# Abstract

Face recognition has become a popular area of research in computer vision because of its potential real-time applications and inherent challenges A general statement of the face recognition problem can be formulated as follows Given a still or video images of a scene, identify or verify one or more persons in the scene using a stored database of faces

In this thesis, the issues pertaining to the representation and recognition of faces have been addressed after understanding the fact that the existing models suffers from one or the other major drawbacks The proposed algorithmic models are broadly classified into a) Spatial domain models and b) Frequency domain models

*Spatial domain* is the term used to describe the analysis of mathematical functions, physical signals or time series of economic or environmental data, with respect to *time* which is also called time domain In the time domain, the signal or function's value is known for all real numbers, for the case of continuous time, or at various separate instants in the case of discrete time Further, the algorithmic models of spatial domain are classified into a) Holistic appearance based models and b) Local feature based models The appearance based models use the whole face region as the raw input to a recognition system

Appearance-based approaches represent the face image in terms of intensity values An image is considered as a high-dimensional vector, i e , a point in a high-dimensional vector space Processing the face images in higher dimension is computationally expensive and hence there is strong need to express the same image in lower dimensional space To meet this objective, Eigenface and Fisherface models were proposed during 1990's These models alone are not effective to address the problem of scaling and rotation as they provide only one degree of freedom during recognition To reach effective efficiency and accuracy, two extensions of Eigenface methods are proposed

Firstly, to achieve rotational and scaling invariance, polar-eigenspace (Polar-PCA) model is proposed Similarly to address the problem of illumination, another extension of PCA is proposed called r-PCA In r-PCA, retinex theory has been used for preprocessing in order to normalize the effect of illumination.

Local descriptors are commonly employed in a number of real-world applications, for instance in object recognition Among the many local descriptors, Scale Invariant Feature Transform (SIFT) algorithm is found to be more well thought-out as it can be computed efficiently, resistant to partial occlusion, and is relatively insensitive to changes in viewpoint For best representation and classification, a combined model called SIFT-FLD, is proposed

On the other hand, we have seen the application of region covariance matrix (RCM) in many computer vision applications because of ease of implementation and sound mathematical theory Hence, we have developed another local descriptor based model which uses the principles of RCM, but the descriptor is computed in the monogenic scale space In the proposed model, energy information obtained using monogenic filter is used to represent a pixel at different scales to form region covariance matrix descriptor for each face image during training phase An eigenvalue based distance measure is used to compute the similarity between face images

*Frequency domain is* a term used to describe the domain for analysis of mathematical functions or signals with respect to frequency, rather than time A time domain graph shows how a signal changes over time, whereas frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies Frequency domain representation of face images has twofold significance (1) effective characterization of a pattern of interest, or effective classification of different patterns, and (2) dimensionality reduction With this backdrop, face recognition based on Fractional Discrete Cosine Transform is introduced Further, for compact representation of the feature vectors, Discriminative Fractional Discrete Cosine Transform is proposed

Edges are skeleton of an image structure with significant information content and hence are important feature points in image matching, shape description etc Edges provide rich information and serve as practical descriptive primitives for face recognition Based on the edge properties namely straightness and crookedness, an edge-based face recognition model has been proposed

All the proposed models are experimentally validated for their applicability on different domains by using standard face databases, viz AT&T, YALE and UMIST face databases Also, necessary theoretical backgrounds for all the proposed models have been provided The superiority over several other models in terms of computational efficiency and recognition accuracy has been established through extensive experimental analysis