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AN IMPROVED FACE DETECTION TECHNIQUE FOR A LONG DISTANCE AND NEAR-INFRARED IMAGES

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Abstract:

Nowadays near-infrared face recognition technology with light intensity and face recognition at a distance without the cooperation of users has gained wide attention toward these surveillance systems. Such type of environmental illumination i.e. near-infrared and face recognition at a distance in both daytime and night time can degrade the performance of surveillance systems. In the last decade, the whole biometric communities have worked on challenging tasks to develop a more accurate protection method against Near-Infrared or Long Distance database at distances of 1 meters, 60 meters, 100 meters, and 150 meters, with both daytime and nighttime images. This paper presents an improved technique of fdlibmex algorithm. The paper presents a detailed study and results of environmental illumination for face recognition. This paper also provides future directions for further research.

Key Words: Biometrics, Near-Infrared, Face Detection, Image Enhancement & Long Distance

1. Introduction:

The Human face plays an important role in our daily life to identify the authentic person but it has a high degree of variability in its appearances [1]. So to overcome this variability improved face detection methods have been introduced. The face is the main attention in the real life to identify any human. In our real life we can recognize the person by face but to identify the human face by computer is a challenging task [2]. In our lifetime, we learned a number of faces and identify these faces even after years of separation but identification for the computer is a typical task because of changing condition such as beard, glasses, aging, mole, mustache or changes in hairstyle etc. Face detection is one of the common topics in the biometrics, computer vision community and pattern recognition [3-4]. Face detection is the basic step of face recognition and the accuracy of face recognition completely depends on the accurate detection of the human face [4]. Nowadays face is commonly used for recognition and tagging in many social places such as Picasso, Twitter, and Facebook [5]. Although face detection and recognition algorithms obtained high accuracy, few of the challenges still exists such as the long distance, illumination, occlusion, and pose. Face detection at a distance is a challenging task due to the following reasons:

- ✓ The quality of images.
- ✓ Surveillance without the cooperation of users.
- ✓ An outdoor condition such as different lighting and weather condition are significant problems in the real life.
- ✓ Long distance also deals with multi-faces.

Face detection and recognition at a distance in the daytime as well as nighttime creating a more interest for the research community because of the increased security issues. Face detection and recognition techniques in surveillance systems need to be coupled with the capability of face recognition at nighttime [6-7]. Use of an infrared light is considered as a promising method of face recognition at night in surveillance applications [8-10]. Using of infrared light in the nighttime for face detection has the following advantages:

- ✓ The near-infrared illuminator is not visible to the human eye.
- ✓ NIR images captured are not affected by temperature and various weather conditions.
- ✓ NIR illuminator cost is relatively low.

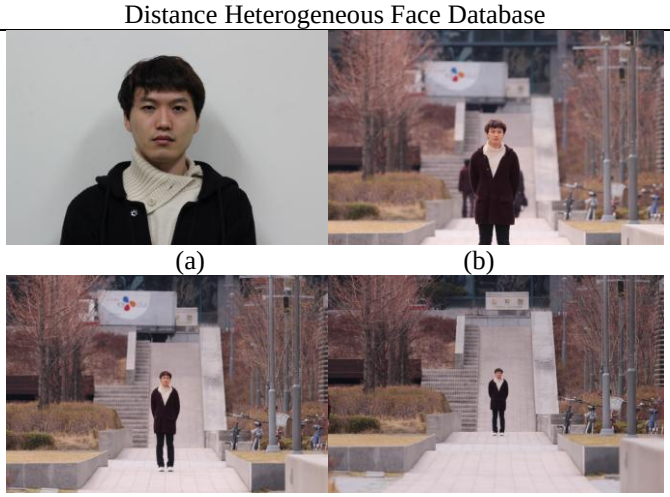
In this paper, we present a new efficient and improved methodology of face detection for a long distance and near infrared images. This improved methodology is fast and simple to identify the human face with high accuracy.

2. Data Acquisition:

The LDHD-DB database consists of both visible and NIR images [1-2]. This database contains frontal facial images of 100 subjects at various distances such as (1) 1m day, 1m night, (2) 60m day, 60m night, (3) 100m day, 100m night (4) 150m day, 150m night. All the images were collected in an indoor and outdoor environment. Table 1 describes the database specification.

Table 1: Summary of Long Distance Face Image Database

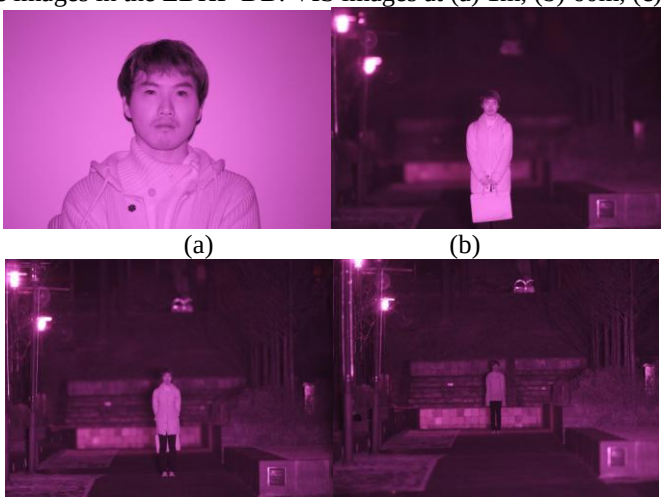
Database	LDHF-DB
No of Subjects	Indoor and Outdoor: 100
Distance	Indoor: 1m, Outdoor: 60m,100m,150m
Image Spectrum	VIS and NIR
Environment	Daytime and Nighttime
Resolution	5184*3456
Format	Still Images
VIS: Visible Light, NIR: Near Infrared, LDHF-DB: Long Distance Heterogeneous Face Database	



(a) (b)

(c) (d)

Figure 1: Example images in the LDHF-DB: VIS images at (a) 1m, (b) 60m, (c) 100m, and (d) 150m.



(a) (b)

(c) (d)

Figure 2: Example images in the LDHF-DB: NIR images at (a) 1m, (b) 60m, (c) 100m, and (d) 150m.

3. Proposed Methodology:

Face detection is an important task to recognize the authentic users [11-12]. This paper presents the new improved algorithm which is fast and simple with high accuracy. We have different steps to identify the face into the long distance image in different environment conditions as shown in Fig-1 & 2.

(a) (b) (c)

Figure 3: Framework for Proposed System on Long Distance dataset for 1meter distance NIR, (a) Original Face, (b) Enhanced Image,(c) Face Detection

Firstly the image is taken from the long distance database and resizes the image up to 50% of the original image. After resizing the image, we enhance the image so that result will be achieved with higher accuracy as shown in Fig. 3. For doing the image enhancement, we follow the algorithm-1. In the next step, we apply Euclidian distance formula to identify the face with high accuracy for long distance [13-14].

$$EU(a,b) = \sqrt{\sum_{i=1}^{n}(Xi - Yi)2} \quad \text{---------- (1)}$$

Finally, we apply the fdlibmex algorithm for identifying the face for long distance database. Kienzle [8] has developed a mex library for detecting frontal faces in images because this algorithm is more efficient and easy-to-use. Finally, we identify the face high accuracy for long distance database. All the steps of face identify as shown in Fig-4.

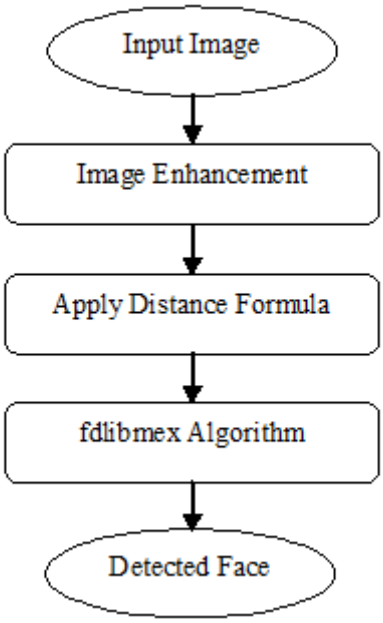


Figure 4: Flow Chart of Proposed Face Detection Techniques

Algorithm I: Image Enhancement

//Create the sorted array

Set Low=0.0080, Up=0.992, size [$m \times n$dimension]

//Find the Vertical value v_{max} and v_{min}

for k=1,… … ….r1

$$array = sort(reshape(img(k), m \times n, 1))$$

$$v_{min}(k) = array(ceil(Low \times m \times n))$$

$$v_{max}(k) = array(ceil(Up \times m \times n))$$

end

// Rescale the pixels

for k=1,… … ….r1

Newimg[k] = (img(k) - v_{min}) * 255 / (v_{max} - v_{min})

end

4. Results:

To analyze the results, we performed a number of experiments on the LDHF-DB face database. The LDHF-DB database includes 800 face images taken from 100 subjects, with each subject providing 8 face images in the daytime as well as nighttime. Each 100 subjects have different distance variation like 1m daytime, 1m nighttime, 60m daytime, 60m nighttime, 100m daytime, 100m night time, 150m daytime and 150 m night time. We evaluate this proposed algorithm to the 50 subjects of each variation of the database. This proposed methodology gives better results as shown in below and accuracy of each variation as shown in Table II.

Accuracy = (No of Accurate Detected Face) / (Total no of Images)

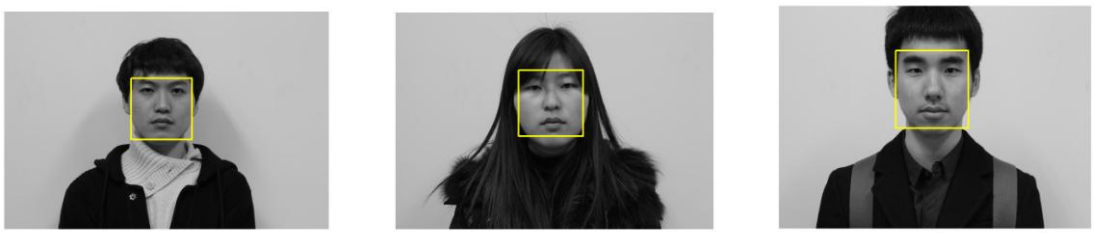


Figure 5: Framework for Proposed Algorithm on Long Distance dataset for 1-meter Daylight Images

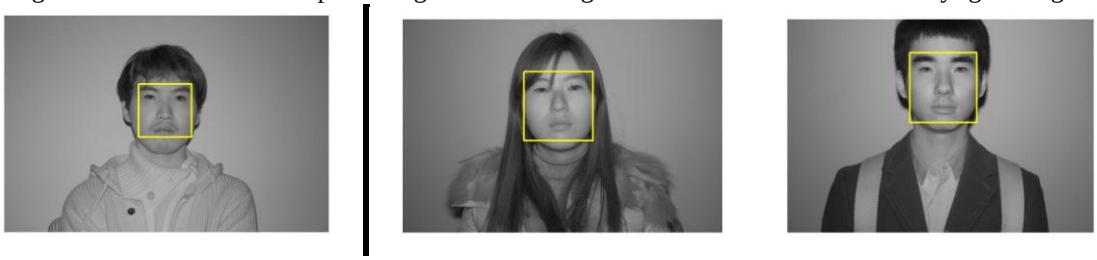


Figure 6: Framework for Proposed Algorithm on Long Distance dataset for 1-meter NIR Images

Figure 7: Framework for Proposed Algorithm on Long Distance dataset for 60-meter Daylight Images

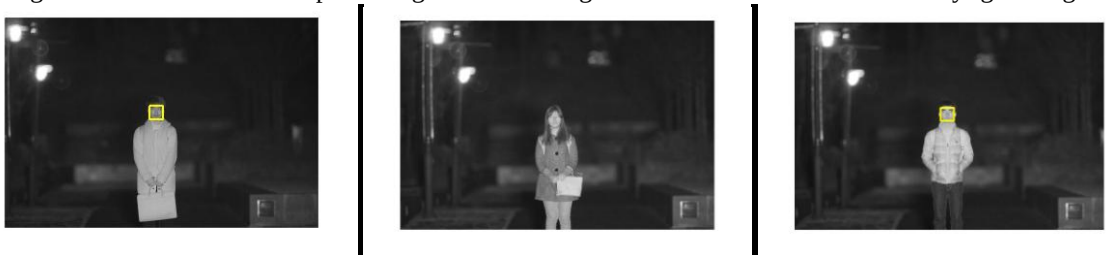


Figure 8: Framework for Proposed Algorithm on Long Distance dataset for 60-meter NIR Images

Figure 9: Framework for Proposed Algorithm on Long Distance dataset for 100-meter Daylight Images

Figure 10: Framework for Proposed Algorithm on Long Distance dataset for 100-meter NIR Images

Figure 11: Framework for Proposed Algorithm on Long Distance dataset for 150-meter Daylight Images

Figure 12: Framework for Proposed Algorithm on Long Distance dataset for 150-meter NIR Images

Table 2: Result of Long Distance Face Image Database

S.No	Distance	Accuracy
1	1m Daylight Images	100%
2	1m NIR Images	100%
3	60m Daylight Images	98%
4	60m NIR Images	96%
5	100m Daylight Images	96%
6	100m NIR Images	92%
7	150m Daylight Images	90%
8	150m NIR Images	87%

5. Conclusions and Further Scope of Work:

The experiments were performed on a standard long distance face database that includes normally daytime images as well as nighttime images from a various distance. The proposed methodology can improve the face detection accuracy at low false matching rates. In the proposed methodology, we do not require any additional hardware and database. The current improved methodology is developed for cooperative user applications for both indoor as well as outdoor. It is not yet suitable for applications which require identifying the uncooperative user such as face recognition in video surveillance. The evaluation results are excellent but there are some challenges left such as illumination, pose, and occlusion in NIR images at a long distance. Future works will be to find out the solutions to overcome these limitations.

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