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Comparative Study of Various Enhancement Techniques for Finger Print Images

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Abstract-Fingerprints are the oldest and most widely used form of biometric identification. Despite the widespread use of fingerprints, there is little statistical theory on the uniqueness of fingerprint minutiae. A critical step in studying the statistics of fingerprint minutiae is to reliably extract minutiae from the fingerprint images. However, fingerprint images are rarely of perfect quality. They may be degraded and corrupted due to variations in skin and impression conditions. Thus, image Enhancement techniques are employed prior to minutiae extraction to obtain a more reliable estimation of minutiae locations, this dissertation, firstly provide discussion on the methodology and implementation of techniques for fingerprint image enhancement and minutiae extraction. Experiments using a mixture of both synthetic test images and real fingerprint images are then conducted to evaluate the performance of the implemented techniques. In combination with these techniques, preliminary results on the statistics of fingerprint images are then presented and discussed. In security applications, biometrics are most often used to verify a person's identity for the purpose of granting access to property or information. There are two different ways to resolve a person's identity: Verification and Identification. Identification means establishing a person's identity and Verification involves confirming or denying a person's claimed identity. Each one of these approaches has it's own complexities and could probably be solved best by a certain biometric system. In the absence of more advanced techniques of personal recognition schemes, this technique is very much useful. Various Enhancement techniques will be discussed by which the image quality is enhanced and Fingerprint Matching techniques are applied and it will contribute to recognize the person and authentic on the basis of physiological or behavioral characteristic possessed by the user. With the help of this technique we will prepare a system which is helpful to identify watermarked fingerprints. The proposed method, technique used will give good result and better performance and used robust preprocessing methods are used to reduce the enhancement errors and will improve the quality of images.

Identification and Verification of person on the basis of biometric features has become known in our society. When the biometric systems are connected to a person's body remarkably decreases the possibility of fraud. A biometric system basically is a pattern recognition system and to recognize the pattern or the image is not an easy task. From the various biometric techniques, recognition done by fingerprint technique is best. Due to various qualities of fingerprint technique like easy to use, reliability, high stability, high acceptance in identification and authentication, fingerprint technique is used mostly. The use of such technique ensures that the facilities provided are used by a authenticated user and no one else. Examples of such applications include secure access to buildings, computer systems, laptops, cellular phones like etc

Keywords: Enroll user recognition, authentication, Verification & Identification.

INTRODUCTION

Fingerprints have been used for over a century and are the most widely used form of biometric identification. Fingerprint identification is commonly employed in Forensic science to support criminal investigations, and in biometric systems such as civilian and commercial identification devices. Despite this widespread use of fingerprints, there has been little statistical work done on the uniqueness of fingerprint minutiae. In particular, the issue of how many minutiae points should be used for matching a fingerprint is unresolved.

The fingerprint of an individual is unique and remains unchanged over a lifetime. A fingerprint is formed from an impression of the pattern of ridges on a finger. A ridge is defined as a single curved segment, and a valley is the region between two adjacent ridges. The minutiae, which are the local discontinuities in the ridge flow pattern, provide the features that are used for identification. Details such as the type, orientation, and location of minutiae are taken into account when performing minutiae extraction defined a set of features for fingerprint identification, which since then, has been refined to include additional types of fingerprint features. However, most of these features are not commonly used in fingerprint identification systems. Instead the set of minutiae types are restricted into only two types, ridge endings and bifurcations, as other types of minutiae can be expressed in terms of these two feature types. Ridge endings are the points where the ridge curve terminates, and bifurcations are where a ridge splits from a single path to two paths at a Y-junction.

Fingerprint images are rarely of perfect quality. They may be degraded and corrupted with elements of noise due to many factors including variations in skin and impression conditions. This degradation can result in a significant number of spurious minutiae being created and genuine minutiae being ignored. A critical step in studying the statistics of fingerprint minutiae is to reliably extract minutiae from fingerprint images. Thus, it is necessary to employ image enhancement techniques prior to minutiae extraction to obtain a more reliable estimate of minutiae locations. The primary aim of this project is to implement a series of techniques for fingerprint image enhancement and minutiae extraction. Experiments using both synthetic test images and real fingerprint images are used to assess the performance of the implemented techniques. These techniques are then used to extract minutiae from a sample set of fingerprint images. By using the extracted minutiae data, preliminary experiments on the statistics of

fingerprints can then be conducted. This dissertation is organized into three main topics, with each chapter focusing on a different topic.

The first step of the fingerprint enhancement algorithm is image segmentation. Segmentation is the process of separating the foreground regions in the image from the background regions. The foreground regions correspond to the clear fingerprint area containing the ridges and valleys, which is the area of interest. The background corresponds to the regions outside the borders of the fingerprint area, which do not contain any valid fingerprint information. When minutiae extraction algorithms are applied to the background regions of an image, it results in the extraction of noisy and false minutiae. Thus, segmentation is employed to discard these background regions, which facilitates the reliable extraction of minutiae.

Computational techniques involving contrast enhancement and noise filtering on two-dimensional image arrays are developed based on their local mean and variance. These algorithms are no recursive and do not require the use of any kind of transform. They share the same characteristics in that each pixel is processed independently. Consequently, this approach has an obvious advantage when used in real-time digital image processing applications and where a parallel processor can be used. For both the additive and multiplicative cases, the a priori mean and variance of each pixel is derived from its local mean and variance. Then, the minimum mean-square error estimator in its simplest form is applied to obtain the noise filtering algorithms. For multiplicative noise a statistical optimal linear approximation is made. Experimental results show that such an assumption yields a very effective filtering algorithm. Examples on images containing 256 Ã— 256 pixels are given. Results show that in most cases the techniques developed readily adaptable to real-time image processing.

A method of improving the definition of a video picture by a computer program, which reduces the lowest grey values to black and the highest to white: used for pictures from microscopes, surveillance cameras, and scanners.

Image enhancement is the improvement of digital image quality (wanted e.g. for visual inspection or for machine analysis), without knowledge about the source of degradation. If the source of degradation is known, one calls the process image restoration. Both are iconical processes, viz. input and output is images.

After registration on the microscope the digital images are loaded to image processing software for further processing. The data includes information about pseudo color, pixel dimensions, time scale etc.First image data get adjusted by background subtraction, contrast enhancement etc. Colors might be assigned; sub volumes selected; z-mismatches corrected by pixel-shifts. The software's offer different options to look at the multidimensional data sets.i.e. slice viewer, gallery view, section view, projections, full 3D volume representations, surface models, time bar, color coded overlays of several channels, transparencies, ...The software offers analytical tools for measurement and quantification: automated counting of features, measurements of areas and volumes, tracing of filaments, measuring of distances, evaluation of co localization, ...

Apart from geometrical transformations some preliminary grey level adjustments may be indicated, to take into account imperfections in the acquisition system. This can be done pixel by pixel, calibrating with the output of an image with constant brightness. Frequently space-invariant grey value transformations are also done for contrast stretching, range compression, etc. The critical distribution is the relative frequency of each grey value, the grey value histogram.

In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging.

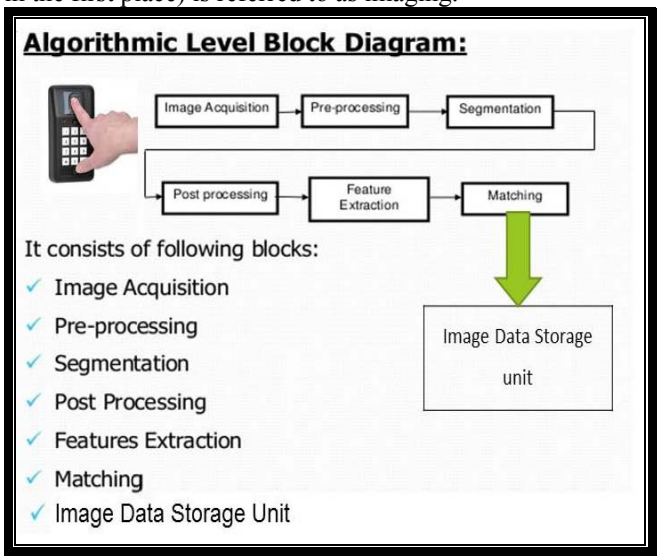

Fig.1. The block diagram of the research platform for Image Processing, analysis & understanding

Image Processing (image in → image out)
Image Analysis (image in →measurements out)
Image Understanding (image in → high-level description out)

EXPERIMENTAL RESULTS

While there are many biometric systems in the market, the aim of biometric systems, image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide better input for other automated image processing techniques. The importance of high-fidelity enhancement in low quality fingerprint image cannot be overemphasized. Most of the existing fingerprint enhancement methods are contextual filter-based methods and they often suffer from two short comings: (1) there is block effect on the enhanced images;

and (2) they blur or destroy ridge structures around singular points. In order to well preserve the ridge structures in singular regions and avoid block effect, now develop a new method for fingerprint enhancement combining no tensor product wavelet filter banks and anisotropic filter. The use of technique first decomposes the fingerprint image using the no tensor product wavelet filter banks. Then modify the approximation sub image using anisotropic filtering and adjust the high frequency coefficients of the three other sub images by applying the adaptive approach to reduce the noises according to the geometry feature of images. Finally, the inverse transform is applied to map the result and a final contrast enhancement is done subsequently. Experiments have been conducted on the fingerprint database. The results demonstrate that the proposed approach is capable of overcoming block effect and enhancing low quality fingerprint while preserving the ridge structures around singular points.

The problem of biometric sensor interoperability has received limited attention in the literature. Most biometric systems operate under the assumption that the data, images to be compared are obtained using the same sensor are restricted in their ability to match or compare biometric data originating from different sensors. Although progress has been made in the development of common data exchange formats to facilitate the exchange of feature sets between vendors, very little effort has been invested in the actual development of algorithms and techniques to match these feature sets. In the Fingerprint Verification Competition, for example, the evaluation protocol only matched images originating from the same sensor although fingerprint data from different commercial sensors was available. This is an indication of the difficulty in accommodating sensor interoperability in biometric systems discuss this problem and present a case study involving two different fingerprint sensors.

The purpose of various enhancement techniques for finger print images conducted three different types of experiments in order to study the effect of changing sensors on matching performance.

1. Matching images within the MSU DBI database.
2. Matching images within the MSU VERIDICOM database.
3. Matching images from MSU DBI against those from MSU VERIDICOM.

Enrollment:-

Users are not required to carry any cards. On enrollment, a user places his or her finger on the scanner, which captures a fingerprint image. The image is sent to client Pc. If the image quality is acceptable, fingerprint minutiae information is extracted, and the image is then discarded. The minutiae information is sent via a secure line to the biometric server, usually located in a secure room. This information is stored in a database on the biometric server. The system may enroll one or up to all ten fingers. Modern one-to-many systems are capable of searching as many as 20,000 templates, even more at times, in real time, within a few seconds.

Identification:-

To obtain access to a facility, the user places the appropriate finger on the sensor, and the captured fingerprint is sent to the client. The client extracts the minutiae information (with the fingerprint image subsequently discarded) and sends it to the biometric server. Here, the minutiae information is run in a one-to-many mode against the entire database of stored templates. If there is a match with one of the templates, the user is granted access. Alternatively, the system may go to the next level of authentication, for example: the corresponding photo of the user whose template has been matched is retrieved from the database and displayed to the operator. If the photo matches to the individual, the user is granted access.

Why we need enhancement for fingerprint?

A fingerprint image enhancement algorithm receives an input fingerprint image, applies a set of intermediate steps on the input image, and finally outputs the enhancement image. Fingerprint Identification is the method of identification using the impressions made by the minute ridge formations or patterns found on the fingertips. No two persons have exactly the same arrangement of ridge patterns, and the patterns of any one individual remain unchanged throughout life. Fingerprints offer an infallible means of personal identification. Other personal characteristics may change, but fingerprints do not. Fingerprints can be recorded on a standard fingerprint card or can be recorded digitally and transmitted electronically to the FBI for comparison. By comparing fingerprints at the scene of a crime with the fingerprint record of suspected persons, officials can establish absolute proof of the presence or identity of a person.

Digital image processing plays a vital role in the analysis and interpretation of remotely sensed data, the overall increased brightness of the enhanced image Utilize computers to provide corrected and improved images for study. Enhancement is the modification of an image to alter impact on the viewer. Generally enhancement distorts the original digital values; therefore enhancement is not done until the restoration processes are completed.

Image processing can be broadly defined as the manipulation of signals which are inherently multidimensional. The most common such signals are photographs and video sequences. The goals of processing or manipulation can be (i) compression for storage or transmission; (ii) enhancement or restoration; (iii) analysis, recognition, and understanding; or (iv) visualization for human observers. The use of image processing techniques has become almost ubiquitous; they find applications in such diverse areas as astronomy, archaeology, medicine, video communication, and electronic games. Nonetheless, many important problems in image processing remain unsolved. It is the goal of this paper to discuss some of these challenging problems as above, enhancement for fingerprint work mention a number of outstanding problems. Then, in the remainder of this paper, enhancement for fingerprint work concentrate on one of them: very-low-bit-rate video compression. This is chosen

because it involves almost all aspects of image processing. Many computer vision and computational photography applications essentially solve an image Enhancement problem the image has been deteriorated by a specific noise process, such as aberrations from camera optics and compression artifacts, that would like to remove. Enhancement for fingerprint research work describes a framework for learning based image enhancement. At the core of our algorithm lies a generic regularization framework that comprises a prior on natural images, as well as an application-specific conditional model based on Gaussian processes. In contrast to prior learning-based approaches, our algorithm can instantly learn task-specific degradation models from sample images which enable users to easily adapt the algorithm to a specific problem and data set of interest by applying it to example enhancement applications including single image super-resolution, as well as artifact removal in JPEG- and JPEG 2000-encoded images for visual effect. The effect of enhancement on cytogenetic diagnosis is further investigated by classification tests conducted prior to and following the chromosome image enhancement. In comparison with conventional techniques, the proposed method leads to better classification results, thereby benefiting the subsequent cytogenetic diagnosis

SIGNIFICANCE OF THE STUDY

In some Canadian jurisdictions, personal information is defined as recorded information about an identifiable individual, other than contact information. Under that broad definition, any biometric information is personal information is considered personally identifiable if an individual may be uniquely identified either from this information only or in combination with any other information. If it is determined that the information is Personal information not just contact information, it will also be considered personal information by other Canadian jurisdictions.

There are two main groups of fingerprint algorithms: minutiae-based and non-minutiae, or pattern-based. The vast majority of systems use minutiae-based algorithms. However, this does not preclude the use of some non-minutiae information as an auxiliary means to improve system performance. In one-to-many matching applications, it is very likely that optional and/or extended data will be used, given the challenges of such an identification system. However, this research work will here make a conservative assumption that only the basic minutiae information is collected in a particular application. In other words, the fingerprint template stored contains at least the number of minutiae per finger, the minutiae positions x, positions y, and directions. This information is not a “meaningless number” but a biological characteristic of an individual’s finger and is, therefore, highly sensitive personal information. Unlike many other forms of personal information, this biometric information cannot be changed, cancelled, or revoked.

OBJECTIVES

Fingerprint image quality assessment is crucial for many fingerprint applications. It affects the performance and interoperability of fingerprint identification, authentication, and built on based crypto systems.

Finger-scan technology is the most widely deployed biometric technology, with a number of different vendors offering a wide range of solutions. Among the most remarkable strengths of fingerprint recognition, In this research work can mention the following:

- ➔ Its maturity, providing a high level of recognition accuracy.
- ➔ The growing market of low-cost small-size acquisition devices, allowing its use in a broad range of applications, e.g., electronic commerce, physical access, PC logon, etc.
- ➔ The use of easy-to-use, ergonomic devices, not requiring complex user-system interaction. On the other hand, a number of weaknesses may influence the effectiveness of fingerprint recognition in certain cases:
- ➔ Its association with forensic or criminal applications.
- ➔ Factors such as finger injuries or manual working can result in certain users being unable to use a fingerprint-based recognition system, either temporarily or permanently.
- ➔ Small-area sensors embedded in portable devices may result in less information available from a fingerprint and / or little overlap between different acquisitions.

After go through literature of fingerprint enhancement techniques this research came to think about objectives like:

1. To collect database from various level.
2. To study and compare existing enhancement techniques.
3. To know best suitable tech for fingerprint enhancement.
4. On the basis of performance evolution, this research set better tech for enhancement of fingerprint.

Motivating factors associated with fingerprint analysis:

In this research work investigated the emotional and motivational factors involved in fingerprint analysis in day-to-day routine case work and in significant and harrowing criminal investigations. Thematic analysis was performed on interviews with HR or Admin experienced fingerprint examiners from a variety of law enforcement agencies. The data revealed factors relating to job satisfaction and the use of skill. Individual satisfaction related to catching criminals was observed; this was most notable in solving high profile, serious, or long-running cases. There were positive emotional effects associated with matching fingerprints and apparent fear of making errors. Finally, in this research work found evidence for a need of cognitive closure in fingerprint examiner decision-making.

METHODOLOGY:

In this research work will tackle existing problem by this research and try to improve results, which is available in

Spatial domain:-

Recent years have seen growing interest in the problem of super-resolution restoration of video sequences. Whereas in the traditional single image restoration problem only a single input image is available for processing, the task of reconstructing super-resolution images from multiple under sampled and degraded images can take advantage of the additional spatiotemporal data available in the image sequence. In particular, camera and scene motion lead to frames in the source video sequence containing similar, but not identical information. The additional information available in these frames make possible reconstruction of visually superior frames at higher resolution than that of the original data, review the current state of the art and identify promising directions for future research.

Frequency domain:-

This paper describes a method for solving the permutation problem in the frequency-domain independent component analysis (FD-ICA) approach to blind source separation (BSS). FD-ICA is a well-known method for BSS of convolutive mixtures. However, FD-ICA has a source permutation problem, where estimated source components can become swapped at different frequencies. Many researchers have suggested methods to solve the source permutation problem including using correlation between adjacent frequencies and direction of arrival (DOA). In this research work propose a modification to the DOA method, based on phase linearity of the FD-ICA de-mixing matrix, that can extend the range of frequencies over which the permutation problem can be resolved. Experiments indicate that our method can provide a better performance than the inter-frequency correlation method and the DOA method in real environments.

Wavelet Domain:-

Loss of information in a wavelet domain can occur during storage or transmission when the images are formatted and stored in terms of wavelet coefficients. This calls for image in painting in wavelet domains; a variation approach is used to formulate the reconstruction problem. In this research work propose a simple but very efficient iterative scheme to calculate an optimal solution and prove its convergence. Numerical results are presented to show the performance of the proposed algorithm.

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.

This paper presents a mineral identification method using Image enhancement methods, perception algorithm and Support Vector Machine theory. First, normalization and image enhancement technology are used to process image, literature using any of the results may use some technique like :- Spatial domain, Frequency domain and Wavelet Domain.

and then perception algorithm is followed to identify ore automatically, last Support Vector Machine learning mechanism is used to improve the recognition rate of ore. Experimental results show that recognition rate of Digital image processing mineral identification method is more than 90% and it can be effectively applied in the field of mineral identification.

CONCLUSIVE REVIEW RESULTS AND FUTURE WORK:-

Review of literature on fingerprint image enhancement put forward attention that there are researches available in spatial domain filtering but very few research work found using filter in frequency domain. Also very few work could be found taking ridge frequency enhancement in review literature process. Though ridge orientation and ridge detection, on single pixel found very well in spatial domain filtering. There are few research work reviewed based on fuzzy concept and filter. In our proposed future work ridge detection and ridge frequency enhancement, both is considered, it is reason two distinct filters one for ridge detection and another for ridge frequency are proposed to be designed

Although biometric technologies present a number of benefits, ranging from stronger user authentication, greater convenience for a majority of users, to improved security and operational efficiencies, they also present a number of risks to informational privacy. Any perceived or real threat to privacy could result in a serious loss of public faith and support. Consequently, organizations must carefully assess, prior to deployment, whether their needs can be met using alternative non-biometric means, and whether the privacy risks are outweighed by the necessity of installing a biometric system.

Image quality is related directly to the ultimate performance of automatic fingerprint authentication systems. Good quality fingerprint images need only minor preprocessing and enhancement for accurate feature detection algorithm. This paper reviewed a large number of techniques described in the literature to extract minutiae from fingerprint images. The approaches are distinguished on the basis of several factors like: the kind of input images they handle i.e. whether binary or gray scale, techniques of binarization and segmentation involved, whether thinning is required or not and the amount of effort required in the post processing stage, if exists. But low quality fingerprint images need preprocessing to increase contrast, and reduce different types of noises as noisy pixels also generate a lot of spurious minutiae as they also get enhanced during the preprocessing steps. Further, more emphasis is to be laid on defining the local criteria, in order to establish the validity of a minutia point, which is particularly useful during fingerprint matching and adopting more sophisticated identification models, for instance extending minutiae definition by including trifurcations, islands, bridges, spurs etc. Also, the paper leads to the further study of the statistical theory of fingerprint minutiae. In particular approaches can be investigated to determine the number of

degrees of freedom within a fingerprint population which will give a sound understanding of the statistical uniqueness of fingerprint minutiae.

The performance of a fingerprint feature extraction and matching algorithms heavily depends upon the quality of the input fingerprint image. Various enhancement approaches such as Histogram equalization, have shown to improve the fingerprint image quality and recognition performance in different studies. Gabor filters have both frequency-selective and orientation-selective properties. It is observed that Gabor filter method of fingerprint image enhancement is giving better results. Minutiae extraction algorithm can detect all the minutiae, including both true and false minutiae, using the Rutovitz Crossing Number (CN) on the skeleton images after thinning stage. In literature review it is found that there are few Fingerprint Image Enhancement research work, which has been done, is based on ridge direction but if the image enhancement done based on ridge frequency along with ridge direction, image would be very quite clear. Selecting such image features i.e. Frequencies and directions which minimize energy function based on energy minimization principle, a very good enhanced image can be produced. Both the features of the images are required to be enhanced, so two distinct filters in Fourier domain, one for enhancing ridge frequencies and other for ridge directions, have to be designed

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