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Iris Image Quality Parameters and Imaging Performance

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Abstract— ***The performance of an iris recognition system can be undermined by poor quality images and result in high false reject rates (FRR) and failure to enrol (FTE) rates. In this article, a signal to noise ratio (SNR), Grey scale Density, Contrast between sclera and Iris, contrast between iris and pupil quality measure for iris images is proposed. The merit of this approach lies in its ability to differentiate between the poor quality Images and the good quality images. An expression of quality based on utility reflects the predicted positive or negative contribution of an individual sample to the overall performance of biometric system.***

The term "quality" should not be solely attributable to the acquisition setting of the sample, such as image resolution, signal to noise ratio, grey scale density, contrast or numbers of parameters. Through such factors may affect sample utility and could contribute to overall quality score. Quality attributes impact authentic and imposter distributions. Effects on authentic and imposter distributions predict effects on match performance.

Overall, this article suggests that it is possible to check and verify the quality of the iris image. It also provides several research directions for future work.

Keywords— Signal to Noise Ratio, Grey Scale Density, Distortion, Pixel Aspect Ratio, Test Targets, Resolution

I. INTRODUCTION

Image processing is used in real time applications that demand good quality of images. During transmission of digital images, the quality of an image is degraded due to the addition of various types of noise, grey scale, illumination, contrast, pixel aspect ratio, image scale, image orientation and optical distortion. The various types of image parameters that differentiate between good and bad image are also studied.

II. RESEARCH METHODOLOGY

In the proposed method, we analysed iris images quality parameters on the based on ISO/IEC 19794-6:2005(E). Our basic article purpose is that we analyse the images captured by different iris scanners and differentiate between the good quality image and the bad quality images. In this article our main focus is on best four image quality parameters and find the results by using MATLAB. The description of each parameter given below.

A. Signal to Noise Ratio
B. Grey Scale Density
C. Contrast1 (Between sclera and iris)
D. Contrast1 (Between sclera and iris)

III. IRIS STANDARDIZATION (ISO/IEC 19794-6:2005)

The purpose of this document is to define a standard for exchange of iris image information. This part of ISO/IEC 19794 contains a specific definition of attributes, a data record format for storing and transmitting the iris image and certain attributes, a sample record, and conformance criteria. Currently, exchange of iris information between equipment from different vendors can only be done using a large-scale image of the entire eye. This is expensive in storage and bandwidth. To provide interoperability among vendors, it is necessary to define a standard, compact representation of a human iris. The biometric data record specified in this part of ISO/IEC 19794 shall be embedded in a CBEFF-compliant structure in the CBEFF Biometric Data Block (BDB).The International Organization for Standardization (ISO) and the International Electro technical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning iris recognition given in Clause 6 and/or Annex A. The ISO and IEC take no position concerning the evidence, validity and scope of this patent right. The holder of this patent right has assured the ISO and IEC that he/she is willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO and IEC.

A. IMAGE QUALITY

The spatial resolution of the iris imaging system should be at least 2 lp/mm at the object plane with 60% modulation. The digital image that is captured from the iris should have pixel resolution equal to at least 8.3 pixels per mm. Image suppliers may indicate higher levels of resolution by specifying in the CBEFF image header an image quality value corresponding to acceptable or good quality in accordance with Table 1

Typical iris diameter values, corresponding pixel resolution in pixels per mm, and optical resolution specified for 60% modulation, are listed in Table 1. Specific recommended values are defined in the following subclasses.

Table 1. Image Quality Levels

Image Quality Level	Image Quality Value	Expected Iris Diameter, Pixel	Minimum Pixel Resolution, pixel per mm	Optical Resolution at 60% modulation, lp/mm	Comments
Poor	0-25	-	-	-	Unaccepted Quality
Low	26-50	100-149	8.3	2.0	Marginal Quality
Medium	51-75	150-199	12.5	3.0	Acceptable Quality
High	76-100	200 or more	16.5	4.0	Good Quality

B. FOCUS QUALITY

Images should have focus quality adequate to preserve the specified spatial resolution. Fig. 1 illustrates a representative iris image with adequate resolution and focus quality. Note that image compression and defocus cause different types of degradations of an image. One algorithm for assessing image focus and assigning a Focus Score in the range of [0, 100] is given in the Appendix [7] of standard ISO/IEC 19794-6:2005(E).

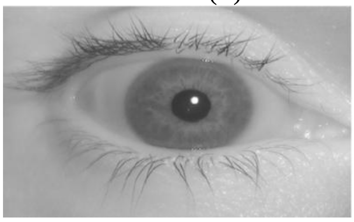


Fig. 1 Iris Image in good focus

C. GREY SCALE DENSITY

The image should have a dynamic range spanning at least 256 grey levels, allocating at least one byte (8 bits) per intensity value and providing at least 7 bits of useful intensity information. The image may utilize eight or more bits per grey value. If specular reflections from the illumination source occur their intensity should be set to the saturation level (the maximum value grey level) or to a grey value of 0. Other areas within the pupil, iris, and sclera of the eye should have intensities greater than 0 and less than the maximum grey level. This recommendation may be amended based on availability of performance data that documents the impact of the proposed change.

D. ILLUMINATION

The eye should be illuminated using near-infrared wavelengths between approximately 700 and 900 nanometres (nm). These recommendations represent current best practice, but do not preclude the use of other wavelengths, including visible light, in future systems. The angle between a line extending from the centre of the illumination source to the pupil centre, and the optical axis of the iris camera should be at least 5 degrees in order to prevent “red-eye” effect. The illumination source should be alongside or below the camera to prevent creation of shadows by the eyebrows.

E. CONTRAST

The iris image should have a minimum of 70 grey levels separation between the iris and sclera and a minimum of 50 grey levels separation between iris and pupil for all colour eyes. See Fig. 2. This recommendation may be amended based on availability of performance data that documents the impact of the proposed change.

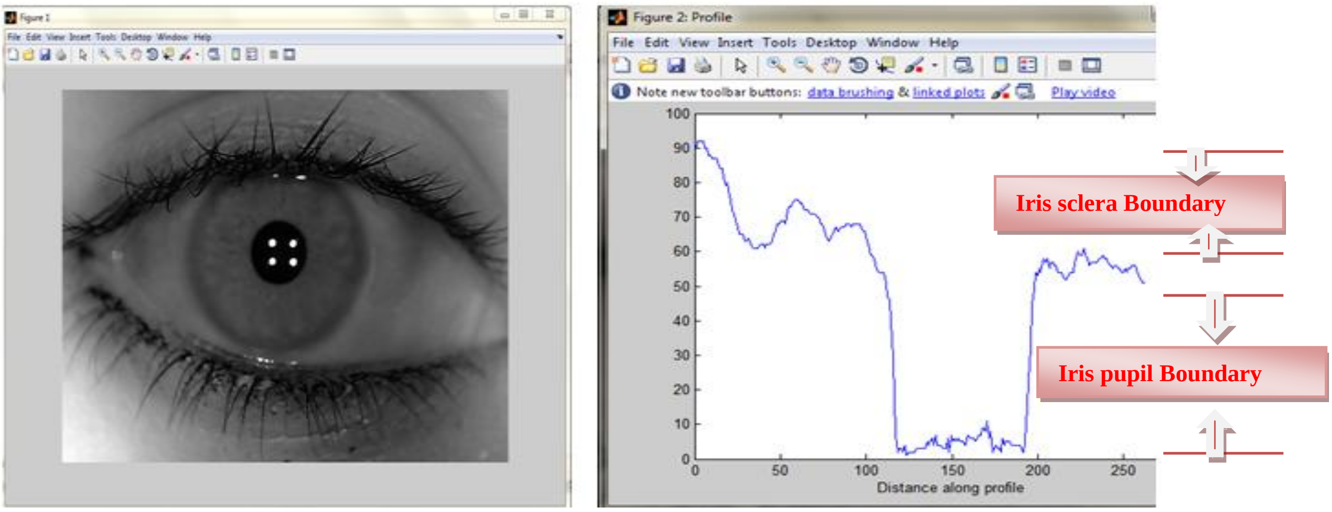


Fig. 2 Iris image and Grey level profile

F. VISIBLE IRIS

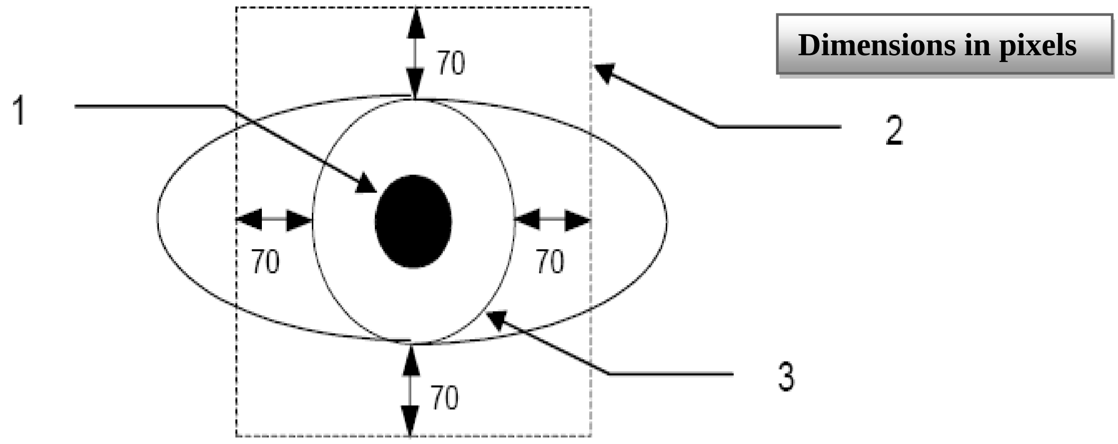
At least 70 percent of the iris should be visible, i.e., not obscured by specular reflections, eyelids, eyelashes, or other obstructions. It is recognized that this may be difficult to achieve among some ethnic populations. This recommendation may be amended based on availability of performance data that documents the impact of the proposed change.

G. PIXEL ASPECT RATIO

The image capture system should produce square pixels, in which the horizontal and vertical dimensions of the pixels are equal. Any difference between horizontal and vertical pixel dimension should be less than 1 percent, that is, the ratio of horizontal to vertical pixel dimension should be between 0.99 and 1.01.

H. IMAGE SCALE

The image scale should be such that an iris with naturally occurring iris diameter range of 9.5 mm to 13.7 mm has a minimum digital iris diameter of at least 100 pixels. The image should be large enough to include at least 70 pixels between the left or right edge of the iris and the closest edge of the image, and at least 70 pixels between the upper or lower edges of the iris and the closest edge of the image. See Fig. 3. This recommendation may be amended based on availability of performance data that documents the impact of the proposed change.



Key

1	Pupil boundary
2	Iris border
3	Iris boundary

Fig. 3 Image Size Specification

I. OPTICAL DISTORTION

The iris image should not exhibit effects of optical distortion including spherical aberration, chromatic aberration, astigmatism and coma consistent with standard optical design practices.

J. NOISE

The image signal-to-noise ratio (SNR) should not be less than 40 dB inclusive of any noise introduced by image compression techniques. This recommendation may be amended based on availability of performance data that documents the impact of the proposed change.

K. IMAGE ORENTATION

The image should contain either the left or right eye and should be presented in the following canonical form. If it must be flipped either horizontally or vertically to attain this form, then parameters in the header structure will indicate the flip required. The canonical form is as follows:

- The image is right-side up, i.e., upper eyelids and eye brows are in the upper part of the image.
- The tear duct (or nasal canthus) of the right eye is on the right side of the image; the tear duct of the left eye is on the left side of the image.

IV. TEST TARGETS

Test targets are useful when evaluating or calibrating an imaging system's performance or image quality. This could include troubleshooting the system, certifying or evaluating measurements, as well as establishing a foundation to ensure the system works well with another. Image quality can be defined by different components, particularly resolution, contrast, modulation transfer function (MTF), depth of field (DOF), and distortion; therefore, one or more types of test targets may be necessary or helpful depending upon the type of system being constructed or what needs to be measured. Fortunately, an array of targets exists that cater towards specific systems including cameras, visual displays, or even a single, thin lens. To be able to choose the correct test target, it is important to first understand the components of image quality.

A. ISO 12233 TARGETS

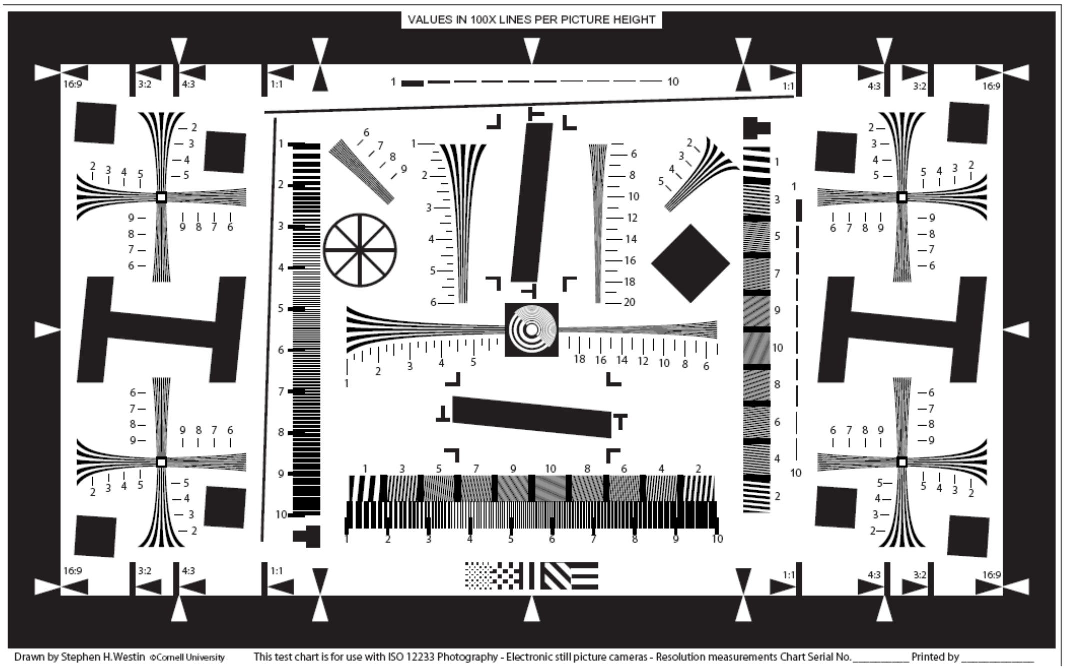


Fig. 4 ISO 12233 Test Chart drawn by Stephen H.Westin

The ISO 12233 Chart is the I3A/ISO standard for measuring the resolution of electronic still imaging cameras. The chart I am using is a very expensive, finely printed variation of the ISO 12233 standard that extends resolution to 4,000 lines per picture height (l/ph) and features other benefits as well. This chart serves as a good visual indicator of sharpness as well as CA and distortion.

B. RESOLUTION TARGETS

Consist of horizontal and vertical bars organized in groups and elements. Each group is comprised of up to nine elements within a range of twelve groups. Every element is composed of three horizontal and three vertical bars equally spaced with one another within a group and corresponds to an associated resolution based on bar width and space. The vertical bars are used to calculate horizontal resolution and horizontal bars are used to calculate vertical resolution. These targets are very popular when considering a target for testing resolution.

Typical Applications: Testing Resolution in Applications such as Optical Test Equipment, Microscopes, High Magnification Video Lenses, Fluorescence and Confocal Microscopy, Photolithography, and Nanotechnology

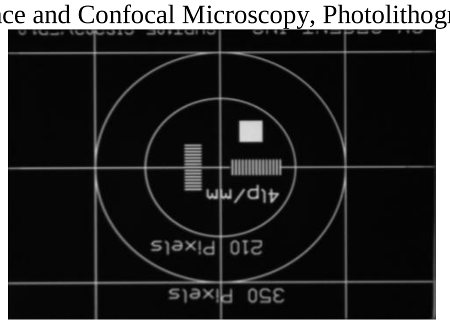


Fig. 5 Resolution Target

C. DISTORTION TARGETS

Used for calibrating imaging systems for distortion, which is a geometrical aberration that may misplace certain parts of the image. These targets consist of a grid of dots that are separated by various distances depending on the application.

Typical Applications: Lower Focal Length Lenses, Systems that Carry a Wide Field of View.

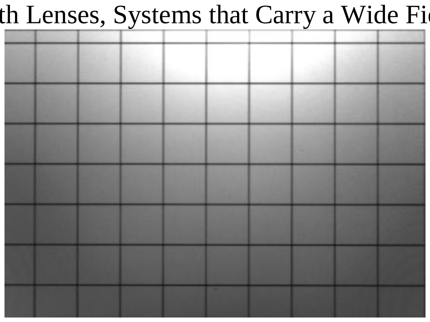


Fig. 6 Distortion Target chart.

V. RESULTS

A. RESULT OF PIXEL ASPECT RATIO IN MATLAB

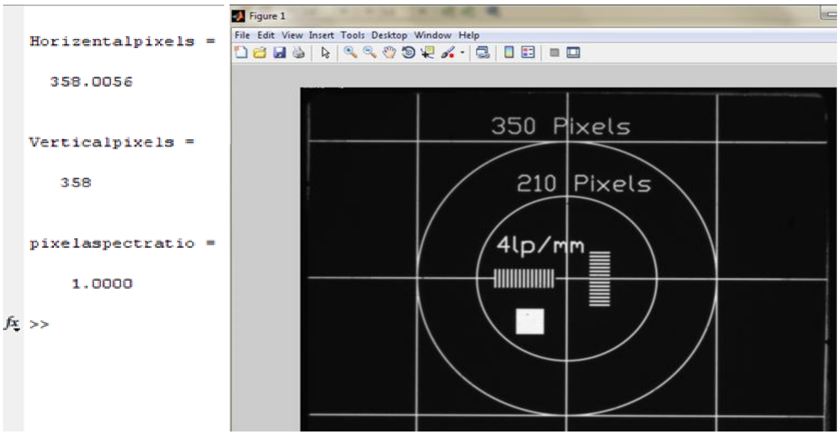


Fig. 7 Pixel Aspect Ratio result by using resolution target.

B. RESULT OF IMAGE MARGIN IN MATLAB

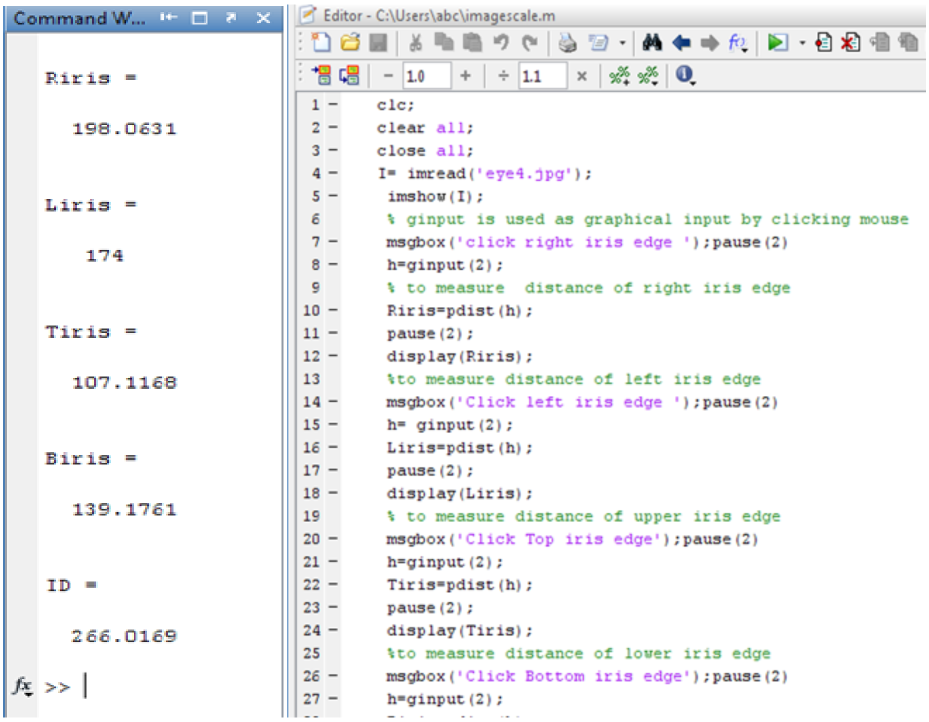


Fig. 8 Image margin and iris diameter result in MATLAB

C. RESULT OF GREY SCALE DENSITY IN MATLAB

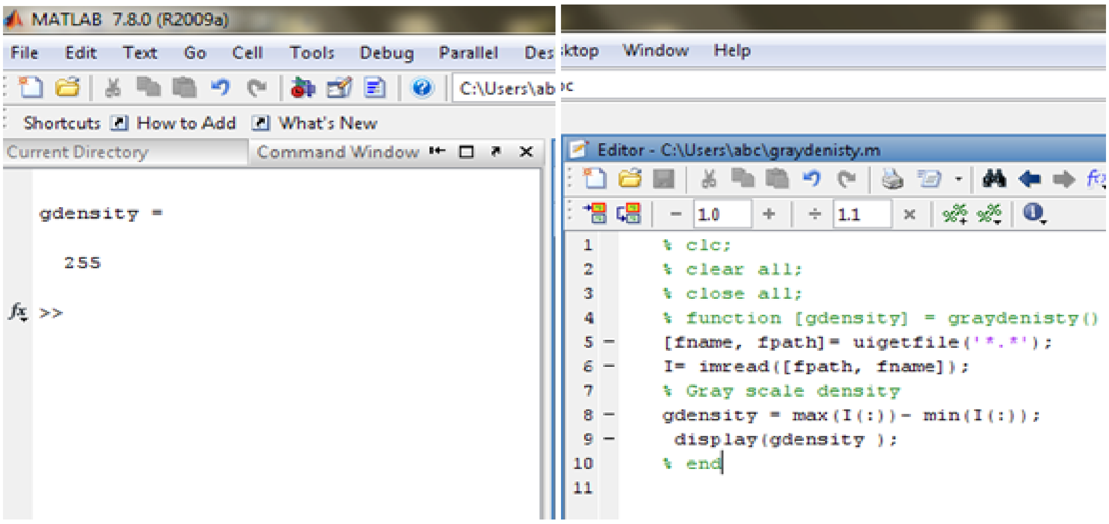


Fig. 9 Grey scale density result in MATLAB

D. RESULT OF CONTRAST IN MATLAB

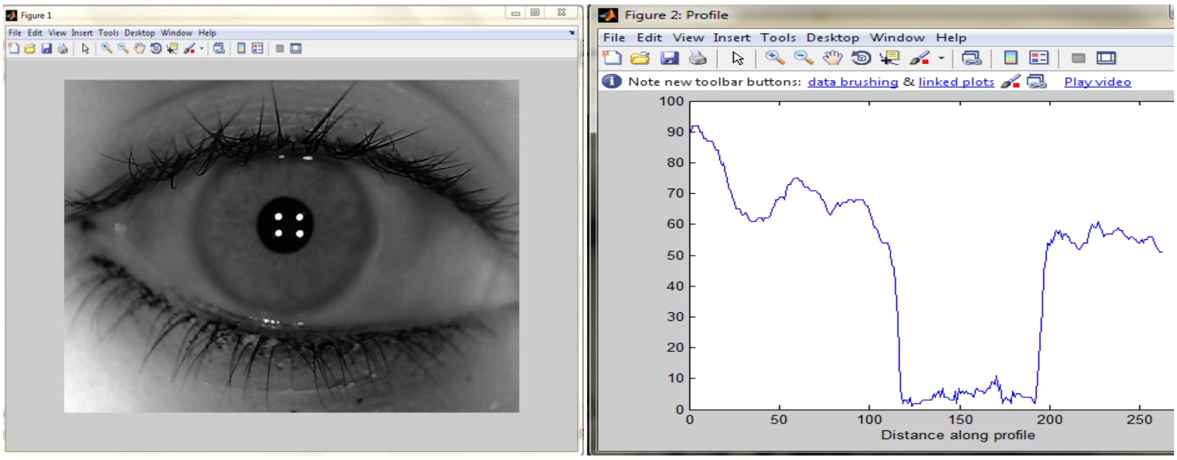


Fig. 10 Contrast result in MATLAB

E. RESULT OFSIGNAL TO NOISE RATIO IN MATLAB

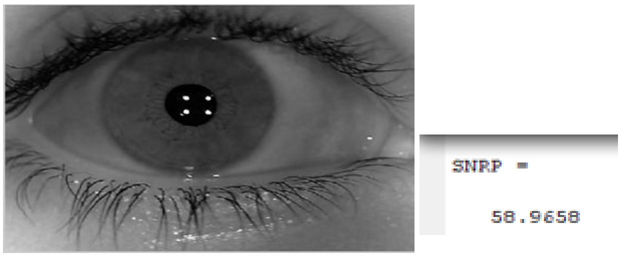


Fig. 11 SNR result in MATLAB

VI. CONCLUSION

It has been shown through empirical analysis that this method selects an ideal representative of selected image quality parameters of Iris.ISO/IEC 19794-6 2005(E) is the base prototype of this dissertation. This method outperforms provide the correct details and data which helps for selecting the good and error free image of iris. This method is also beneficial for selection of good biometrics iris scanner.

VII. RELATED WORK

There are many biometric technologies which commonly be used in government, forensics and commercial area (Jain & Ross, 2004) such as iris recognition, fingerprints, hand geometry, and DNA (Ganorkar & Ghatol, 2007). Biometric technology can be the solution for the problems of security according to its advantages (U.S. Government's Biometric Consortium, 2011). According to Jain, Ross, and Prabhakar(2004), there are four requirements that must be met for the physical characteristics of biometric indicators can be used, and they are:

a. Universality, which means that everyone must own the characteristic.
b. Distinctiveness is only owned by one person which each characteristic is different within human.
c. Permanence, this means that the characteristic is unchangeable.
d. Collectability, it can be measured quantitatively.

Iris biometrics research is an exciting, broad, and rapidly expanding field. At the same time that there are successful practical applications that illustrate the power of iris biometrics, there are also many fundamental research issues to be solved on the way to larger scale and more complex applications.

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