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MULTI-AGENT APPROACH TOWARDS FACE RECOGNITION

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Abstract

In today's sensitive environment, there are so many biometric technologies including face recognition are available for person recognition and are coming of age due to the need to address sensitive security concerns in the 21st century. But, the single biometrics technique is not adequate for person identity recognition due to both sufficiently accurate and user-acceptable for universal application. The main challenges of face recognition today are handling & implementing the different stages of face recognition such as capturing face, the feature extraction stage, Color segmenation, Skin-region detection stage, the template acquisition and classification stage are spatially and functionally distributed, with complex hierarchies of security levels and interacting user requirements. An approach based on innovative multi-agent based computing paradigm is sufficient & promising towards the face recognition systems deployed in such distributed environments. This paper is organized as follows. Part 1 discusses introduction; Part 2 discusses the technology of face recognition with its application domain & tools; Part 3 discusses the agent technology with multi-based computing paradigm with highlighting its three-layer structural model and three-layer functional model; Part 4 reviews previous approaches in related multi-agent based computing paradigm towards face recognition

Keywords : Biometric technologies, Face recognition, Multi-agent

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1. Introduction

Face recognition and other biometric technologies like fingerprint, voice, gait, iris, retina, palm geometry, vein patterns, are available for person recognition and are coming of age due to the need to address sensitive security concerns in the 21st century. Privacy concerns that have slowed down public acceptance of these technologies in the past are now yielding to society's need for increased security while maintaining a secure & violence free society.

Strong and correct face recognition in a distributed environment is a challenging goal because of the gross similarity of all human faces compared to large differences between face images of the same person due to variations in facial expression change, aging, personal appearance (make-up, glasses, facial hair, hairstyle, disguise) [4], change in scale, location and in-plane rotation of the face (facing the camera) as well as rotation in depth (facing the camera obliquely, or presentation of a profile, not full-frontal face), lighting variation, camera variations, channel characteristics (especially in broadcast, or compressed images).

Figure 1 - Sample variations of a Single Indian Child Face in pose, facial appearance, lighting and expression

Face recognition has the advantage over other major biometrics, in that everyone has a face and everyone readily displays the face. Uniqueness, another desirable characteristic for a

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biometric, is hard to claim at current levels of accuracy [4]. The automatic recognition of human faces spans a variety of different technologies. At a highest level, the technologies are best distinguished by the input medium that is used, whether visible light, infra-red [2, 3] or 3-dimensional data [1] from stereo or other range-finding technologies.

In recent years applications of biometric technologies are not just limited to high security border control and national security scenarios, but in day-day civilian and e-commerce applications [5]. But, the single biometrics technique is not adequate for person identity recognition due to both sufficiently accurate and user-acceptable for universal application. Multimodal biometrics can provide more robust solutions to security and convenience requirements of many applications such as video surveillance, crime investigation, and health informatics scenarios, where there is a need to recognize the identity from insufficient biometric sensor data [9].

The main challenges of face recognition today are handling & implementing the different stages of face recognition such as capturing face, the feature extraction stage, Color segmenation, Skin-region detection stage, the template acquisition and classification stage are spatially and functionally distributed, with complex hierarchies of security levels and interacting user/provider requirements. The face recognition systems deployed in such distributed environments require that the system is adaptive and flexible in configuration, for which an approach based on innovative multi-agent based paradigm can be very promising [5].

2. Techniques/ Algorithms of Face Recognition with its application domain & tools

2.1 Techniques/ Algorithms of Face Recognition Face recognition techniques/algorithms can be roughly classified into the following categories.

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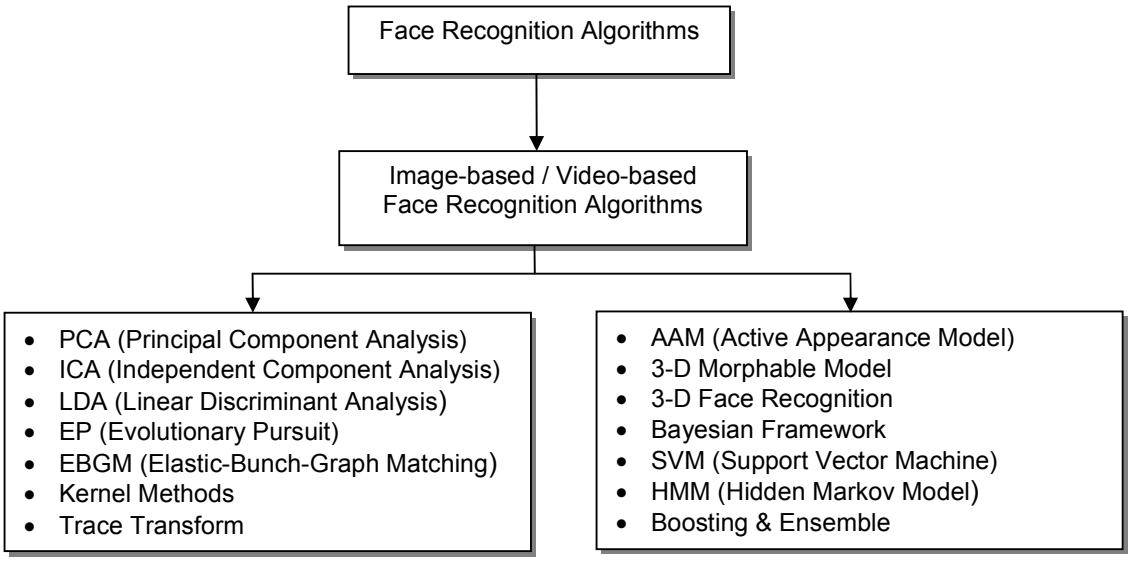

Figure 2 - Face Recognition Techniques / Algorithms

2.2 Application Domain

Many applications for face recognition have been envisaged, and some of them have been hinted at above. Commercial applications have so far only scratched the surface of the potential. Installations so far are limited in their ability to handle pose, age and lighting variations, but as technologies to handle these effects are developed, huge opportunities for deployment exist in many domains. Some popular application domain of face recognition are Access Control, Identification Systems, Surveillance, Pervasive Computing [4].

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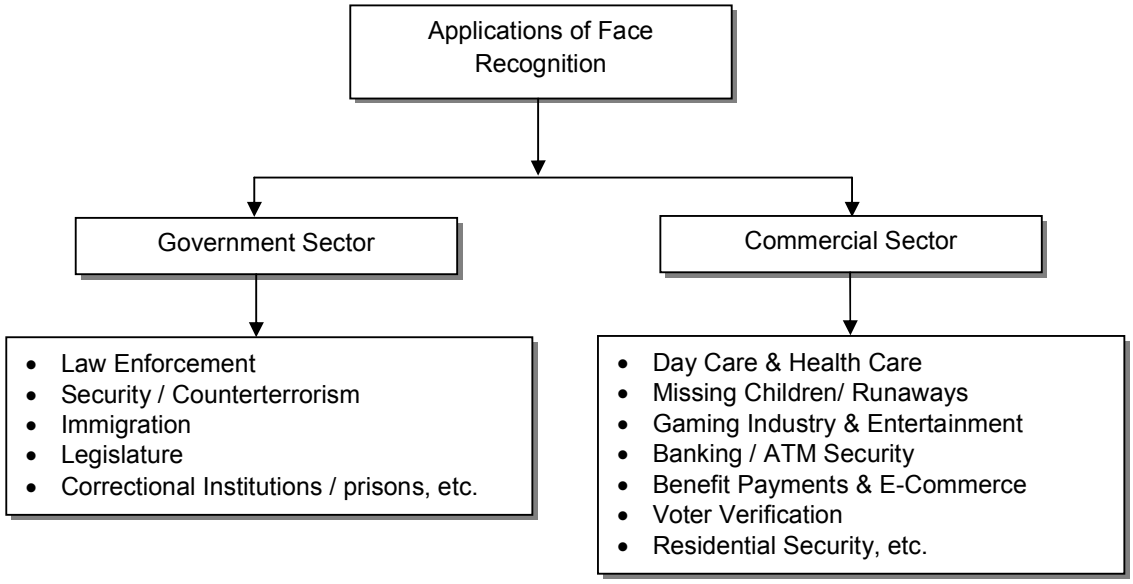

Figure 3 – Applications of Face Recognition

(Source http//faculty.darden.virginia.edu/smither/101.pdf)

2.3 Tools / Software for Face Recognition System

The following table shows the some popular tools/software used in world wide

Tools/ Software	Tools/ Software
Google's Picasa digital image organizer	Rank Deficient Faces
Apple iPhoto	JNI2OpenCV
Sony's Picture Motion Browser (PMB)	NeuroFaceDemo (ORL face database)
Facebook face recognition technology	Face Tracking DLL from The Advanced

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	Multimedia Processing Lab (AMP)
Windows Live Photo Gallery	Real-time face detection program from FhG-IIS (Fraunhofer Institute IIS, Germany)
Face Recognition ActiveX DLL 1.11	Perceptual User Interfaces Demo code from Institute for Information Technology, Computational Video Group, Canada
FaceDatabases	SVM's for Face Detection etc.

Table – 1 Tools / Software for Face Recognition System used in world-wide (Source http//en.wikipedia.org/wiki/Facial_recognition_system)

3. Agent Technology with Multi-Agent based Computing Paradigm

An agent is a goal-oriented, computational entity which acts on behalf of another entity (or entities). Agent systems are self-contained software programs processing domain knowledge and ability to behave with some degree of independence to carry out actions to achieve specified goals. They are designed to operate in dynamically changing or unstable environments.

3.1 Properties of Intelligent Agents Software agents are an innovative technology designed to support the development of complex, distributed, and heterogeneous information systems. This is however no complete standard /consensus definition of an agent. As a result, agents tend to be characterised in terms of a number of their behavioural attributes.The following figure shows the commonly cited main attributes of agents

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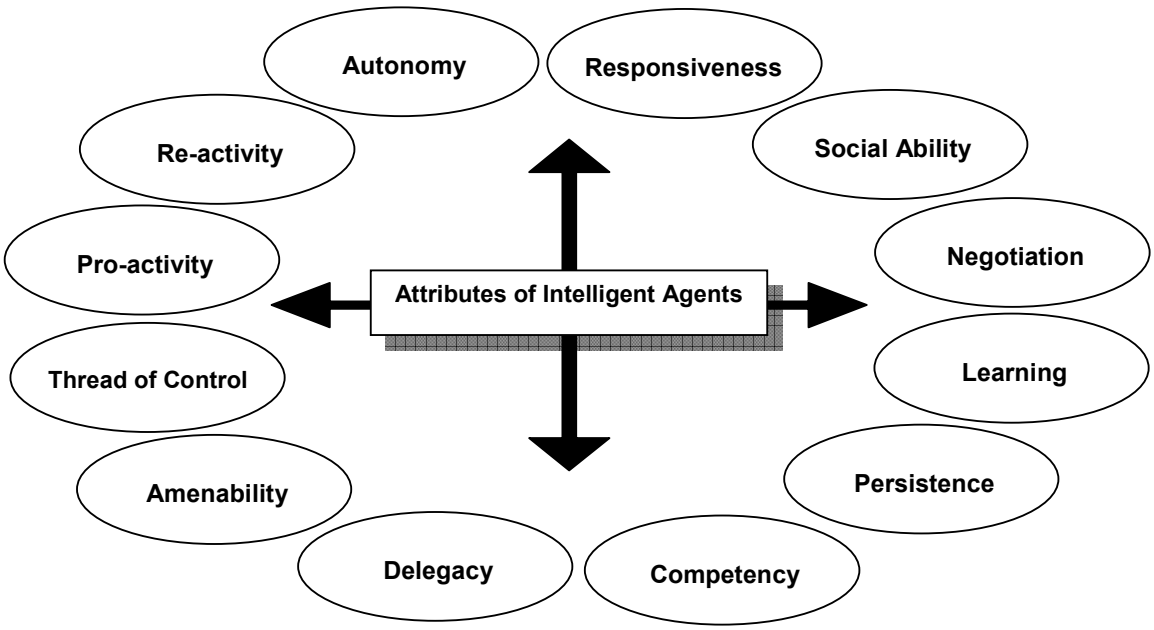

Figure 4 – Attributes of Intelligent System

Multi-Agent systems are one of the most exciting research areas in artificial intelligence (AI) at the moment. A multi-agent system is a collection of independent agents that communicate in order to co-operate in the joint resolution of a complex task. An agent may be defined as an autonomous software entity that receives inputs and interacts with its environment, performing tasks in the pursuit of a set of goals [23].

3.2 Multi-Agent based computing paradigm The use of intelligent agent methodology allows efficient management of complexity introduced by the use of facial biometrics for remote access. Intelligent autonomous agents [25], and multi-agent systems form a vibrant and rapidly expanding research field [26]. Innovative multi-agent architecture is used to solve

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the problem of distributed face recognition in complex environments. The architecture is based on, a multi-agent systems framework, proposed by Intelligent Systems Group at the University of Canberra [27] for distributed face recognition task. The architecture consists of a fusion of multi-layered structural and functional models in a network-oriented distributed environment [9].

The multi-layer structural and functional model can be viewed in two ways one at structural level, and the other at the functional or operational level, as shown in Figure [4, 5].

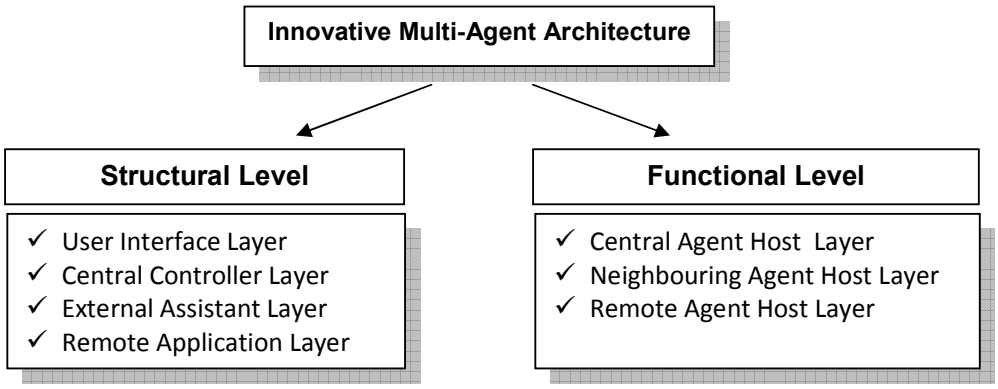

Figure 5 Innovative Multi-Agent Architecture

The details of each layer [9] in the structural level can be summarized as

- **User Interface Layer** This layer allows an easy access to the system by establishing a point-to-point input/output layer explicitly connecting the input/output device and the application server. All recognition schemes are hidden from the end user. A user interface is used to accept the input image and return recognition results.

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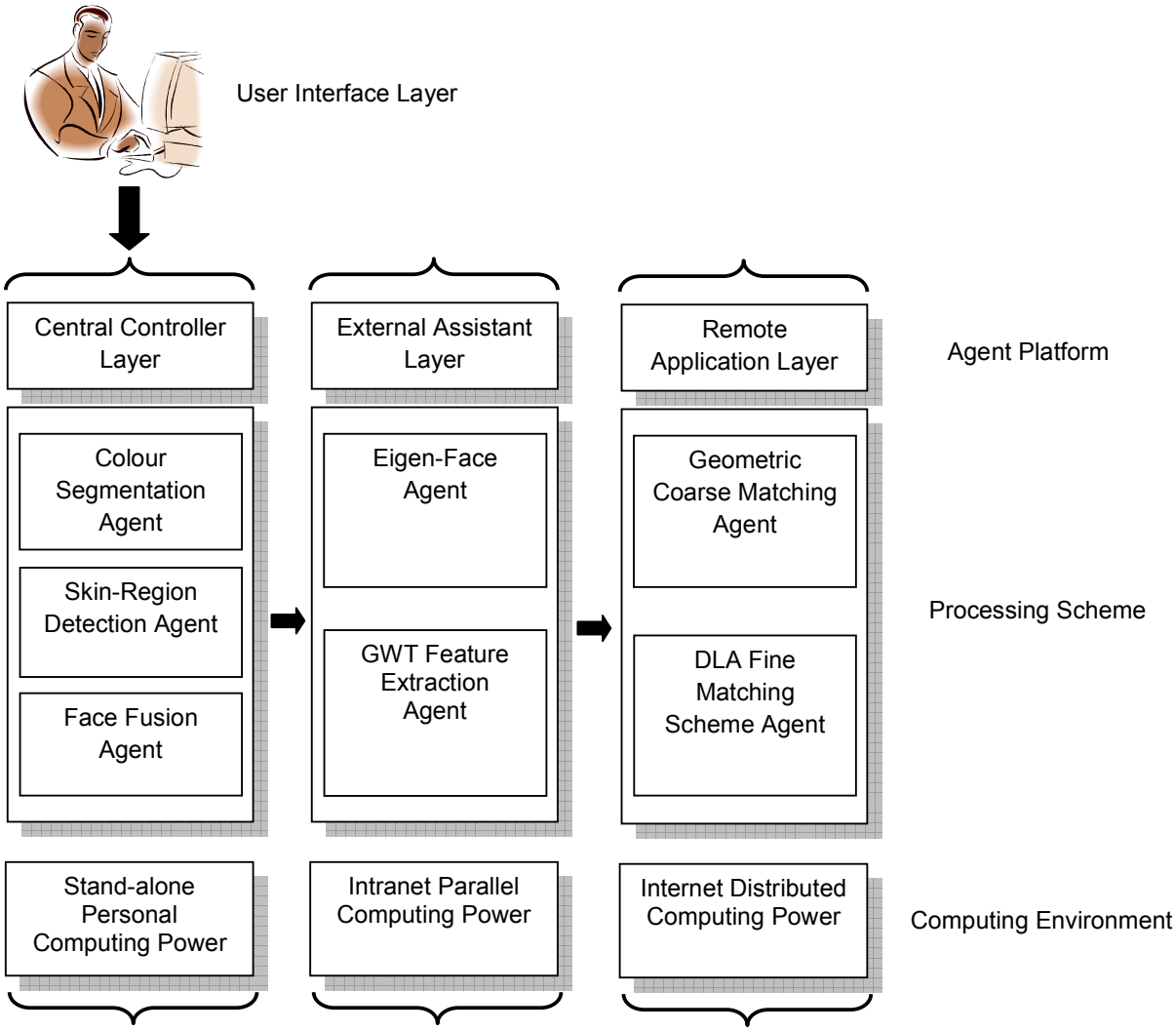

Figure 6 Multi-Agent based Face Biometric System Architecture

- **Central Controller Layer** This layer is the main part of the whole system and connects all sub-systems. A novel face detection scheme based on fusion of multiple colour

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spaces is implemented in this layer. Three stages of face detection that is Colour segmentation, the skin-region detection, and face fusion is done by three agents in this layer

- **Color segmentation agent** The facial region is localized by this agent based on statistical skin colour distribution and thresholding. Then the knowledge about facial patterns (distribution of non-skin sub-regions) is used to determine instances of face within such regions. The agent uses morphological operators to divide different convex objects, removing regions that are too small, and recovering regions' sizes while keeping the same topological structure.
- **Skin region detection agent** This agent localizes the face region by matching the skin regions with a template, and eliminates those skin regions which do not correspond to face region such as hands.
- **Face Fusion agent** This agent performs fusion of face segmentation and face region detector based on multiple colour spaces such hue-saturation(HSV) colour space, chrominance-luminance colour space (YCrCb) colour space, and RGB colour space.

- **External Assistant Layer** The external assistant layer extracts features from face images, including both local and global features. First, global features are extracted by principal component analysis (PCA) or Eigen-face approach, while local features are obtained by active appearance model (AAM) and Gabor wavelet transform (GWT).
- **Remote Application Layer** Remote face matching scheme is implemented in this layer. Based on the fact that large image databases with different formats might be located in different places over the network, it makes more sense if the agent moves to the remote data source for searching and matching, rather than transferring large volumes of data over the network for processing. In this layer, we explicitly create a matching agent, initializing it with matching algorithms and dispatching it to the Internet. Upon reaching a

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new host, the matching agent interacts with remote agents and communicates with the backend databases for searching and matching.

4. Approaches in related multi-agent based computing paradigm towards face recognition

Moreover, for distributed implementations, the different stages of face recognition, such as the acquisition stage of capturing face biometric information, the feature extraction stage, and the classification stage are spatially and functionally distributed. The face recognition systems deployed in such distributed environments require that the system is adaptive and flexible in configuration, for which an approach based on innovative multi-agent based paradigm can be very promising [22] .

As a related work, Chetty, and Dharmendra. Sharma [9] presented an application of agent technology to the problem of face recognition. With a new composite model consisting of multiple layers, the system can achieve high performance in terms of robustness and recognition in complex visual environmental conditions. The robustness of the complex face recognition system is enhanced due to integration with agent based paradigm, with more than 95% accuracy achieved under illumination, pose and expression variations of faces in images with multiple faces, and background objects.

Hee-Sung Kim and Jong-Ho Kim [7] proposed a gradient method for face recognition and is compared to the PCA method. The gradient method combined with the template matching or neural net method shows that they are both good in recognition rate and the time effectiveness. Particularly, the recognition process is stem to the variation of the illumination directions. Its recognition rate is as high as more than 96 % without any special preprocessing for the removing of the illumination variations.

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Georgy. Kukharev and Adam. Nowosielski [8] proposed two main subsystems face detection and face recognition. The face detection subsystem integrate skin-color, mask analysis, and face features, redactors, knowledge and template matching. A new model was presented for face recognition subsystem based on Euclidean distance metric, correlation and cosine transform. The idea is to reduce searching space for improve accuracy and speed some modifications to the well-known methods. The proposed system was tested by using the ORLdatabase and the result recognition rate is up to 96.7%.

Gouda I. Salama, Aly A. Fahmy and Magdy A. Elbhar [24] proposed a multi-agent model which was enhance the performance of a real-time face recognition system using multi-classifier agents incorporated with multi-feature approach. The experimental results was showed that the recognition rate had been improved up to 99.5% interpreted as 1.5 seconds in threading mode, and 1 second in distributed mode.

5. Conclusions

Facial Recognition technology with multi-agent approach provide a practically feasible techniques for overcoming the performance and user acceptability obstacles to the widespread adoption of biometric systems. Much research effort around the world is being applied to expanding the accuracy and capabilities of this biometric domain, with a consequent broadening of its application in the near future. This paper introduces an innovative multi-agent computing paradigm for distributed face recognition problem. With the support of multi-agent approach, the system is potentially useful in a wide range of distributed face recognition services such as remote video surveillance, health informatics and criminal identity verification.

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