Summary of the UGC Minor Project entitled

A STUDY ON IMAGE PROCESSING USING MORPHOLOGICAL OPERATORS

The main objective of the study was to familiarize morphological operators and suitable algebraic structures. It also aims to create a comprehensive theory of multi-valued morphological algebra, its algorithms and to create morphological equivalents of different image processing methods.

Images are generated by a wide range of physical devices, which includes still and video cameras, scanners, X-ray devices, ultrasound etc. They can be used for a multiplicity of purposes, including entertainment, medical imaging, business and industry, military, civil, security, and scientific analyses. This ever-widening interest in digital image processing stems from the advancement in the quality of pictorial information obtainable for human construal and the processing of scene data for independent machine perception. Digital image processing begins with one image and creates a customized version of that image. Digital image analysis is a process that converts a digital image into something other than a digital image, such as a set of measurement data, alphabet text, or a decision. Image digitization transforms a pictorial form to numerical data. A digital image is a two-dimensional discrete signal. It is also an N X N array of elements. In this array, each entry(element) is a number which corresponds to the sampled intensity. An image can be changed into a digital format either with a digital camera, or by a scanner. Digital images can be constructed directly on a computer screen. However, it is restricted both in spatial coordinates and in its allocated intensities. In general, image-processing operations can be classified into four types: Pixel operation, Local operation, Geometric operation and Global operation. As the topic is based on lattice theory, it is also discussed in this project.

Mathematical morphology involves geometric analysis of shapes and textures in images. An image can be characterized by a set of pixels. Morphological operators performs with two images. The image being processed is referred to as the active image, and the other image, being a kernel, is referred to as the structuring element. Each structuring element has a specified shape, which can be thought of as a probe or a filter of the active image. The active image can be modified by probing it with the structuring elements of different sizes and shapes. By selecting the size and shape of the neighborhood, we can create a morphological operation that is

perceptive to specific shapes in the input image. To improve performance, the structuring elements are broken into smaller pieces, a technique known as structuring element decomposition. There are different types of structuring elements such as linearly-sloped, convex, concave, two-dimensional grayscale structuring element etc. Decomposition properties of structuring elements are also included in the project.

The fundamental operations in mathematical morphology are dilation and erosion. Dilation inserts pixels to the boundaries of objects in an image, while erosion takes out pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. The dilation operator is commutative, associative, translation invariant, increasing and distributive with respect to union and intersection. The erosion operator is dual to dilation. It is increasing, translation invariant, distributive with respect to union and intersection, but not associative. Dilation and erosion are often combined to implement image processing operations. For example, morphological opening of an image is defined as an erosion followed by a dilation, using the same structuring element for both operations. The related operation, morphological closing of an image, is the reverse: it consists of dilation followed by an erosion with the same structuring element. The opening removes all of the pixels in the regions that are too small to contain the structuring element. It tends to smooth outward bumps, break narrow sections, and eliminate thin protrusions. The opposite sequence, closing will fill in holes and concavities smaller than the structuring element. It tends to eliminate small holes and remove inward bumps. Both opening and closing are increasing, idempotent and have the duality property.

In grayscale morphology, a gray scale image includes brightness information. Each pixel value in a gray scale image corresponds to an amount or quantity of light. Grayscale images can be represented as binary images in a three- dimensional space, with the third dimension representing brightness. Grayscale dilation and erosion are defined in terms of the notions of top surface and umbra. Convolution and correlation are also defined. The grayscale dilation erosion duality theorem establishes the relationship between the grayscale erosion between an image f and structuring element k with the grayscale dilation between the inverted image of f and the reflection of k.

For shape recognition and the processing of binary images, morphological hit-or-miss transformation is used. Here the structuring element consists of a pair of binary images. it is very

important to extract features of objects, describe shapes, and recognize patterns for which morphological algorithms are used. Thinning, thickening, skeletonization, pruning etc are defined. Morphological edge operators based on grayscale morphological operations can be efficiently implemented in real-time machine vision systems that have special hardware architecture for grayscale morphological operations. Simple morphological edge operators perform grayscale edge detection in a morphology based vision system by taking the difference between an image and its erosion by a small structuring element. The difference image is the image of edge strength. We can then select an appropriate threshold value to threshold the edge strength image into a binary edge image. The blur-minimum morphological edge operator is defined in terms of dilation, erosion and blurring operations. It is noise insensitive. For the ideal step edge, it produces a result that has nonzero edge strength on both the edge pixels. However, due to the effect of blurring, the edge strength assigned to the edge pixels is one-third of the edge contrast. For ideal ramp edges of larger spatial extent, a nonzero edge strength will be assigned to more than one pixel. However, the edge strength of the true edge pixel is usually higher than that of its neighbors. The performance of the blur-minimum morphological edge operator may be poor in the presence of noise. To overcome this problem, it was proposed a twofold modification that uses a so-called alpha-trimmed mean (ATM) filter to smooth noise models other than Gaussian distribution.

Morphological operations make image data into a simplified manner, conserve essential shape characteristics, remove noises and allow the underlying shape to be identified and optimally recreate from their noisy distorted form.

The quality of an image mainly depends upon two parameters: the number of samples and the number of gray levels. The larger these two numbers the better the quality of an image. However, this requires a large amount of storage space because the size of an image is the product of its dimensions and the number of bits needed to store gray levels. At a lower resolution, an image can generate a checkerboard effect or graininess. The visual quality requisite of an image depends upon its relevance and application. To get the highest visual quality and at the same time the lowest memory requirement, one may perform fine sampling of an image at the sharp gray-level transition areas and coarse sampling in the smooth areas.

Mathematical morphology is highly applied in medical field for the detection of cancer cells. This can be done by segmenting the MRI images of the affected area. It can be used for early

detection of intracranial tumors. The method includes two stages to detect and segment a tumor. Here the inputs are MRI scanned images. In the first stage, morphological operators are used to enhance the quality of input image. In the second stage, appropriate threshold value is used to segment tumor from MRI images. The purpose of image enhancement is included where the images before and after enhancement are segmented to show that the segmented images after enhancement are better, helping doctors/physicians diagnose diseases accurately. All the operations in mathematical morphology can be implemented using MATLAB.

The topic of the project consists of a broad and coherent collection of theoretical concepts, which are collected from books and journals. Morphological Operators and their features are discussed. In image processing, a general approach is provided by mathematical morphology, where the images being analyzed are regarded as sets of points, and the set theory is applied to morphological operations. This approach is based upon logical, rather than arithmetic, relations between pixels and can take out geometric features by choosing a suitable structuring shape as a probe. In image processing and analysis, it is important to extract features of objects, describe shapes, and recognize patterns. Such tasks are referred to geometric concepts, such as size, shape, and orientation. Mathematical morphology acquires this concept from set theory, geometry, and topology and analyzes geometric structures in an image. Most essential image-processing algorithms are represented in the form of morphological operations. Binary Image Processing and Grey Scale Image processing were discussed in detail in this project. The secondary data were collected from websites, journals, books and from research centers. Also, hospitals were visited to get image samples. The project consists of Six chapters:- 1) Introduction 2) Preliminaries 3) Binary morphology 4) Gray Scale Morphology 5) Morphological Algorithms and Image Processing 6) Conclusion