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# Varying Illumination and Pose Conditions in Face Recognition

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**Abstract**

One of the most remarkable ability of human vision system is to recognize face. Robustness to variations in facial expressions is one of the greatest challenges in field of face recognition. Human face can have lot of variations in appearance. Face recognition system must be capable of identifying face despite these variations. This study is an effort to address the effect of varying illumination and pose conditions in face recognition. Under varying illumination and pose conditions, the face of same person appears to be different due to varying lightening and different viewing conditions. Majority of research in this field has been focused on frontal face recognition.

*Keywords:* Illumination and Pose Conditions; Image Representations; Distance Measurements;Template Matching and Features Based Systems

## 1. Introduction

Many methods and techniques have been proposed for recognizing the human face. Recognizing face even after long time period is one of the most remarkable ability of human vision system [1]. Biometrics could play an utmost important role by uniquely identifying individual based on physiological or behavioral characteristics. In traditional systems one has to remember a key or passwords. There is an always threat to forget or lost key/ passwords but its not possible for individual to lost or forget biometric [2]. Face recognition was the second most widely used biometric technique among other techniques as per survey [3]. Basically various face recognition methods can be classified under holistic template matching based methods, geometrical local feature based methods and hybrid methods.

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All the face recognition methods have certain advantages and disadvantages even they had been applied successfully. Based on the specific requirements or environment conditions, certain face recognition approach should be selected. Real face is a 3D object, may be surrounded by complex background details and illuminated by different light sources. When 3D object is projected on 2D surface, actual details of image may vary tremendously. Face recognition technology should be capable of handling these variations in face. Variations may be due to genetics, identity or racial factors or may be due to aging factors, facial expressions, deformations or hair changes factors. Face recognition system must also be robust to processing problems and other problems like image resolution, noise and camera distortions.

## 2. Varying Illumination Conditions in Face Recognition

In this problem the face of same person appears to be different under varying illumination conditions. Most of the research in the field of face recognition is focused on the frontal face, while very little research work had been done in this field based upon varying illumination and pose conditions. It is very hard to prove reliability of face recognition system in varying illumination and pose conditions [4][5][6]. Illumination and pose variations are the most significant factors affecting the face recognition system. Facial features may be diminished due to shadows from direct light source because of 3D structure of face. Experimentally it had been shown [7] for the face recognition systems based upon Principal Component Analysis [8] that differences in appearance due to illumination variations are even greater than the differences between candidates. In this study various approaches regarding face recognition for invariant illumination has been discussed as recognizing face with varying illumination conditions is a matter of concern in computer vision now a days. Earlier research work for face recognition in varying illumination conditions were focused on the image representations. Mostly these image representations were insensitive to illumination variations.

Different image representations and distance measures on face dataset with varying illumination conditions, varying pose and expressions were evaluated [7]. To overcome illumination variations earlier work with image representations for face recognition was not sufficient by itself, while these image representations contained first and second derivatives of grey level image, 2 dimensional Gabor like filters, edge maps and logarithmic transformations. Images were compared under varying illumination conditions and found that ratio of two images from same object was simpler as compared to the ratio of images from different objects [9]. Principal Component Analysis and Correlation methods were outperformed with this approach. Class based re-rendering and face recognition with changing illumination had been covered in which a quotient image was proposed [10]. This approach was different from the earlier image representations and outperformed the Principal Component Analysis method. With varying illumination conditions the proposed quotient image had been used for re-rendering same class object. Turk and Pentland's eigenface algorithm [11] had been extended to Fisherfaces by employing Fisher's Linear Discriminant Analysis classifier [12].

With strong illumination variations Fisherfaces outperformed eigenfaces during experiments on a face dataset. A convex cone in the image space could be formed under varying illumination conditions for set of images of an object with fixed pose [13]. While recognizing face, low dimensional linear subspaces could be used for approximation of human faces illumination cones [14]. Eigenfaces and Fisherfaces methods were outperformed by an algorithm based on this approach. For appearance based methods, training images of dataset of various subjects were required under varying illumination conditions. This restriction of training images of dataset was overcome by the proposed algorithm given by authors [15]. Even higher face recognition rates had been reported under varying illumination conditions with CMU PIE dataset [16].