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A Study on Image Processing and Techniques

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Abstract— the objective of this project was to investigate methods to recover the maximum amount of available information from an image. Some radio frequency and optical sensors collect large-scale sets of spatial imagery data whose content is often obscured by fog, clouds, foliage and other intervening structures. Often, the obstruction is such as to render unreliable the definition of underlying images. Various mathematical operations used in image processing to remove obstructions from images and to recover reliable information were investigated, to include Spatial Domain Processing, Frequency Domain Processing, and non-Abelian group operations. These imaging techniques were researched and their effectiveness determined. Some of the most effective techniques were selected, refined, extended and customized for this project. Several examples are presented showing applications of such techniques with the MATLAB code included. A new advanced image processing technique was developed, tested, and is being proposed for the removal of clouds from an image. This technique has been applied to certain images to demonstrate its effectiveness. The MATLAB code has been developed, tested and appended to this report.

Keywords— *Techniques, MATLAB Code, Operations, Stack Filters, Computational Approach.*

I. INTRODUCTION

The objective of this project was to investigate methods to recover the maximum amount of available information from an image. Some radio frequency and optical sensors collect large-scale sets of spatial imagery data whose content is often obscured by fog, clouds, foliage and other intervening structures. Often, the obstruction is such as to render unreliable the definition of underling images. Various mathematical operations used in image processing to remove obstructions from images and to recover reliable information were investigated, to include Spatial Domain Processing, Frequency Domain Processing and non-Abelian group operations. These imaging techniques were researched and their effectiveness determined. Some of the most effective techniques were selected, refined, extended and customized for this project. Several examples are presented showing applications of such techniques with the MATLAB code included. A new advanced image processing technique was developed, tested and is being proposed for the removal of clouds from an image. This technique has been applied to certain images to demonstrate its effectiveness. The MATLAB code has been developed, tested and appended to this report. processing is being performed with the goal of identifying objects in an image, pre-processing to enhance the image is often helpful. Therefore, the first topic addressed in this report involves some popular methods of image enhancement. The first type of concept being presented is Spatial Domain Processing which involves the direct manipulation of pixels. The spatial domain refers specifically to the (x, y) image plane. The second type of concept will be based on Frequency Domain Processing. This will involve taking the Discrete Fourier Transform (DFT) of the spatial image $f(x, y)$ to produce a frequency domain image $F(u, v)$, processing the image in the frequency domain, and then taking the inverse of the DFT to obtain the filtered spatial image $g(x, y)$. The choice of Spatial Domain Processing versus Frequency Domain Processing depends on the nature of the problem. Frequency Domain Processing offers a great deal of flexibility in filter design. A combination of these two methods produces the best results in some cases. The authors, Gonzalez, Woods and Eddins [1] have created, documented in their book, and made available via the Internet, a set of image processing functions that extents the Image Processing Toolbook (IPT) package by about 35%. These functions will be referred to as GWE functions.

Another term sometimes used for spatial filtering is neighbourhood processing. This technique involves replacing the value of a centre point with a new value computed based upon the values of the points within the neighbourhood. A popular method of defining the neighbourhood, along with the center, is a group of nine points. These points consist of the center, the two points directly above and below the centre, the two points to the right and left of the center and the four points at the end of the two diagonals on a rectangle drawn about the center. Functions to isolate the edge of an image are often used as a pre-process to image segmentation. These functions typically use the first or second derivative about the center.

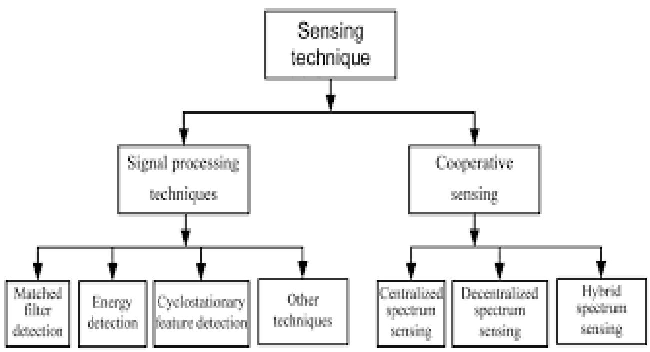

Figure.1

The IPT has several popular functions used to compute the edges. Among these are the Prewitt method, the Roberts method, the Sobel Method, the Canny method, the Laplacian and the zero-crossing method. The first four methods are based on the first derivative. The Laplacian is based on the second derivative. The zero-cross method finds edges by looking for zero crossings after filtering the image with a filter specified by the user. The first five methods all use a 9 point mask, w, to be applied to the center point and the 8 points surrounding the center, as designated above. The "edge" function in the IPT is used to find the edge of an image with the user designating which of the six above methods to be used. The "special" function in the Image Processing Toolbook (IPT) can be used to generate the mask, w, for the Prewitt, Sobel or Gaussian methods (along with 6 other types of masks).

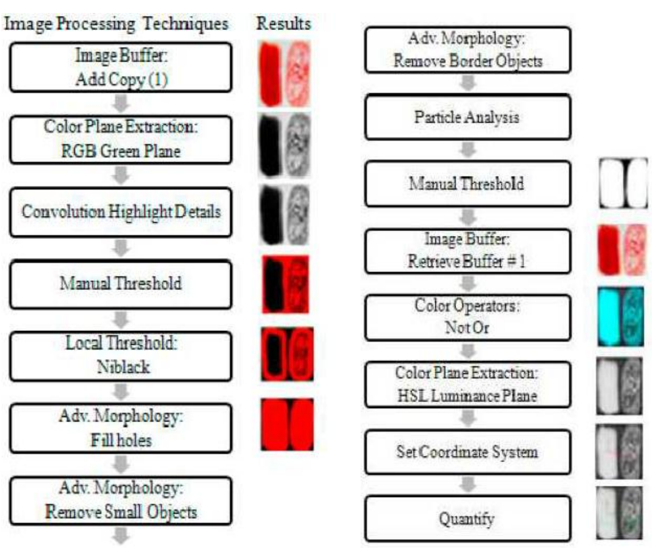

Figure.2

However, the mask can be generated by the user if so desired. The IPT function, "imfilter", with one form having the syntax imfilter(f, w), filters the image, f, with the mask provided by the user. Linear spatial filtering is applied. The following example shows the use of the Sobel edge function as applied to a tank vehicle.

```
 % Program tank_edge1.m
% This program uses the Sobel method to find the edges of a tank.
Z1 = imread('tank_pic1.jpeg'); %Read the tank image.
Z2 = rgb2gray(Z1);
Z3 = edge(Z2,'sobel');
Imshow(Z3)
```

II. METHODOLOGY

Image restoration and image enhancement have a lot in common but fundamentally have different objectives. The techniques presented above can be employed for both concepts. As the name implies, image restoration has the objective of restoring an image that has been degraded to its previous quality. This implies knowledge of the original appearance of the image and knowledge of the method in which it was degraded. Given knowledge of how the image was degraded, if an inverse of the process is applied, the image will be restored to its original appearance. An example is shown below. The first image shows a small airplane flying over a house top with clouds. The second image is a fog scene. The third image shows the plane embedded in the fog which was fabricated by adding 50% of the intensity of the fog image to the plane image. Since it is known how the plane image was corrupted, recovery of the plane image was made by subtracting out the image that was added. The result is shown in the fourth image.

III. RESULTS AND DISCUSSION

Finally, a much more mathematically intensive method of image segmentation will be presented. In addition to, and including what has been presented above, there are several methods used for removing obscuration information from images: Logical Image Operations, Connected Operations, Stack Filters, and Adaptive filters (using adaptive blind learning algorithms for image processing). A new advanced image processing technique has been developed as a result of this research based on combining these techniques. In order to understand this new method, the essential mathematical basis for each of the last four mentioned techniques is presented below.

IV. CONCLUSION AND FUTURE SCOPE

A grey-scale image partitions the underlying space into regions where the grey-level is constant, the so-called flat zones. A connected operator is an image transformation that coarsens such partitions. Such operators can delete edges, but they cannot change their shape or their location. As a result, connected operators are well-suited for many imaging tasks, such as segmentation, filtering, and coding. Connected operators have become popular in recent years. This is mainly due to the fact that they do not work at the pixel level, but rather at the level of the flat zones of an image.

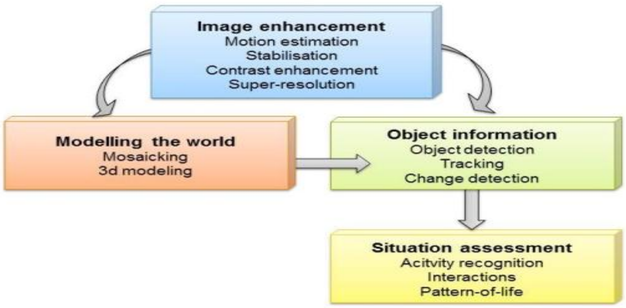

Figure.3

A connected operator can strengthen or weaken boundaries (or even remove them), but as stated above, it cannot shift boundaries or introduce new ones. Therefore, it preserves contour/shape information, which is known to carry most of the image content perceived by human observers. The flat zones of an image are defined as the maximally connected regions of its domain of definition with constant gray level value. In the case of binary images, the flat zones are called grains (foreground) and pores (background). The defining property of a connected operator is that it must coarsen the partition generated by the flat zones of an image.

The main conclusions of the study may be presented in a short Conclusion Section. In this section, the author(s) should also briefly discuss the limitations of the research and Future Scope for improvement.

V. PREPARE YOUR PAPER BEFORE STYLING

Many modern signal processing systems and structures incorporate discrete valued operators as basic building blocks. One example is the well known class of stack filters, based on monotone Boolean functions. Another example is the class of threshold Boolean filters, commonly used in document image processing. A number of multi-scale/multi-resolution pyramidal decomposition structures based on the median operation (special case of stack filters) and used in compression and de-noising applications have been recently proposed by a number of authors. Traditionally, analysis of deterministic or statistical properties of such systems or structures has been 29 conducted in a "static" sense; that is, the system's dynamic characteristics have not been utilized, precluding long-term or steady state analysis in all but the trivial cases. A new, dynamic analysis approach has been developed for the analysis of such systems. By modeling the sliding window as a Markov chain, it can determine the output distribution function of any recursive stack filter as well as its breakdown probabilities and can determine the output distributions of a new, more general, class of stack filters based on mirrored threshold decomposition. The method used relies on finite automata and Markov Chain theory. The distribution of any recursive stack filter is expressed as a vector multiplication of steady-state probabilities by the truth table vector of the Boolean function defining the filter. Furthermore, the proposed dynamical analysis approach allows us to study filter behavior along the time dimension. Analogously to recursive linear (IIR) filters which can be unstable, recursive stack filters also can possess a kind of instability. However, this instability manifests itself in a different sense - the filter can get "stuck" on certain values, unable to change. This phenomenon is sometimes referred to as streaking. Using the dynamical approach, we can analyze streaking by computing so-called run-length distributions. Additionally, the dynamic analysis approach allows us to study deterministic properties of stack filter systems, or more generally, of systems based on Boolean functions. Finite automata provides a convenient tool for studying invariant (root) signals of stack filters.

A. Units

A new combined combinational approach is being proposed to remove interferences from images and to recovery the maximum amount of available information.

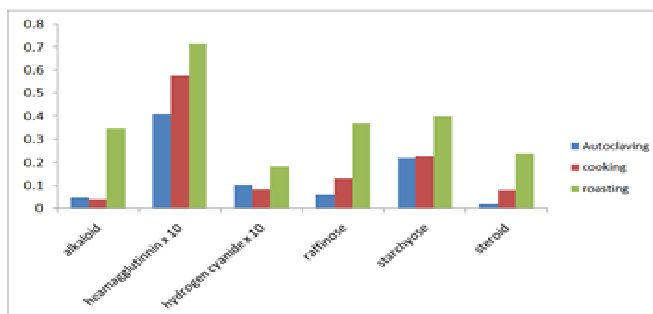

Figure.4

It is based on the following **three steps:**

A.1. First step:

To identify areas of the interferences on the images; a combination of image segmentation methods, adaptive threshold gain and morphological methods, has been developed;

A.2. Second step:

To refill the identified areas from step one with wanted areas on the images; a histogram-statistical approximately equivalent method has been developed;

A.3. Third step:

To smooth the neighbourhood of the refilled areas; the MATLAB function refill will be used here.

- Clustering basically means grouping similar data points into different clusters or groups. This section presents two related approaches for clustering: the K-means algorithms and the self-organizing map. The two most important issues in clustering include similarity measurement and the clustering procedure.

B. Equations

Various methods to remove obstructions from images and to recover reliable information were developed. These methods were successfully tested and the results presented along with the MATLAB code. Included is a new advanced image processing method that was developed and tested. This method uses a combination of Logical Image Operations, Connected Operations, Stack Filters, and Adaptive filters (using adaptive blind learning algorithms for image processing). The effectiveness of these techniques was demonstrated on a variety of images with obstructions to include fog and clouds. Further work is need on the identification/recognition of objects following the segmentation process.

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