ASSESSMENT OF THE IRIS RECOGNITION USING EDGE DETECTION ALONG BENCHMARK DATASETS

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Abstract. An individual's identity has grown more essential for individuals to satisfy modern corporate the community's higher safety standards. Iris represents one of the finest and most precise biometric systems now in utilization, with multiple edge detection methods used. As a consequence, understanding the different kinds of edge detection algorithmic methods which are now under operation is crucial. Three edge detection methods are used to be assessed on iris data during the present research. These methodologies are carried out using the MATLAB environment, which provides the evaluation with verified results. CASIA and MMU are the datasets that are used for this purpose. In contrast, the results reveal that the canny edge detection method works quite efficiently. Visual quality is crucial in vision-based recognition of objects. The present research assesses the visual aesthetic using various quality indicators such as PSNR and MSE. When compared to PSNR and MSE, however, MSE is recognized as the best image quality statistic.
Keywords: *recognition, assessment, image quality, edge detection*

Introduction

An image is a spatial representation of a two dimensional or three-dimensional scene. It is a matrix or an array, of pixels in rows and columns (pictorial elements). Image processing is a way for carrying out certain operations on an image to acquire an improved picture or to extract relevant information from it. In the same way, digital image processing involves the use of a computer to change the nature of a digital image. It is a sort of signal processing where an input is an image and an output can be an image or features. The processing of images is one of fast expanding technologies today. It also forms a core research subject in the fields of engineering and information technology. The technology of digital imaging helps to manipulate digital photos using computers. The pre-processing, enhancement and display extraction of information is three general phase's frameworks where all forms of data must pass while employing digital technologies. A digital image consists of a limited number of elements, each having a specific position and values. These items are known as picture elements, pixels and image elements. The term pixel is the most usable form of the digital picture elements (Elmasry et al., 2020; Shinde and Dani, 2012). Bole's prototype operates in building a one-dimensional representation of the gray-level profiles of the iris. He used zero-crossing of 1-D wavelet transform of the resulting representation. Using a family

of Gabor Filters was studied in some papers. They constructed the analytic image (a combination of the original image and its Hilbert transform) to demodulate the iris texture. A modified Haralick's co-occurrence method with multi-layer perceptron is also introduced for extraction and classification of the irises (Poursaberi and Araabi, 2005).

Iris recognition offers a number of possible applications, like access control, network security and so on. In banks and financial organizations, iris recognition technology is being used, replacing the loud and time-consuming systems, pin-based systems and password-based systems. The applications of medical management are turning to technologies for biometric iris recognition. Its great precision and user-friendliness allow iris recognition technology to identify the correct state of insurance that prevents fraud and duplicate medical records. Increased security concerns have led to significant modifications in international airport security systems. This has led to a growing interest in the state of art biometric (Alonso-Fernandez et al., 2018). The initial stage in this research will be to identify iris using several types of edge detection methods, provide the comparison of the results of the selected edge detection methods and finally to check the performance of these methods.

Literature review

This section includes algorithms, methods, procedures, processes, approaches, techniques, detectors, models, and filters, as well as all of the history research where their links were used as evolutionary and provided the optimized form of solutions for edge detection issues. As a result of the researcher's efforts, the number of filters has grown over time. They worked hard to improve, enhance, co-relate, and collaborate on various methods to solve edge detection problems in image processing, and they created new, modified methods. Image processing has been employed in a variety of sectors of science, and it has become increasingly important as computers have progressed (Li et al., 2022). Image enhancement and border detection are two strategies for iris recognition image preprocessing. Iris recognition is commonly regarded as one of the most reliable methods of identification (Sun and Hua. 2018). Image processing is becoming a fundamental aspect of artificial intelligence systems in research and technology. In the discipline of image processing, satellite imaging and military applications are seen as future trends. In addition, developments in internet devices and mobile technologies will aid in the development of image processing systems in handheld devices. To put things in perspective, image processing's future appears to be bright and secure (Razzak et al., 2018). Spoken commands, anticipating government information requirements, translating languages, recognizing and tracking people and things, diagnosing medical conditions, performing surgery, reprogramming defects in human DNA, and automatic driving all modes of transportation will all benefit from advances in image processing (Bhatt et al., 2021).

Image processing basically includes the following three steps: (1) importing the image by using image acquisition; (2) image analysis and manipulation; and (3) output that can be an altered image or a report based on image analysis. Iris biometric systems include all physical biometric systems, which operate at low false acceptance rates and are highly secure biometric systems. Various researchers employed different edge detection algorithms to improve the recognition of iris. Multi-scale edge operator employed by Nabti et al. and achieved a rate of 99.5% iris detection. The researchers also employed the JLUBR-IRIS database of canny edge operators with two hundred iris

images. In iris recognition, they obtained remarkable precision and efficiency. The researchers have applied canny edge detection technique for iris edge detection but no connected to strong edges. This operator is based on three basic objectives i.e., low error rate, well localized edge points and single edge point response (Kittisuwan, 2018). Iris biometric systems include all Iris recognition is used in jails for the recognition of prisoners. They all utilize iris recognition and immigration control at their borders (Saravani et al., 2018). For locating iris areas combined with reducing noise from eyelids, presented an intero-differential operator. The evaluation from the publication whether pupil and eyelash noises in his method are taken into account is almost impossible. The researchers have created an iris segmentation noise detection model. Although not considered in the model for pupil noises, the second noise regions were immediately divided into the time-consuming image from the original iris, and the third was untested on the basis of the existing identification algorithm for big iris data sets (Chang et al., 2000).

The efficient approach of extracting various features such as iris and an eyelash utilizing various edge sensing techniques was introduced. Edge detection algorithms can further be used to segment the image into many necessary analytical components. This phase in the pre-processing helps to remove the most significant form in an image, ignoring the identical unwanted regions and remarking the RoI (Shahrasbi and Rahnavard, 2016). The researchers submitted an ID-based iris pattern recognition system. With the application of the multi-channel Gabor filter and wavelet transformation, the system had the global feature extraction. This method was less sensitive to noise due to its extraction of global features (Pleschberger et al., 2020). The quick iris recognition system was proposed in Ansari et al. (2017) using modular neural grids. The other scholars used iris recognition circular symmetric filter in Khmag et al. (2019). A segmentation procedure based on Hough Transform integro-differential operators is introduced. This shortened the calculation time and omitted potential centers. Eyelash and noises of pupils were not taken into account in his way too (Shams et al., 2021). Edge detection is a method in which spots in an iris image are identified where there is a major change in intensity. Several operators such as Canny, Prewitt, Roberts, and Sobel etc. are available for edge detection. The operator Prewitt is particularly noise-sensitive. And the high frequency variation is not taken into account. Only when the image acquired is less acoustic and clearly defined edges are the Roberts operating companion well. The Sobel operator is similar to the operator of Prewitt, except the mask termed the convolution kernel is 3x3. In 1986, John F. Canny invented the canny operator. It identifies the edges by searching for the local maximum image gradient. For calculating the gradient, the derivative of the gauze filter is employed. The first derivative is used to calculate the edges, and the second to calculate the edges' directions. The strong and weak edges are detected by this method. Only those weak edges connecting to strong edges are identified by the canny operator. This operator is built on three fundamental goals: low failure rate, properly located edge points and one edge point response (Pion-Tonachini et al., 2019).

Materials and Methods

The general flow of the image recognition based on different steps or levels such as initial level is image acquisition, intermediate level is preprocessing (segmentation, normalization etc.), pre-final level is feature extraction and the final level is matching.

Besides this, edge detection methods are used and try to improve the efficacy. While he preprocessing level based on the conversion of the image from a color image to grayscale image whereas iris localization, edge detection, filtration, etc. All these steps involved in preprocessing level. *Figure 1* described the general flow of the research baed on iris recognition.

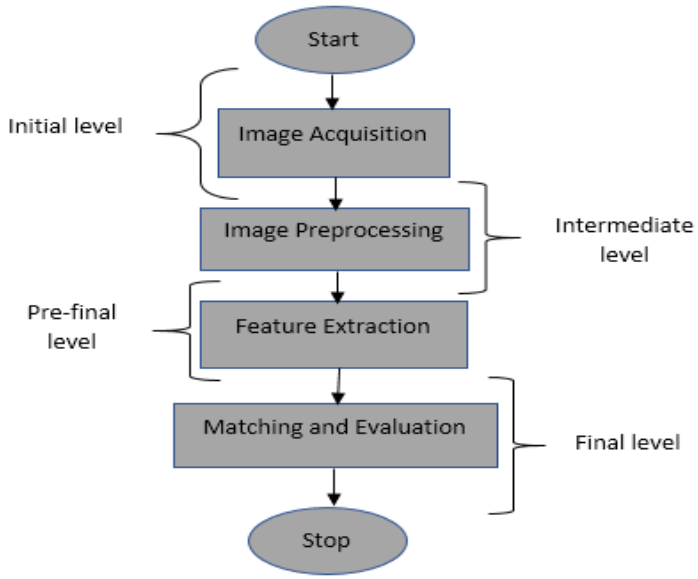


Figure 1. *General flow of image recognition.*

Image acquisition (initial level)

Image acquisition is the operation of acquiring an image from a source, usually hardware systems such as cameras, sensors, and so on, in image processing and machine vision. It is the first and most crucial stage in the workflow sequence because the system cannot perform any processing without an image. The image that the system acquires is frequently raw and unedited. Depending on the field of work, the initial setup and long-term maintenance of the hardware used to collect the images might be a crucial element in image acquisition in image processing. A desktop scanner to a huge optical telescope can be used as the hardware device. Visual artifacts can be formed if the hardware is not properly configured and aligned, complicating picture processing. Improperly configured hardware can also produce photos of such poor quality that they are unrecoverable even after intensive processing. During the picture capture process, incoming light energy from an object is transformed into an electrical signal by a set of sensors sensitive to that sort of energy. These tiny subsystems work together to offer the most accurate representation of the item to your machine vision algorithm. While the sensor system and cameras are largely dependent on existing technology, users have complete control over lighting. Therefore, this research used benchmark datasets of the iris recognition such as CASIA and MMU as well as provide the comparative analysis of these datasets.

Image pre-processing (intermediate level)

The process of dividing an image into parts or regions is known as image segmentation. The characteristics of the pixels in the image are frequently used to divide

the image into parts. Looking for abrupt discontinuities in pixel values, where this typically indicates edges, is one of the methods which used for locating regions in an image. These edges can be used to define regions. By segmenting an image, it's easier to process only the important part of the image rather than the entire image. The goal of segmentation is to simplify and/or change the representation of an image into something more meaningful and easier to analyze. Image segmentation is commonly used to locate objects and boundaries (lines, curves, etc.) in images. Detecting the inner and outer boundaries of iris texture is critical in all iris recognition systems. Simple geometric models are used to model the iris boundaries and the two eyelids in segmentation techniques. The pupil and limbus are frequently represented as circles, while the two eyelids are represented as parabolic arcs. It is desirable in segmentation to distinguish the iris texture from the rest of the image. The inner (pupil) and outer (limbus) boundaries of an iris are normally detected and segmented.

Feature extraction (pre-final level)

In the field of image processing, features are extremely important. Feature extraction techniques are used to obtain features that will be useful in image classification and recognition. Techniques for extracting features are useful in a variety of image processing applications, such as character recognition. Because features define an image's behavior, they reveal its position in terms of storage required, classification efficiency, and, of course, time consumption. The feature extraction techniques were created in order to extract features from synthetic aperture radar images. This technique extracts high-level features required for target classification. Size, shape, composition, location, and other characteristics that are unique to a target are referred to as features. Techniques such as segmentation are used to isolate the desired object from the scene so that measurements can be taken on it later. Quantitative measurements of object features enable image classification and description. A formal procedure for feature extraction describes the relevant shape information contained in a pattern, making the task of classifying the pattern easier. Feature extraction is a subset of dimensionality reduction in pattern recognition and image processing. The primary goal of feature extraction is to extract the most relevant information from the original data and represent it in a lower dimensional space. When an algorithm's input data is too large to process and is suspected of being redundant (lots of data but not much information), the input data is transformed into a reduced representation set of features (also named features vector).

Matching and evaluation (final level)

Image matching, also known as broad multiple baseline stereo which is the technique of establishing a sufficient number of pixel or region correspondences between two or more photos portraying an identical environment in order to determine the physical connection among the recording devices that created these images. Wherever, the action of rotating the template across the full image and calculating the similarity between the template and the covered window on the image is known as template comparison.

Results and Discussion

The outcomes of the experimental testing are the key to improve the parameters working or measurements. According to this research, CASIA and MMU iris dataets

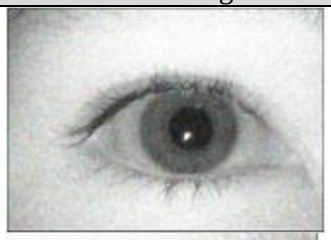
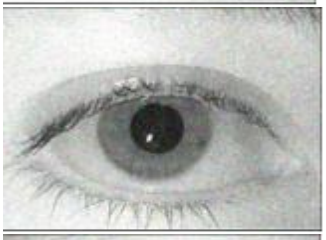
used for empirical testing and get the results in the form of PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error). The PSNR and MSE for five images from the CASIA and MMU dataset were calculated using various approaches. Images that are noisy are turned into filtered images, and the outcomes for all metrics are compared. According to *Table 1*, all indicators produced nearly consistent results.

Table 1. *Image quality metrics for CASIA dataset.*

Image no.	Noisy image	Filtered image	PSNR	MSE
Image 1			20.33	1297.14
Image 2			2055	1261.76
Image 3			20.45	1267.09
Image 4			20.35	1271.73
Image 5			21.61	927.08

In a comparable manner, PSNR and MSE are now computed for five images from the CASIA and MMU dataset in *Table 2*. PSNR, on the other hand, is balanced in terms of visibility, whereas MSE are not. As a result, PSNR is more easier for one to manage than MSE. This is due to the fact that MSE causes numerical mistakes, while PSNR generates impression and image faults. As the noise level increases, so does the regaining quality of the output image is difficult. As a result, PSNR outperforms all other measurements.

Table 2. *Image quality metrics for MMU dataset.*

Image no.	Noisy image	Filtered image	PSNR	MSE
Image 1			22.41	824.88
Image 2			22.65	754.08
Image 3			22.17	926.34
Image 4			22.15	835.16
Image 5			22.05	911.33

Comparative analysis of image quality metrics

Figure 2 depicts a comparison of the PNSR values of the CASIA and MMU datasets. There is a significant difference between these two datasets. The CASIA dataset displays a steady result for each of the four images before increasing in the graph for image 5. The MMU dataset shifts for three images before returning to a consistent result for images 4 and 5. Because of the high PNSR value, the first four images of the MMU dataset are highly favored over the first four images of the CASIA dataset. However, the fifth image of the CASIA dataset is superior to the fifth image of the MMU dataset. As a consequence, the MMU dataset results in this graph are good in terms of PSNR. *Figure 3* depicts a visual examination of MSE values from the CASIA and MMU datasets. In the illustration, the CASIA dataset demonstrates change for five images. Aside from that, MMU datset reflects the increase and drop of 5 images. Because of low values close to zero, the first four images of the MMU dataset outperform the CASIA dataset. However, because of the lowest value, the fifth image of the CASIA dataset is

superior to the fifth image of the MMU dataset. As a result, the MMU dataset findings are very good.

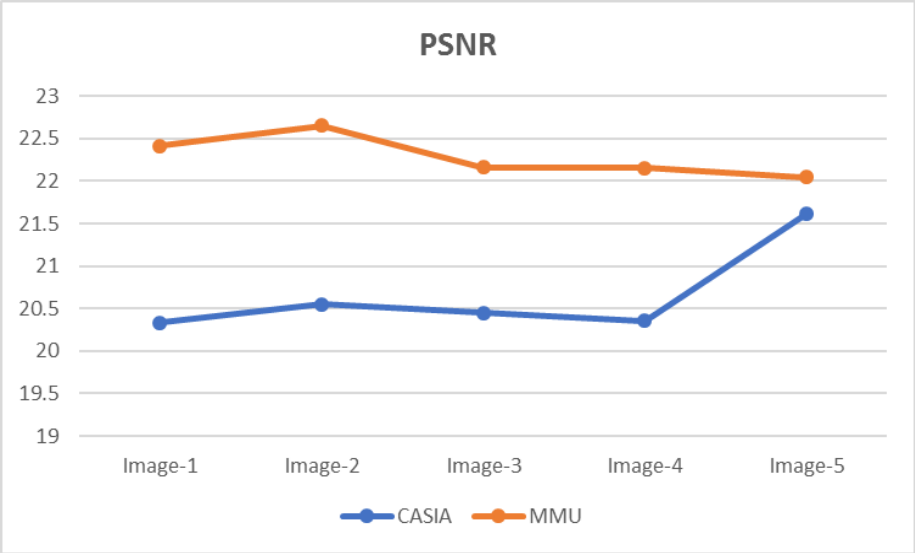


Figure 2. *Comparative analysis of PSNR along CASIA and MMU.*

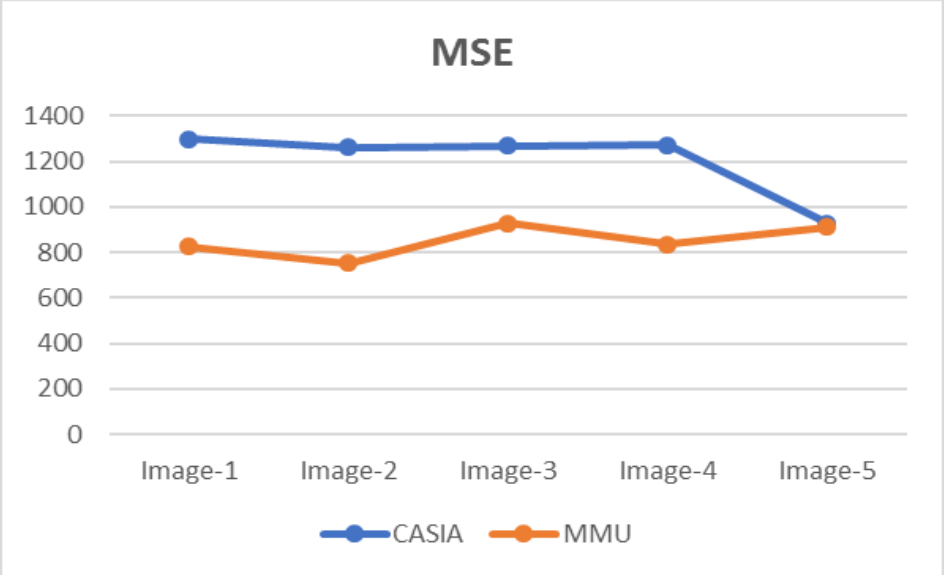


Figure 3. *Comparative analysis of MSE along CASIA and MMU.*

Conclusion

This study incorporates all of the findings from the research methodologies. The main objectives are fulfilled by the needed tasks of comparative examination of benchmark datasets (CASIA and MMU). The calculation of the PSNR and MSE for the images is evaluating performance using parameters. The study's accomplishments show a significant improvement in image quality and clarity. This study also contains recommendations for potential enhancements that future investigators should consider in order to focus on the experimental results, obtains the flaws identified in this work, and applies the highlighted work to other areas that require attention. In the future, new

filtered methods can be developed to overcome the limitation and improve image quality while minimizing noise. Reduced operational complexity is one of the next research directions that will increase the capability of this research.

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Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

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