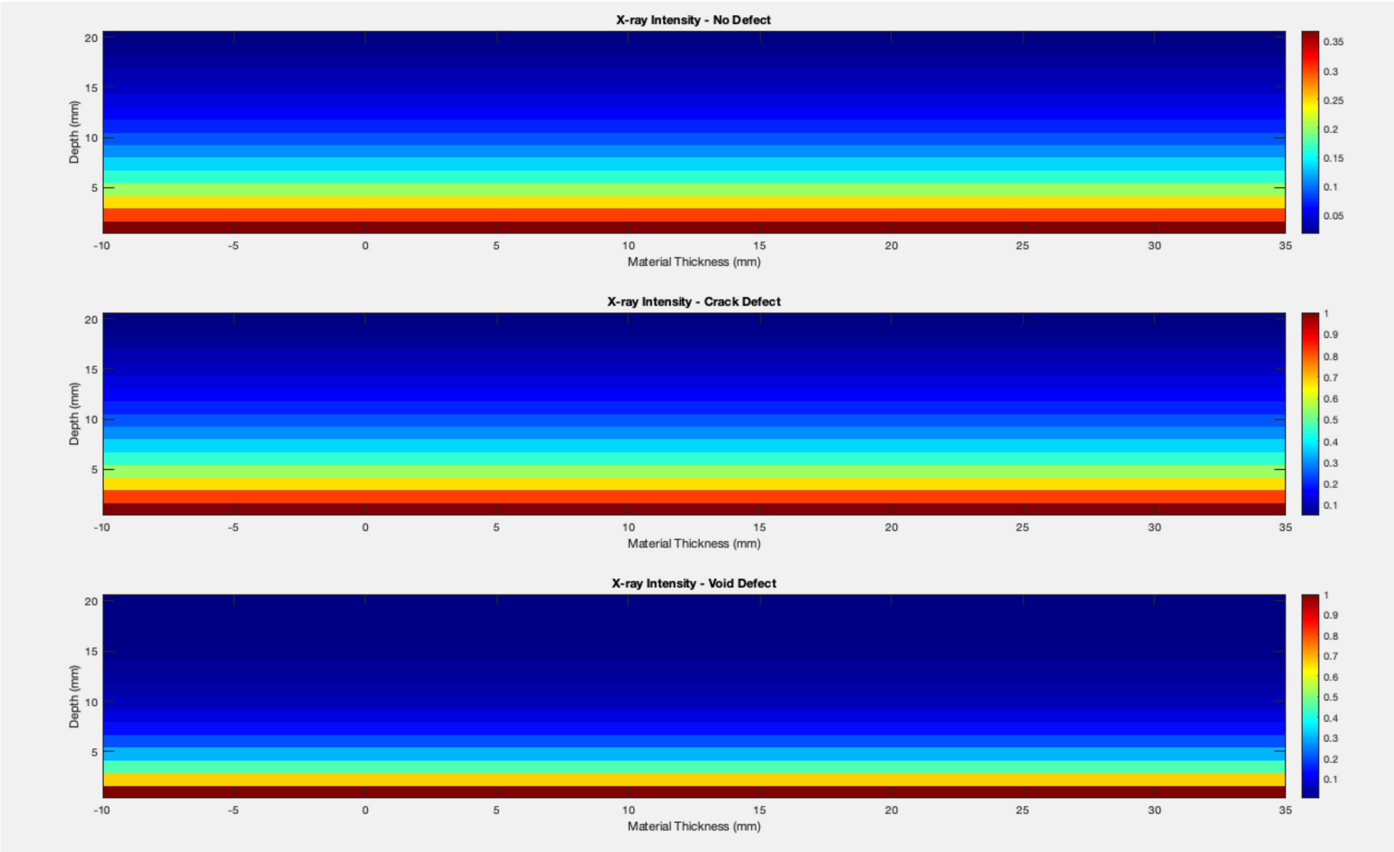
Parameter	Value	Description
Crack Size	2 mm	Size of the simulated crack
Void Size	3 mm diameter	Diameter of the simulated void
Defect Depth	5 mm	Depth of the internal flaw

Simulation Parameters:

Parameter	Value	Description
Material Thickness	5 mm to 20 mm	Range of material thickness to be tested
X-ray Beam Intensity	1000 µA	Intensity of the X-ray beam
Pixel Resolution	512 x 512	Resolution of the simulated radiographic image

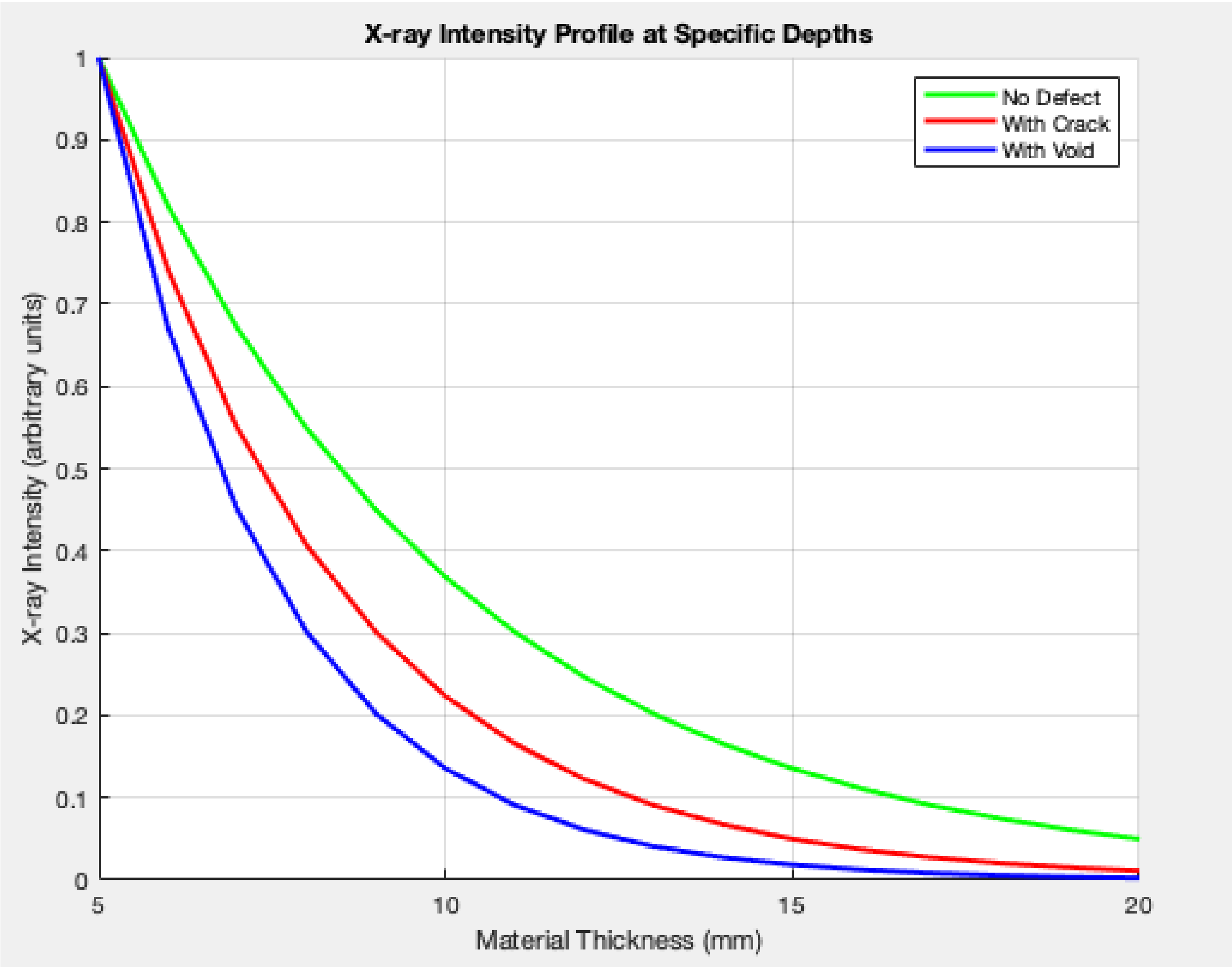
Results:

Heatmap Comparison for No Defect and Flaw Types:



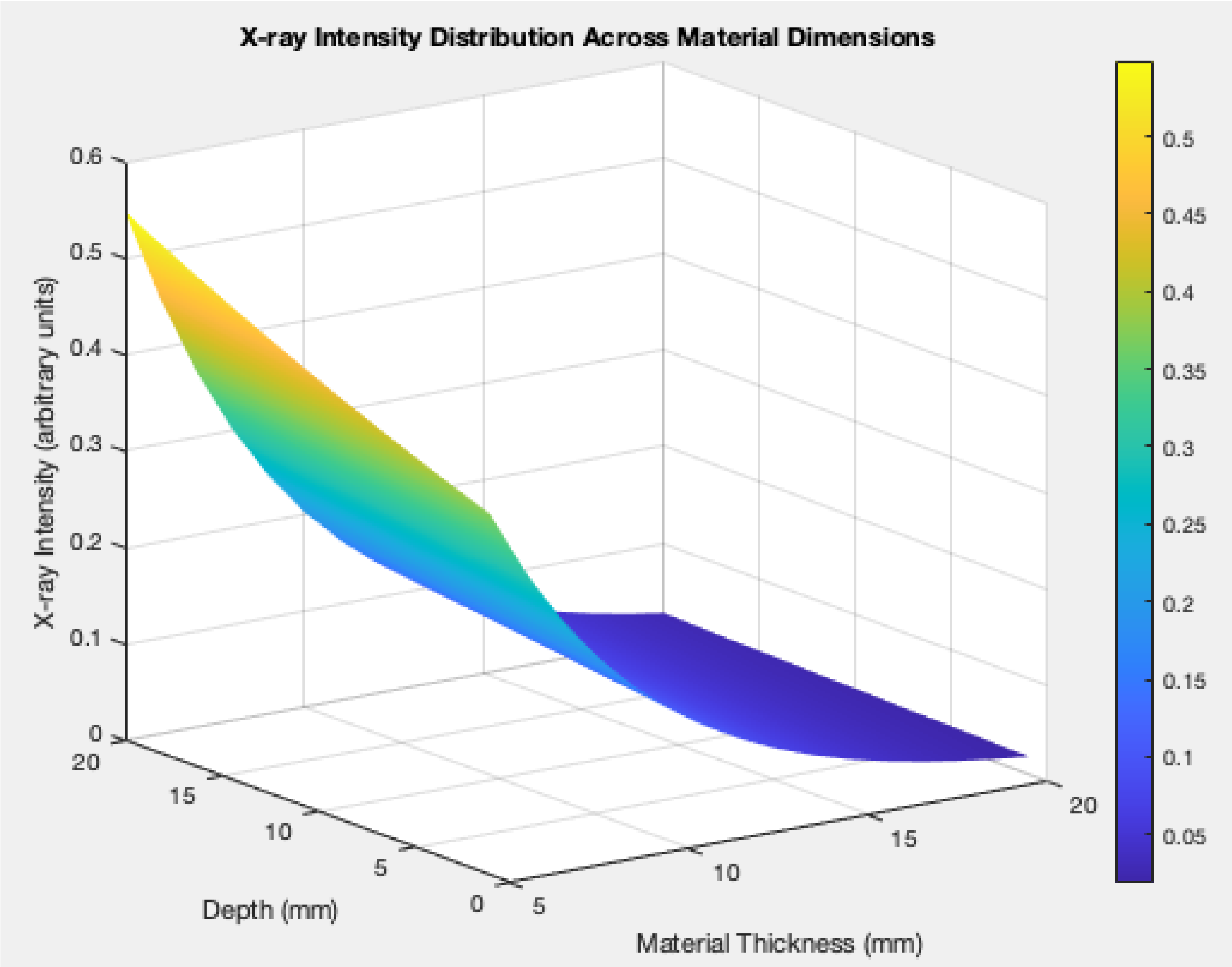
Heatmaps were generated for different flaw types. The heatmap for **No Defect** shows a consistent X-ray intensity across thicknesses. However, for **Crack** and **Void** defects, the X-ray intensity decreases, indicating the attenuation caused by these flaws at different material thicknesses and depths.

Intensity Profiles at Different Depths:



Line plots were generated to show the X-ray intensity profiles at different depths (5 mm, 10 mm, 15 mm). The profiles highlight how X-ray intensity decreases more significantly with flaws, particularly with voids, compared to materials with no defects.

3D Surface Plot:



The 3D surface plot illustrates how X-ray intensity varies across material thickness and depth, with the effect of a crack defect superimposed. The plot clearly shows the reduction in intensity as the crack depth and material thickness increase.

Conclusion:

The simulation effectively demonstrated how Radiographic Testing (RT) can detect internal flaws and measure material thickness. The results indicated that flaws such as cracks and voids cause significant attenuation, which can be observed in the X-ray intensity profiles.

Key Findings:

- **No Defect**: X-ray intensity remains uniform across material thickness and depth.
- **Crack Defect**: Increased attenuation, especially at deeper depths.
- **Void Defect**: Greater attenuation, showing a stronger effect compared to cracks.

This project highlighted the potential of RT in flaw detection and material characterization. It also showcased how simulation can be an effective tool for visualizing and understanding NDT principles in material science.