1. Introduction

1.1 Image Processing:What makes it So special?

Vision is the most advanced of our senses.However,unlike humans, who are limited to the visual band of the electromagnetie(EM)spectrum,imaging machines cover almost the entire EM spectrum,ranging from gamma to radio waves.They can operate also on images generated by sources that humans are not accustomed to associating with images. These include ultrasound,clectron microscopy,and computer-generated images.Thus,digital image processing encompasses a wide and varied field of applications.

1.2 Multidisciplinary Nature

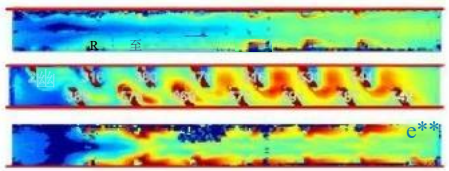
Image Processing is a vibrant field that manipulates and analyzes images to extract valuable information.As we sail through the 2lst century,the application of Image Processing has permeated various disciplines from agriculture to manufacturing,medical diagnostics to satellite imagery analysis,photography enhancement,robotics and facial recognition.

SAR satellite image for forest mapping

Brain scan templates

1.3 Image Processing:Chemical Engineering

The current landscape of Chemical Engineering is witnessing a paradigm shift,with Image Processing techniques being employed to analyze chemical processes,monitor reactions, and optimize production systems.From microscopic imaging of chemical reactions to large-scale process monitoring, Image Processing serves as a powerful tool,opening new avenues for innovation and efficiency.



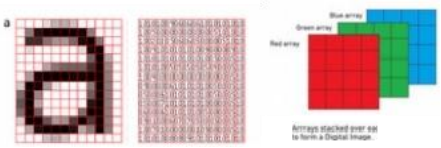
Turbulators destroying the boundary layer and increasing heat transfer

2. Obiective

Analysis of porous medium by employing image processing techniques and artificial neural networks (ANN).

3. Methods in Image Processing

Examining the techniques of image processing like filtering,segmentation,and feature extraction that contribute to enhancing and understanding visual data.



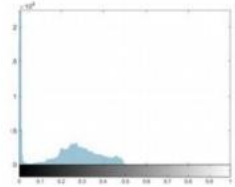
A digital image is a two-dimensional array of discrete,quantized values representing spatially distributed image elements or pixels. Each pixel carries specific intensity or color information,forming the basis for visual representation and analysis.

Image types examined in image processing techniques are usually grayscale,colored and binary images.

i.Adjusting Contrast

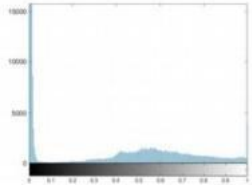
Low contrast can make the image difficult to see and analyze.Contrast adjustment involves altering the range between the lightest and darkest elements in an image.

Roundworms in a medical slide



Histogram of intensities the original image

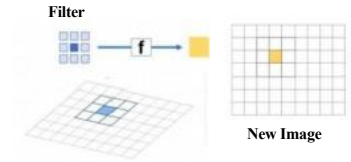
Image after contrast adjustment



Histogram of intensities after adjustment

ii.Noise Filtering/Spatial Filtering

Spatial filtering smooths your image,removing noise and unwanted detail.An initial attempt to segment the tumor in the medical scan given below does not isolate the tumor.The bloodvessels and other bright areas can throw off the segmentation,as can random variation in pixel intensities.Spatial filtering can even out both types of unwanted variation.



spatial filtering replaces each pixel with a weighted sum of the pixels around it

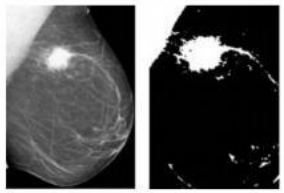
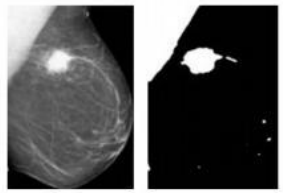


Image is bright where this a tumor,skin,and blood vessels.
These appear as noise in the binarization.



Medical scan after linear spatial filtering with 5x5 filter.
Binarization result after noise reduction.

iii.Texture Segmentation

Texture represents the variation of intensity values in an image.Segmentation by texture uses spatial filtering to identify regions with high or low variation.

Zebra stripes have high variation of intensity

applying 3x3 range filte

Binarizing filtered image

iv.Morphological Dilation and Erosion

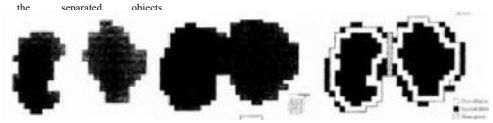
Morphological operations,like dilation and erosion,modify images. Dilation expands object boundaries by adding pixels,while erosion shrinks boundaries by removing pixels.

The size and shape of a chosen structure dictate how many pixels are added or removed in these operations.

v.Watershed Algorithm

Watershed algorithms are used in image processing primarily for object segmentation purposes,that is,for separating different objects in an image.

This allows for counting the objects or for further analysis of the separated objects.



Dam Construction in Watershed Algorithm

4.Applications

i.Particle Analysis:

In fuid mechanics and process engineering,image processing helps analyze particle size distribution,shape,and concentration in suspensions or emulsions.This is crucial for understanding and optimizing processes like filtration,sedimentation,and crystallization.

ii.Quality Control:

Help in assessing product quality in chemical manufacturing. Also help to detect defects,ensure proper mixing,and analyze surface characteristics

iii.Process Monitoring and Control:

Real-time image processing enables monitoring and controlling various chemical processes.It assists in identifying anomalies, monitoring reactor conditions,and ensuring process safety in complex chemical reactions.

iv.Analysis of Porous Bed:

Image processing techniques analyze images of porous materials and help quantify pore size distribution,shape,connectivity, and tortuosity within the porous structure.

iv.Fluid Dynamics:

Image processing techniques are utilized to analyze flow patterns,visualize heat transfer,and understand mixing phenomena in reactors or heat exchangers.This aids in optimizing designs and improving efficiency in chemical processes.

v.Bioinformatics:

Image processing techniques are applied in fields such as bioinformatics and bioengineering within chemical engineering. They aid in medical imaging analysis,drug development,and tissue engineering by processing and interpreting images from techniques like MRi,CT scans,and microscopy.

5. Result

Studied various image processing techniques and their practical use cases by using MATLAB image processing toolkit.

6. References

1.Digital Image Processing 3/e by Gonzalez,and Woods
2.Digital Image Processing Using MATLAB by Gonzalez, Woods,and Eddins
3.MATLAB Academy's Image Processing online course
4.www.imageprocessingplace.com

7. Group 5

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