# Graceful Labeling Based Active Appearance Model for Biometric Identification

Sathiamoorthy G[1], Janakiraman T N[2], Narasimhan Ranga Raajan[3], Sairam N[4]
[2] Department of Mathematics ,NIT Trichy, India
[1] School of Humanities and Sciences, SASTRA University, India
[3] School of Electrical & Electronics Engineering, SASTRA University, India
[4] School of Computing, SASTRA University, India
[1] sami@maths.sastra.edu, [3] nrraajan@ece.sastra.edu, [4] sairam@cse.sastra.edu

*Abstract*— . **We present a new model for reading face images and image sequences using Graceful Labeling Active Appearance Model (GLAAM). The GLAAM contains a statistical, photo-realistic model of the chassis and grey-level appearance of faces. This paper demonstrates the use of the GLAAM's efficient iterative matching scheme for image interpretation. We use the GLAAM as a basis for face identification, obtain good results for difficult images. We show how the GLAAM framework allows identity information to be decoupled from other variation, allowing evidence of identity to be integrated over a sequence. The GLAAM approach makes optimal use of the evidence from either a single image or image sequence. Since we derive a complete description of a given image our method can be used as the basis for a range of face image interpretation tasks.**

**Keyword- Graceful labeling, GLAAM, Face identification.**

## I. INTRODUCTION

Facial expressions identification acts an important role in human communication since has more influence than simpler sound information. Psychology studies [2] describe that there are six basic emotions universally recognized: joy, sadness, surprise, fear, anger and disgust. Notice that, these expressions are also compatible with MPEG-4 norm. Clearly, in order to extract facial information from one image we need to solve first the problem of finding the face on it. Traditionally, there are two different ways to approach this problem. Anthropometric feature extraction [7] based on detection of facial characteristics such as eyes, eyebrows, mouth and nose, or using appearance based methods. The last one, is preferable since it is able to extract relevant face information without background interference and describes facial characteristics in a reduced model. Our work on facial expressions recognition belongs to the appearance based approaches.

GL based Appearance based face recognition involves image pre-processing and the use of statiscal redundancy reduction for compact coding. To synthesize a complete image face, both shape and textute are modelled. The AAM represents both shape and texture variations observed in a training image set and the correlations between them. Supervised dimension reduction use the knowledge of class structure and the use of multi-linear models allow low-dimensional representations which account for variations in geometry, orientation and illumination.

## II. GRACEFUL LABELING

A simple undirected graph with p vertices and q edges, vertex set V(G) and edge set E(G) such that a function f is called graph labeling of tree G if f: V(G) → {0, 1, 2,…, q} is injective and the induced function f*: E(G) → {1, 2, 3, …, q} defined as f*(e = uv is an edge in G) = $\left|f(u)-f(v)\right|$ is bijective.

Let $P_5$ be basic path of $FT_{G\,(5)}$ tree. Let $s_1, s_2,\dots, s_5$ be such vertices, which are termed as supporting vertices of $FT_{G(5)}$ tree. In $FT_{G(5)}$ at each $s_i$, a star $S_i$ with i branches having centre $c_i$ with one of the branch vertex of $S_i$ merged with $s_i$. Here $\{|S_1|, |S_2|,\dots, |S_5|\}$ forms in random with the condition that the present star must be greater than or equal to the previous star having one of the branch points in each of those stars is merged with a point on a path on n vertices as support points respectively and hence it has been denoted as $FT_{G(5)}$ tree.

Main result The set of all random trees with hanging stars obtained from set of all random trees with hanging stars in the stage (i-1). (i.e.) $FT_{G(i-1)}$.

Let $S_1, S_2, \dots, S_5$ be stars with $\left|V(S_i)\right|$ = i for i = 1, 2, 3, 4, 5. Let the support points of the hanging stars $S_1, S_2, \dots, S_5$ be $s_1, s_2,\dots, s_5$ respectively and denote the free leaves of each of the stars $s_i$ by $f_1^{(i)}, f_2^{(i)}, \dots, f_{i-1}^{(i)}$ for i = 1, 2, 3, 4, 5.

Let $c_1, c_2\dots, c_5$ be the central values of the stars $S_1, S_2,\dots, S_5$ respectively.

A tree with random growing n hanging stars as branches whose cardinality are in random which are non-decreasing is denoted $FT_{G\,(5)}$.

It can be verified that the number of vertices in $|V(T)|$ can be define by the relation

$$|V(T)| = |V(S_1)| + |V(S_2)| + |V(S_3)| + |V(S_4)| + |V(S_5)|$$

Also the edges of $|E(T)|$ can be defined by the relation

$$|E(T)| = |E(S_1)| + \ldots + |E(S_5)| + 4$$

where 4 denotes the number of edges in the base path from which the stars are hanging .

Without loss of generality assume that $|E(S_1)|$ = $q_1$ =0, $|E(S_2)|$ = $q_2$ = 4, $|E(S_3)|$ = $q_3$ = 5, $|E(S_4)|$ = $q_4$ = 8, $|E(S_5)|$ = $q_5$ = 10 and q= 31.

A general tree is drawn in the following figure 1.

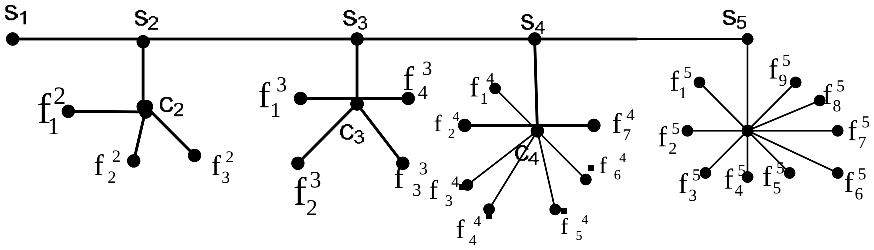

Fig 1: General Tree on graceful labeling

We also denote the labeling of node v in the tree as l (v).

R (1): l ($s_1$) = 0; l ($c_2$) = 1 and l ($s_2$) = 31.

R(2): $l(c_{2i+1}) = 31 - \left(\sum_{i=1}^{5} q_{2i} + i - 1\right)$.

R(3): $l(c_{2i}) = \sum_{i=1}^{5} q_{2i-1} + i - 1$.

R(4): $l(s_{2i}) = q - \left(\sum_{i=1}^{5} q_{2i-1} + i - 1\right)$.

R(5): $l(s_{2i+1}) = \sum_{i=1}^{5} q_{2i} + i - 1$.

Assigning of Free leaves:

1) Let the free leaves of growing m<sup></sup>th star of $RT_{G\,(m)}$ at $s_m$ be $f_1^m, f_2^m, \ldots, f_{m-1}^m$.
2) Let the free leaves of $S_2$ are labeled with values 30 to 28.
3) The labeling of free leaves of odd stars of $S_{2m+1}$ based on its supporting vertex $s_{2m+1}$ as follows.

   R(6)a: labeling of free leaves of $S_{2m+1}$ is {integers starting from $l(c_{2m})$ + 1 to the number of leaves in the particular star assigned in ascending order except the value of $l(s_{2m+1})$ } .
4) The labeling of leaves of even stars $S_{2m}$ based on its supporting vertex $s_{2m}$ as follows.

   R(6)b: labeling of leaves of $S_{2m}$ is { integers starting from $l(c_{2m-1})$ –1 to the number of leaves in the particular branch assigned in descending order except the value of $l(s_{2m})$. }

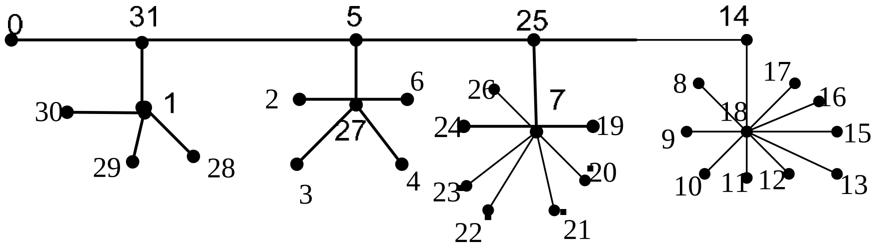

FIG 2: CALCULATED TREE WITH VERTICES AND EDGES.

## III. GLAAM BASED FACE IDENTIFICATION

GLAAMs combine a powerful model of joint shape and texture with a gradient-descent fitting algorithm. GLAAM was first introduced by Cootes et al. in 1998 [11] and, since then, this modelling has been widely used in face and medical image analysis.

During a training stage, we use a set of manual landmarked images, these images are selected as representative examples of the face variability. All the training images have been manually landmarked with N ¼ 60 landmark points (see Fig. below), the position of these landmarks conform the face shape s ¼ ($x_0$, $y_0$, ... , $x_j$, $y_j$, ..., $x_{59}$, $y_{59}$) of each image i. The training set of landmarked face-shapes {$s_0$, ..., $s_i$, ...,$s_M$} are aligned using Procreates analysis, to obtain invariance against 2D [14] rigid changes (scale, translation and roll rotation). A shape model is created through Graceful labeling based principal component analysis (GLPCA) of the aligned training shapes [see (1)] where s represents the mean shape, Ps represents the principal axis of the subspace and bsi are the coefficients that represent the shape si in the shape subspace.

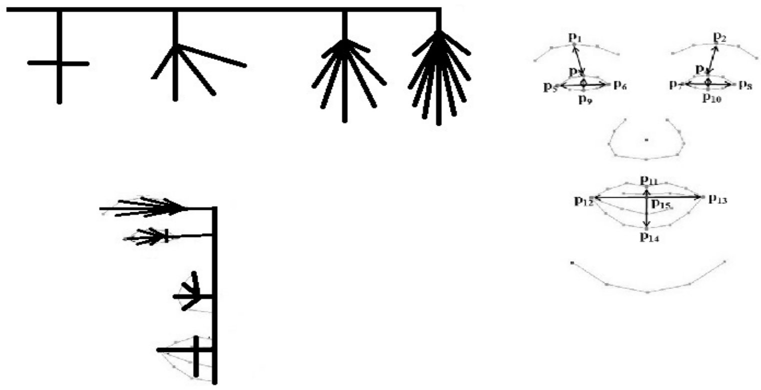

Fig 3: Landmark on face

## IV. CONCLUSION

In this paper, we studied the performance of a novel GLAAM [14, 15, 16] based fully automatic face recognition system able to handle pose variation between probe and gallery images. We showed the importance of keeping the identity information through the proper handle of shape subspace coefficients, and the relationship between our model for pose estimation/ frontalization [6] and the appearance model proposed in [9]. The frontalization method used relies on having a good fitting in the GLAAM land marking step. All above, a good placement of nose landmarks seems to be crucial when symmetry needs to be applied. Therefore the landmark process has been thoroughly studied in this paper. Two approaches, pose-dependent GLAAM and view-based GLAAM, have been compared both in terms of land marking and recognition. The multi resolution scheme of pose dependent GLAAM allowed a faster fitting to the correct pose-dependent model but suffered a higher sensitivity to errors of the face feature detector than the pure view-based approach.

Recognition results over database available similar values compared to the performance achieved with manually landmarked faces and slightly worse values than view-based approach when a larger number of models are trained. We have also seen that, with a proper landmark initialization, the pose-dependent scheme performs slightly better than the view-based scheme in terms of speed and accuracy.

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