

ATENE O D E D A V A O U N I V E R S I T Y



“Image Enhancement for Face Detection and Recognition under Irregular Lighting Conditions”

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By

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Image Enhancements for Face Detection and Recognition under Irregular Lighting Conditions

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Abstract

In recent years, face detection and recognition has been a part of lives. From social media to companies, it has been typically used as security and access control systems but it is also useful in multimedia information processing areas. One factor to consider upon using this technology is its accuracy to detect facial features from an image that is dark and has dark shadows casting over the face due to irregular lighting. In this paper, we will discuss our proposed enhancement method and apply it to an existing FaReS (Face Recognition System) to improve the overall quality of images.

General Terms: Emgu CV, FaReS, Visual Studio

Additional Key Words and Phrases: Computer Vision, Image Processing, Image Enhancement, 2-D, 3-D

1. INTRODUCTION

1.1 Background of the Study

One of the most crucial problems in face detection and face recognition is the variations of light intensity in input images processed by FaReS (Face Recognition System). It produces dramatic decrease of recognition performance and if an image has low contrast and has dark lighting, some places on the image will remain too dark. Its image quality should be improved for better recognition and performance. So our proposed enhancement aims to improve image quality and apply our proposed enhancement to our chosen FaReS. This system will be used in a Desktop environment and be made using C#, face detection and recognition libraries.

1.2 Problem Statement

The main problem in this study is to fix the external factor which makes almost any FaReS with an algorithm slow down or even give inaccurate results, due to irregular lightings in an image. This study aims to increase detection rate of FaReS by using an effective image enhancement technique and algorithm and apply it to our chosen FaReS.

The specific problems of the study are as follows:

- (1) How large will the proposed enhancement method affect the overall accuracy of FaReS?
- (2) How far can the proposed enhancement method improve image quality?
- (3) What difference can the proposed enhancement method to our FaReS have from other existing FaReS?

1.3 Objectives

The main objective of this study is to improve face detection and recognition by enhancing the images gathered and test the images to the existing ones in the database. The researchers will be testing our system at ADDU claveria gate.

The specific objectives of the study are as follows:

- 1 To know the overall effectiveness and the increase of quality in images
- (4) To know the limits of the proposed enhancement method
- (5) To show the improved version of a FaReS based on the proposed enhancement.

1.4 Significance of the Study

In our present day, Technology is adapting and improving every day and we need it to make our works faster and more efficient. So our study will provide improvement to potential applications of existing FaReS mainly its accuracy of detection and recognition.

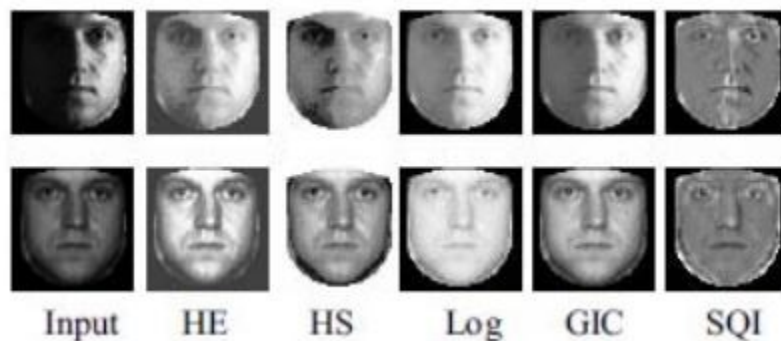
1.5 Scope and Limitations

- Use of Emgu CV as the computer vision library
- C# Language
- Limited to desktop use only
- A Database will be used to store data
- 10 or more images per person in the database
- Processes front view images only
- Non real time program
- Use of pre-existing FaReS

2. REVIEW OR RELATED LITERATURE

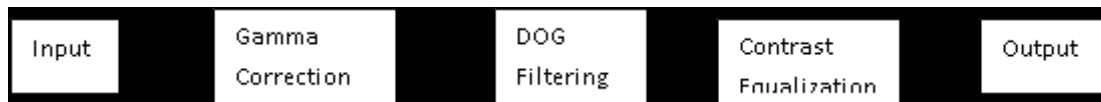
2.1 Preprocessing Technique for Face Recognition Application under Varying Illumination Conditions

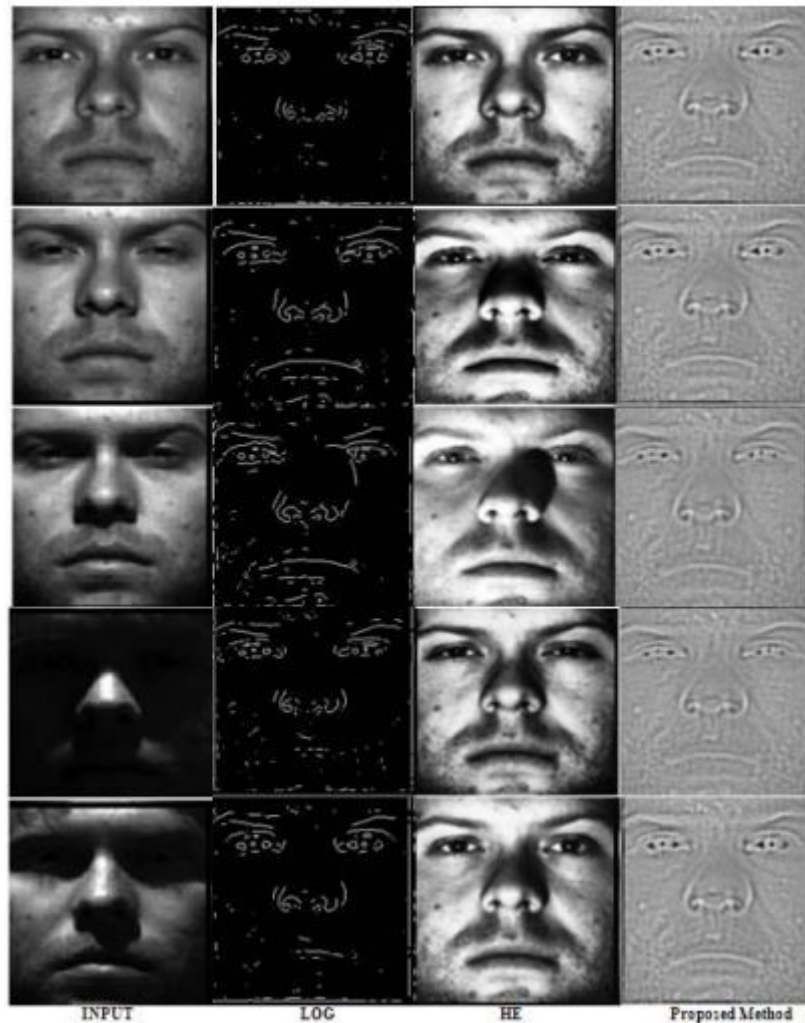
Their study aims to enhance images that have varying illumination conditions so that performance of FaReS will be improved. They proposed a preprocessing method to solve this problem in face images. They presented typical preprocessing methods such as Histogram Equalization (HE), Histogram Specification (HS), LOG, Gamma Intensity Correction (GIC) and SQI. They tested each method and produce results to which method is better and proposed a technique to use after test/experimentations.



The results show that HE, HS and GIC are better than the other two methods. Furthermore, they need no complex operations and the complexity of time and space is not high.

The proposed method uses the features of gamma correction, DOG filtering and contrast equalization techniques.





2.2 A Preprocessing Approach for Image Analysis Using Gamma Correction

Their problem was that many imaging devices may not display the actual appearance of objects. This technical limitation, known as gamma distortion, often disturbs the image. And in FaReS, the system may fail to recognize faces correctly due to changes in illumination. This study presents a new simple and robust image enhancement algorithm for image analysis by modifying the gamma value of its pixels. For local gamma correction the image is divided to overlapping windows and then the gamma value of each window is estimated by minimizing the homogeneity of concurrence matrix. They present a new preprocessing technique for estimating the gamma values without any calibration information or knowledge of the imaging device. They consider

subjective and objective image quality assessment to demonstrate the performance of the proposed algorithm. They also compare the results of their proposed method with histogram equalization, and those generated by three other existing gamma correction methods.

2.3 An Improved Difference of Gaussian Filter in Face Recognition

The researchers in the paper stated that FaReS are not robust enough with illumination and pose when images are dark. In this paper, they analyze an improved DOG filter with different parameters in horizontal and vertical directions and the improved filter uses oval recognition domain instead of round recognition domain of classic DOG filter. The improved filter is used to compare with major illumination pretreatment methods. The experiment result shows the improved method has better recognition and false detection rate.

3. METHODOLOGY

3.1 PHASE 1 – Data Gathering

- Research regarding image enhancing and techniques
- Research or find a viable existing FaReS to use
- Gather images for testing

3.2 PHASE 2 – Implementation

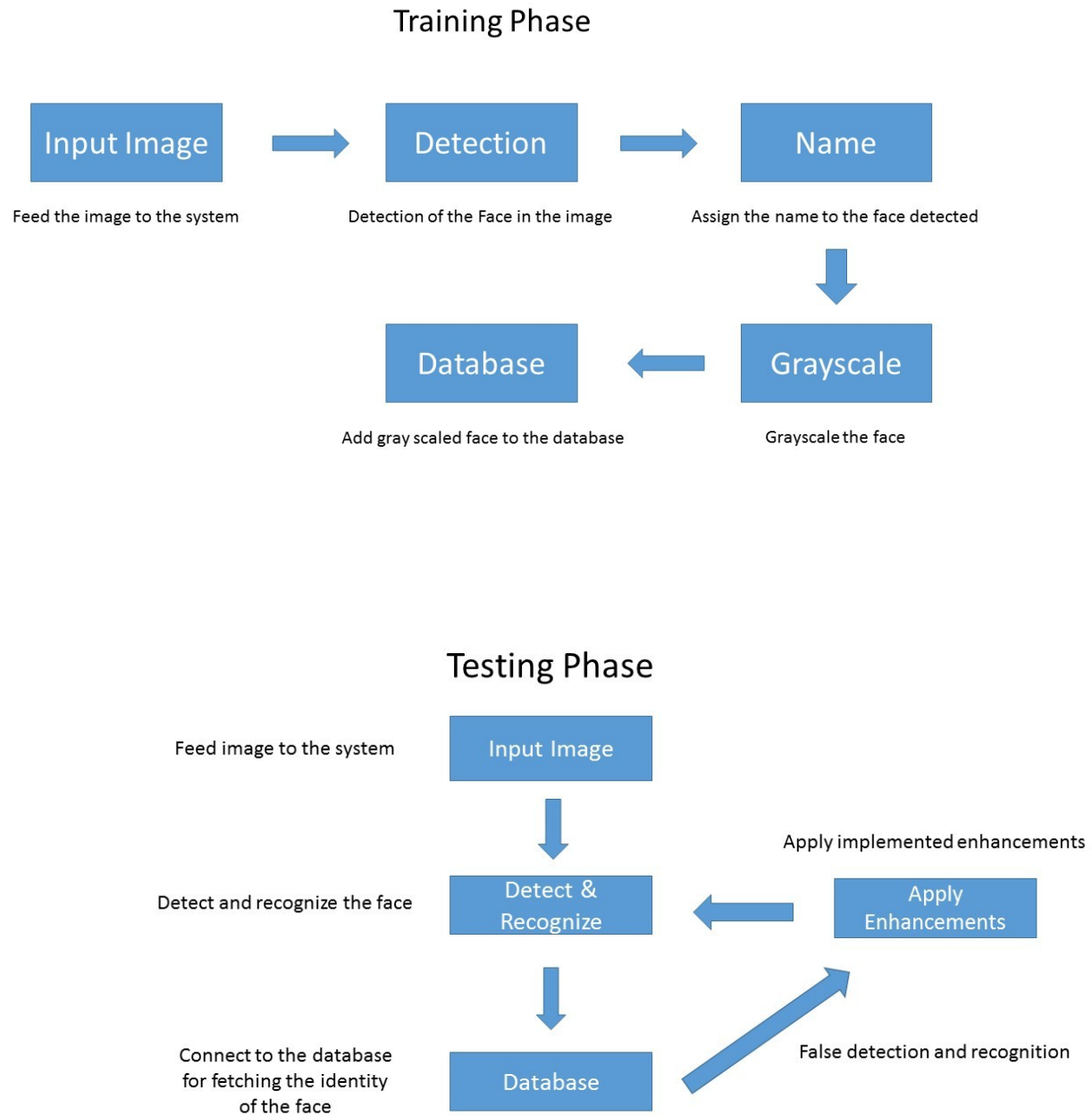
- Use the gathered tools for development
- Store gathered images for face recognition

- Begin training of the system
- Apply image enhancing method to image
- Test comparison of images

3.3 PHASE 3 – Evaluation

- Evaluate system
- Evaluate results
- Fix existing bugs in the system

3.3 Conceptual Framework



4. THEORETICAL BACKGROUND

4.1.1 Gamma Correction

Is a nonlinear gray-level transformation and enhances the local dynamic range of the image in dark or shadowed regions while compressing it in bright regions.

4.1.2 Difference of Gaussian Filtering

Gamma correction does not remove the influence of overall intensity gradients such as shading effects. Difference of Gaussians is a grayscale image enhancement algorithm that involves the subtraction of one blurred version of an original grayscale image from another, less blurred version of the original. It is useful for enhancing edges in noisy digital images.

4.1.3 Contrast Equalization (Contrast Correction)

The Contrast Correction in Perfectly Clear is constrained by the patented invention of Perfect Exposure, which limits light adjustments to the physics principles of how the eye gathers light ensuring that the correction reproduces photos with true, accurate color ... the true Real Colors.

4.2 Tools

4.2.1 Emgu CV

It's a cross platform .Net wrapper to the OpenCV image processing library. Allowing OpenCV functions to be called from .NET compatible languages such as C#, VB, VC++, IronPython etc. The wrapper can be compiled by Visual Studio, Xamarin Studio and Unity, it can run on Windows, Linux, Mac OS X, iOS, Android and Windows Phone.

4.2.2 Visual Studio

It's an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services. Visual Studio supports different programming languages and allows the code editor and debugger to support any programming language, provided a language-specific service exists. Built-in languages include C, C++ and C++/CLI, VB.NET, C#, and F#. Support for other languages such as M, Python, and Ruby among others is available via language services installed separately. It also supports XML/XSLT, HTML/XHTML, JavaScript and CSS.

4.3 Algorithms

4.3.1 Principal Component Analysis (PCA)

PCA is one of the most successful techniques that have been used in image recognition and compression. PCA can do prediction, redundancy removal, feature extraction, data compression and much more. It's a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The main idea of using PCA for face

recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space called Eigenface.

4.3.2 Eigenface

It's the name given to a set of eigenvectors when they are used in the computer vision problem of human face recognition. This method recognizes faces in an image by and treating it as two-dimensional (2-D) rather than three-dimension (3-D). The system functions by putting face images onto a feature space that spans the significant variations among known face images which are called "eigenfaces". This method characterized an individual face by a weighted sum of the eigenface features and to only compare these weights to those of known individuals.

5. RESULTS AND DISCUSSION.

5.1 Implementation Results.

The proposed image enhancements such as gamma correction, difference of Gaussian and contrast equalizer shows changes in the image quality, detection and recognition rate of images that are having irregular lighting conditions. The researchers will present the effects of these enhancements through this section.

5.1.1 Data Gathering.

The researchers gathered several participants for the image inputs. The researchers took several pictures among the participants that would be used as experiments for the system being develop. Also the images for testing where also gathered with the same participants in different locations.

5.1.1.1 Training.

The researchers took 10 or more images among the participants that will be used for training. The images trained are all front images. There are images that

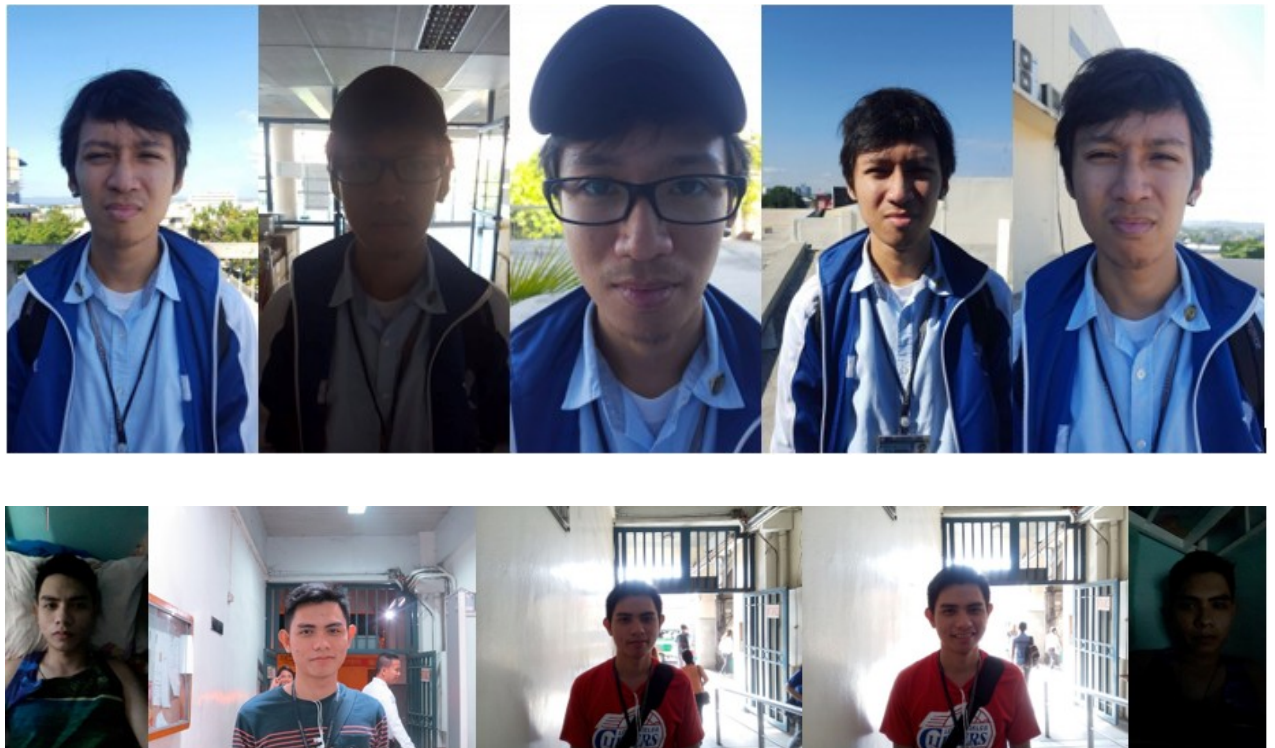
are slightly bright and dark that are still detectable used for training. This will increase the accuracy in recognizing the images of the participants. The names of these participants are also based on the order of the faces trained.

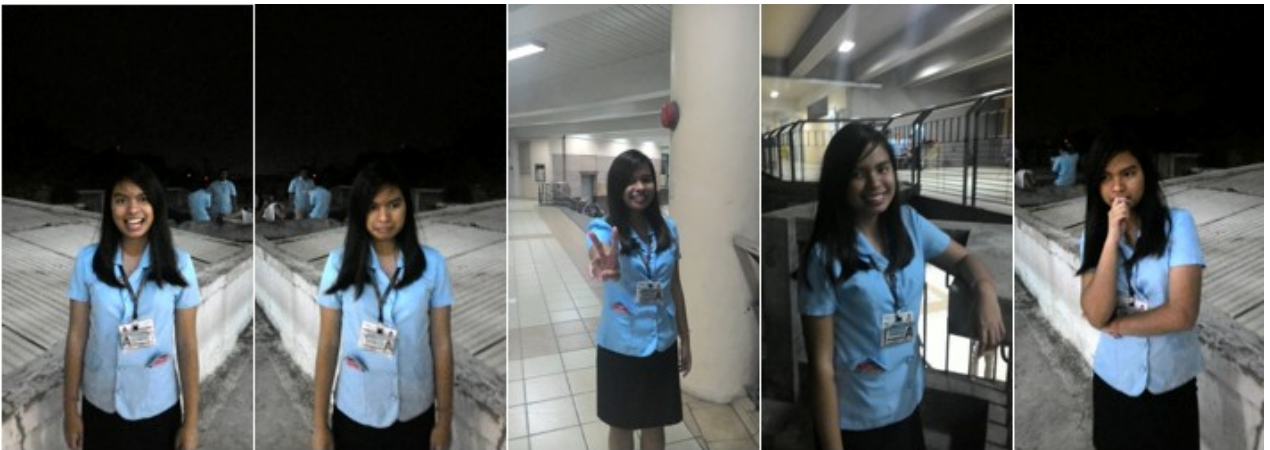
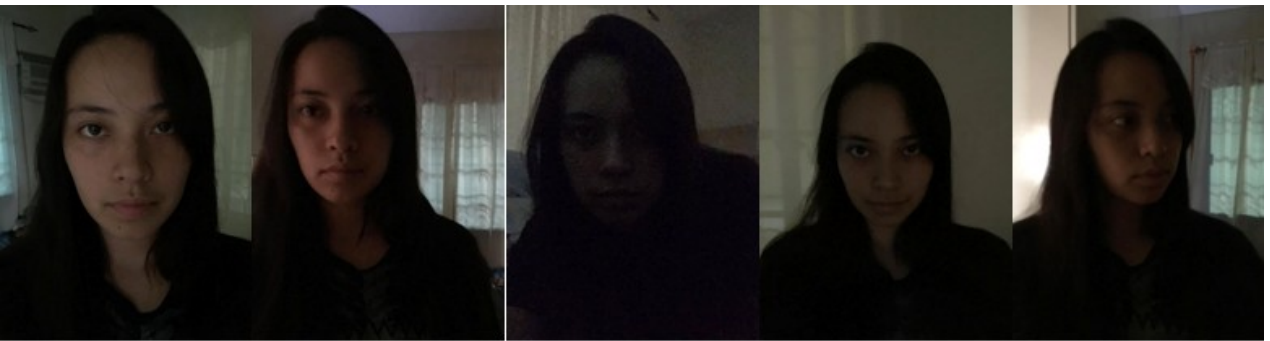


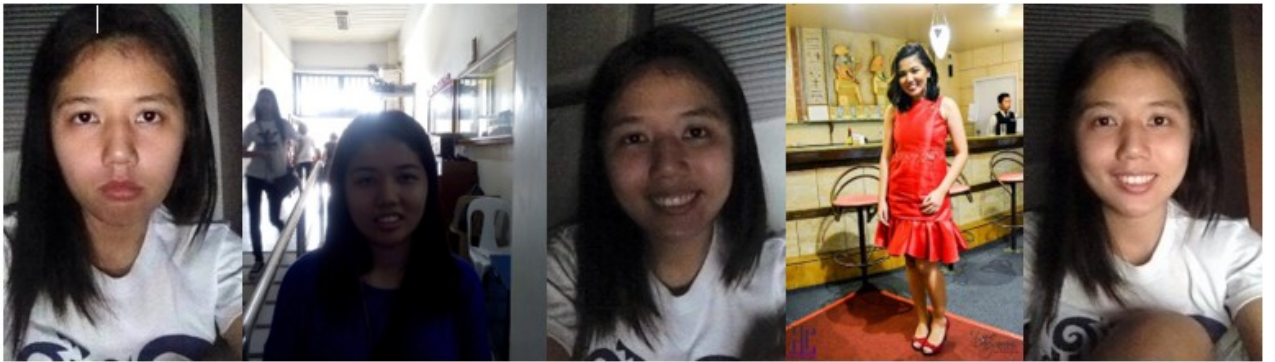


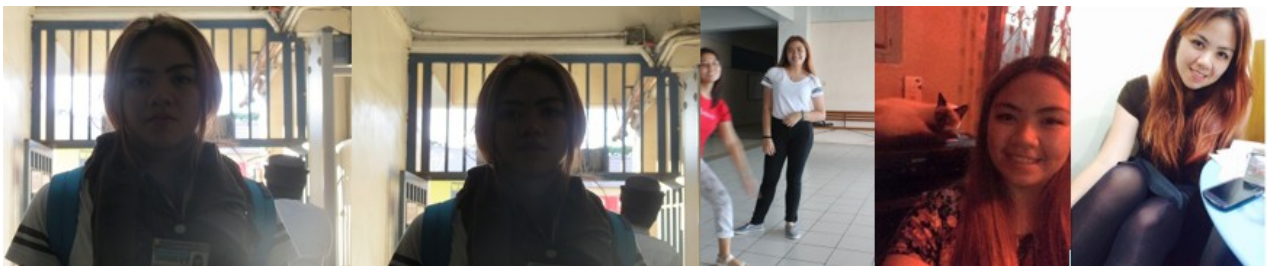
5.1.1.2 Testing Data.

During the testing the researchers took 5 images with different angle lightings and face angles among the participants. The images for testing are those that have irregular lighting. And also just front view images.









5.1.2 Enhancing Method for Image.

The researchers proposed the use of gamma correction, difference of Gaussian and contrast equalization as image enhancements. Each enhancement will be used to improve the images that are not detectable and recognizable.

5.1.2.1 Gamma Correction.

```

Console.WriteLine(gammaAdd);
if (imageBoxFrameGrabber.Image != null)
{
    Image<Bgr, Byte> tempImg = new Image<Bgr,byte>(updatedFrame.Bitmap);
    tempImg._EqualizeHist();
    if (gamma != 0)
    {
        tempImg._GammaCorrect(gamma);
    }
    int add = gammaAdd;
    gamma = 0.04f * add;
    this.labell1.Invoke((MethodInvoker)delegate { this.labell1.Text = ""+ add; });
    this.currentFrame = tempImg;

    this.imageBoxFrameGrabber.Image = currentFrame;
    imageBox1.Invoke((MethodInvoker)delegate { imageBox1.Image = originalImg; });

    recogs();
}

```

This is the function for Gamma Correction.

The image here is being called from the imagebox then the gamma correction is applied by using the `_GammaCorrect()` preexisting method and the gamma value is being manipulated through a formula which is “ $\text{gamma} = 0.04 * \text{value}$ ”. The “value” variable there is going through a loop which start from 1 to 100. Every after change of value the image is being scanned if there are viable faces to be detected and recognized.

Here is an example:

without gamma correction



with gamma correction

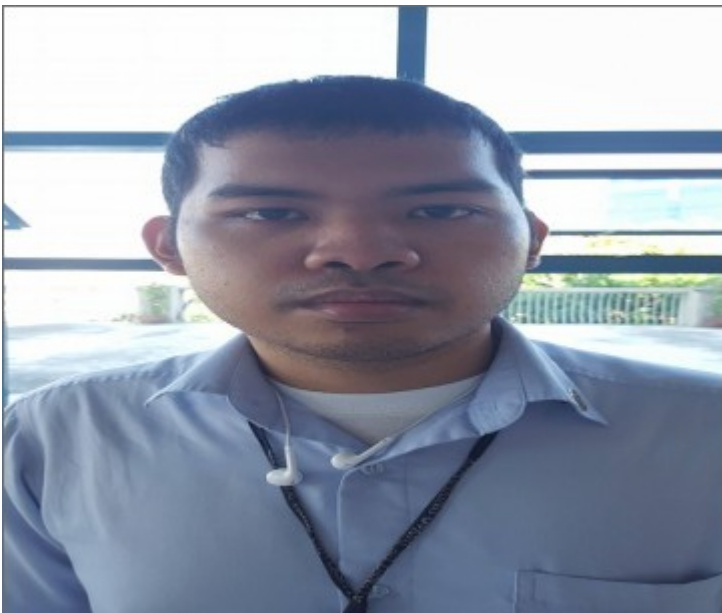


5.1.2.2 DoG (Difference of Gaussian)

```
Image<Bgr, byte> iTemp = new Image<Bgr, byte>(new GaussianBlur(5).Apply(imageBox1.Image.Bitmap));  
Image<Bgr, byte> iTemp2 = new Image<Bgr, byte>(new GaussianBlur(35, 20).Apply(imageBox1.Image.Bitmap));  
  
imageBox1.Invoke((MethodInvoker)delegate { iTemp2.Sub(iTemp); });  
currentFrame2 = iTemp2.Sub(iTemp);  
  
recogs2();
```

This is the function for DoG. The image here is stored into 2 temporary variables. The first variable the image is blurred. The second variable the image is also blurred but less blurred than the first one. After blurring the 2 images which are stored in 2 temporary variables the more blurred image is then subtracted by the less blurred image. It will then result in showing the facial features of the images. There are also instances that the image face is not detectable, there will be no facial features seen after the application of dog.

Original Image



DoG applied



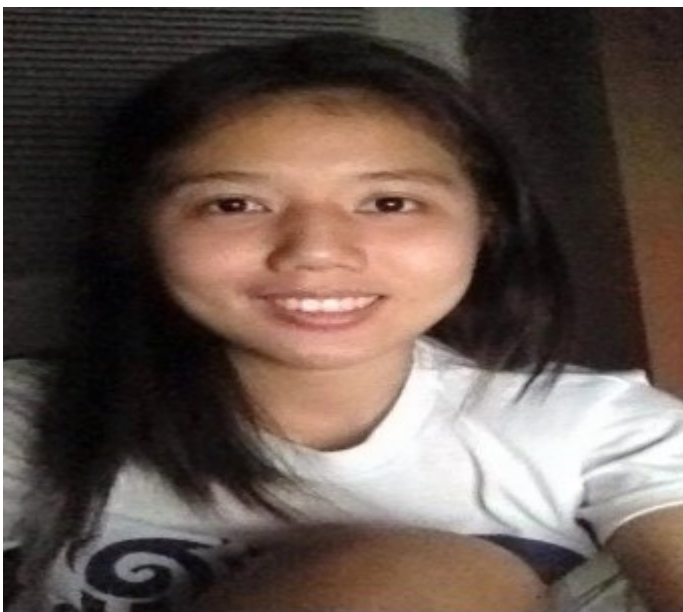
5.1.2.3 Contrast Equalization Technique

```
Image<Bgr, byte> iTemp = new Image<Bgr, byte>(new ContrastCorrection( 15 ).Apply(imageBoxFrameGrabber.Image.Bitmap));
imageBoxFrameGrabber.Invoke((MethodInvoker)delegate { imageBoxFrameGrabber.Image = iTemp; });
currentFrame = iTemp;

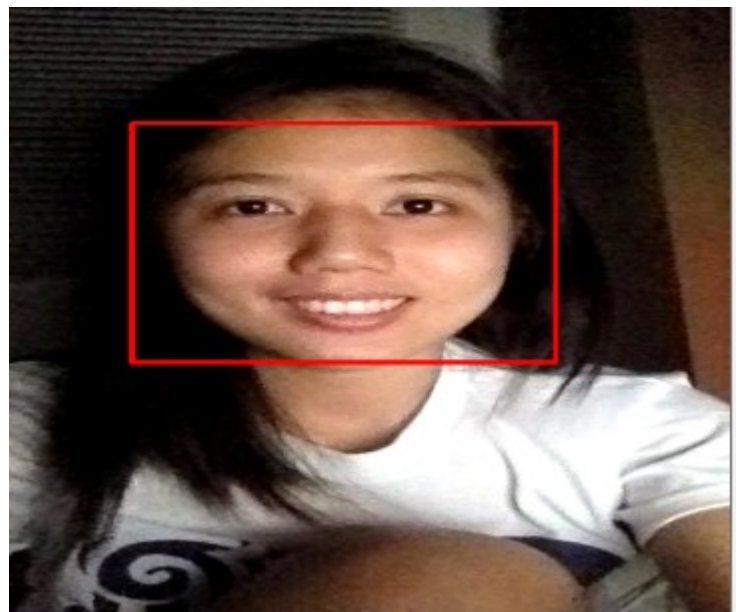
this.imageBoxFrameGrabber.Image = currentFrame;
imageBox1.Invoke((MethodInvoker)delegate { imageBox1.Image = originalImg; });
recogs();
```

This the function for a contrast equalization technique. There is no such thing as a contrast equalization but one technique that manipulates the contrast of an image is ContrastCorrection() preexisting method. The image here is being called from the imagebox. The image is stored in a temporary variable and its contrast will be manipulated through the ContrastCorrection() method. The method receives an integer value which will change the images contrast for better image detection and recognition.

Original image



contrast applied



5.2 Results

D= Detected Only, RD = Detected and Recognize W= Wrong Detection

F = Detected, Wrong Person N= None

Test Subject	Original					Total	Enhanced					Total
	P1	P2	P3	P4	P5		P1	P2	P3	P4	P5	
Alfred	D	W	D	N	N	2 0/5	D	N	D	N	N	2 0/5
Brent	W	R D	R D	R D	F	4 3/5	D	R D	R D	R D	RD	5 4/5
Geno	R D	R D	F	F	F	5 2/5	R D	R D	D	D	D	5 2/5
Tina	F	F	D	F	N	4 0/5	D	F	R D	F	W	4 1/5
Maria	D	F	F	F	D	5 0/5	R D	R D	D	D	RD	5 3/5
Dan	D	W	D	N	W	2 0/5	D	D	D	D	W	4 0/5
Perkeean	D	F	F	D	D	5 0/5	D	D	D	D	RD	5 1/5
Mark	D	N	R D	R D	RD	4 3/5	D	N	R D	R D	RD	4 3/5
Riki	D	D	F	D	D	4 0/5	D	D	D	D	D	5 0/5
Sam	F	N	D	W	N	2 0/5	F	F	D	W	N	3 0/5
Total					16 %	371 8/50					68 %	431 14/50

Face detection rate = 76 %

Face detection rate = 86%

Face Recognition rate = 16%

Face recognition rate = 28%

Here the enhanced part is being discussed in much detailed.

Alfred	Applied gamma and contrast accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly
Brent	Applied both enhancements	As is, image is correct	As is, image is correct	As is, image is correct	Gamma first then contrast
Geno	As is, image is correct	As is, image is correct	Gamma first then contrast	Gamma first then contrast	Gamma first then contrast
Tina	Applied both enhancements	Applied enhancements accordingly	Applied contrast then gamma	Applied enhancements accordingly	Applied enhancements accordingly
Maria	Applied Gamma only	Gamma first then contrast	Applied enhancements accordingly	Applied enhancements accordingly	Gamma first then contrast
Dan	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly
Perkeen	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Gamma first then contrast
Mark	Applied enhancements	Applied enhancements	As is, image is	As is, image is	As is, image is

	accordingly	accordingly	correct	correct	correct
Riki	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly
Sam	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly	Applied enhancements accordingly

Here are the results before and after the application of the implemented enhancements to the images. As you can see in the table there are 5 kinds of images being tested. The first part shows the accuracy of the system without the using the implemented enhancements. The second part shows how the enhancements affected the images and its overall accuracy.

The table below shows how the enhancements is applied accordingly. The values used are automatically produced by the system. Applied accordingly means gamma then contrast, if results are unsatisfactory apply vice versa.

6. Conclusion and Recommendation.

6.1 Conclusion.

The proponents have successfully added an Image Enhancement techniques for the viable preexisting Face Detection and Recognition system with the help of EmguCV library. The enhancement used are gamma correction, DoG and Contrast equalization technique. Gamma correction automatically adjust the gamma value of the image until the face in the image will be recognize, the DoG has been discovered that it is not for face recognition but facial features detection and Contrast equalization darkens and lightens the image for better detection and recognition.

The only flaw of this is the database of the facial recognition being used. The databases use facial images as data and stores it in a folder. During the recognition the face detected are being compare to each face then respond to a

similar feature. The database is also part of the preexisting FaReS borrowed/used.

6.2 Recommendation.

The following recommendations are presented as ways to improve this study:

- Images that are used to train should be very clear and free from noise.
- Train different angles of images for there will be cases that faces are not in full front view during when those images are tried to be recognize.
- Find image processing algorithms to detect and recognize the face of participant in far distance.
- Add more image processing algorithms to increase the accuracy rate.
- Try to find a different approach for a database that will be faster to access during recognition time.

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