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THEME

FACE AGE ESTIMATION

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ABSTRACT

Human age estimation is very interesting challenge today also. The prediction of age based on different techniques and by human, itself is very similar now. The major challenges for machine based age estimation are still alive. Challenges are uncontrolled environment, different light settings, variant posing and expression, ageing effects and life style. Human age estimation started with craniofacial growth has now reached to the condition where challenges are changing into opportunities for developing of applications. Applications include Biometrics, forensic investigation during crime , security control. Feature extraction deals with extraction of features like facial landmarks, shape and texture for further analysis. Feature reduction is considered for faster analysis of feature vectors. Lastly, regression, classification or combination is used for estimation of the age.

Keywords : Biometrics , face analysis , age estimation.

Résumé

L'estimation de l'âge humain est un défi très intéressant aujourd'hui également. La prédiction de l'âge basée sur différentes techniques et par l'homme, elle-même est très similaire maintenant. Les principaux défis de l'estimation de l'âge basée sur la machine sont toujours d'actualité. Les défis sont l'environnement incontrôlé, les différents réglages d'éclairage, les variantes de pose et d'expression, les effets du vieillissement et le style de vie. L'estimation de l'âge humain a commencé avec la croissance craniofaciale a maintenant atteint la condition où les défis se transforment en opportunités pour le développement d'applications. Les applications incluent la biométrie, l'enquête médico-légale lors d'un crime, le contrôle de sécurité. L'extraction de caractéristiques traite de l'extraction de caractéristiques telles que les repères faciaux, la forme et la texture pour une analyse plus approfondie. La réduction des caractéristiques est envisagée pour une analyse plus rapide des vecteurs de caractéristiques. Enfin, la régression, la classification ou la combinaison est utilisée pour l'estimation de l'âge.

Mots clés : Biométrie , analyse faciale , estimation d'âge.

ملخص

يعتبر تقدير العمر البشري تحديًا مثيرًا للاهتمام اليوم أيضًا. إن التنبؤ بالعمر بناءً على تقنيات مختلفة وبواسطة الإنسان ، هو

نفسه مشابه جدًا الآن. لا تزال التحديات الرئيسية لتقدير العمر المعتمد على الآلة قائمة. تتمثل التحديات في البيئة غير المنضبطة ، وإعدادات الإضاءة المختلفة ، والوضعية المتغيرة والتعبير ، وتأثيرات الشيخوخة ، وأسلوب الحياة. بدأ تقدير عمر الإنسان مع النمو القحفي الوجهي وقد وصل الآن إلى الحالة التي تتحول فيها التحديات إلى فرص لتطوير التطبيقات. تشمل التطبيقات القياسات الحيوية ، والتحقيق الجنائي أثناء الجريمة ، ومراقبة الأمن. يتعامل استخراج الميزات مع استخراج الميزات مثل معالم الوجه والشكل والملمس لمزيد من التحليل. يعتبر تقليل الميزة لتحليل أسرع لمتجهات الميزات. أخيرًا ، يتم استخدام الانحدار أو التصنيف أو الجمع لتقدير العمر

.الكلمات المفتاحية : القياسات الحيوية ، تحليل الوجه ، تقدير العمر

شكر و عرفان

" رواه البخاري وصححه الالباني عن ابي هريرة رضي الله عنه ان النبي صلى الله عليه وسلم قال "من ال يشكر الناس ال يشكر الله ومن هذا الحديث نتوجه بالشكر والامتنان الي كل من ساندنا من قريب او بعيد في انجاز هده المذكرة ونخص بالذكر الاستاذة المشرفة د. التجاني امينة

إهداء

الي ينبوع العطاء الذي زرع في نفسي الطموح والمثابرة والدي العزيز

الي من تعجز الكلمات عن ذكري ماثرها الي الشمس التي انارت دربي الي التي لن اوفيها حقها مهما قلت فيها امي الغالية الي من يحملون في عيونهم ذكريات طفولتي وشبابي اخوتي واخواتي

الى من ذاقت السطور عن ذكرهم فوسعهم قلبي أصدقائي الي كل

محبي العلم والمعرفة

Abbreviations

DLQP : depth local quantized pattern

EER : equal error rate

FAR : false acceptance rate

FRR : false rejection rate

ROC : receiver operating characteristics

SVM : support vector machines

FCM : Fuzzy c Means

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General introduction

Age estimation is an important task in facial image classification. For research purposes, definitions of basic terms are given. Age estimation in this study is defined as age of a person based on his or hers biometric features, precisely on the basis of two-dimensional facial images [1]. Facial characteristic points can be defined as a standard reference points on human face used by scientists in order to recognize a person's face, or in this case, to estimate the age of a person [2]. Human age estimation is assigning label to person by specifying exact age or the range of age automatically. Humans can estimate age effortlessly. While computer based age estimation requires methods for feature extraction that analyze the face shape and texture along with robust classification algorithm to estimate the age.

In chapter 1 : is the basics and details of the task of biometrics. We have provided an overview of biometrics by presenting the concepts, definitions, required methods, and history to be able to understand this work. After that, we talked about a comparison between biometrics techniques and applications of the biometrics system, and presented their types, and we touched upon the answers to biometrics. And its shortcomings, and finally we talked about its evaluation

In chapter 2 : important details about face analysis, and we provide an overview of automatic verification of face analysis by presenting some concepts, definitions and terms required to understand this chapter. After that, we explained both face detection, face modeling and classification, and from this we touched on the challenges, difficulties and applications of face analysis We enumerated them as follows (protection, etc.), and finally, Illumination and occlusion

In chapter 3 : we gave a literary look at determining age. After this, we presented a program through which age is estimated through the image of the face. The experimental results for estimating the ages of people through images were presented and discussed.

Chapter 1: Biometric fundamental

1- Introduction

Biometric is a physical or behavioral characteristics of an individual which is used in various applications for identification and access control. Various unique identifiers are fingerprint, iris, palm print, retina. DNA, teeth, Keystroke dynamics, and signatures. Recently the hand based biometrics are used in various real time applications due to the cost factor and stability. Fingerprint, finger texture, hand geometry, hand vein patterns, palm print and finger knuckle are commonly used hand biometrics traits **[1].** Among hand based biometric traits, the fingerprint is very popular in the biometric system and is used in access control and for attendance system.

1.1 Definition of Biometrics

Biometrics are automated methods of recognizing a person based on a physiological or behavioral characteristic. Biometric technologies are becoming the foundation of an extensive array of highly secure identification and personal verification solutions. Examples of physiological characteristics include hand or finger images, facial characteristics, and iris recognition. Behavioral characteristics are traits that are learned or acquired. Dynamic signature verification, speaker verification [2]

1.2 History in Biometrics

Although automated biometric systems have only existed for a few decades, they are based on ideas that are hundreds and thousands of years old. In the mid-1800s, the rapid urbanization of the industrial revolution increased the need for formal methods of identifying people, creating a boom in biometrics. Today, biometrics are employed in law enforcement, commercial applications, migration control, civil identification, healthcare, and more.

1.2.1 Timeline

- In 1892, Sir Francis Galton developed the first fingerprint classification system.
- In 1903, New York state prisons began using fingerprints.
- In 1960, face recognition first became semi-automated due to research by Woodrow W. Bledsoe.
- In 1969, the FBI sought to automate fingerprint recognition.
- In 1994, the Immigration and Naturalization Service developed IDENT as a law enforcement tool for the USBP. By 1999, IDENT contained 1.8 million biometric identities.

- In 2011, the U.S. Department of Defense and the U.S. Department of Homeland Security signed a Memorandum of Understanding that provided the policy framework for interoperability between the DoD's Automated Biometric Identification System (ABIS) and IDENT. [3]

1.3 Types of Biometrics

There are many types of biometrics currently in use, and many more types to come in the very near future (DNA, holograms [4], etc.). Today, some of the most common ones in use are:

1.3.1 Fingerprints : A fingerprint is the pattern of ridges and valleys on the surface of a fingertip, the formation of which is determined during the first seven months of fetal development. Fingerprints of identical twins are different and so are the prints on each finger of the same person

1.3.2 Face recognition : Face recognition is a nonintrusive method, and facial images are probably the most common biometric characteristic used by humans to make a personal recognition. The applications of facial recognition range from a static, controlled “mug-shot” verification to a dynamic, uncontrolled face identification in a cluttered background (e.g., airport).

1.3.3 Iris recognition: The iris is the annular region of the eye bounded by the pupil and the sclera (white of the eye) on either side. The visual texture of the iris is formed during fetal development

and stabilizes during the first two years of life complex iris texture carries very distinctive information useful for personal recognitio

·Hand and finger geometry

1.3.4 Signature verification: The way a person signs his or her name is known to be a characteristic of that individual. Although signatures require contact with the writing instrument and an effort on the part of the user, they have been accepted in government, legal, and commercial transactions as a method of verification.

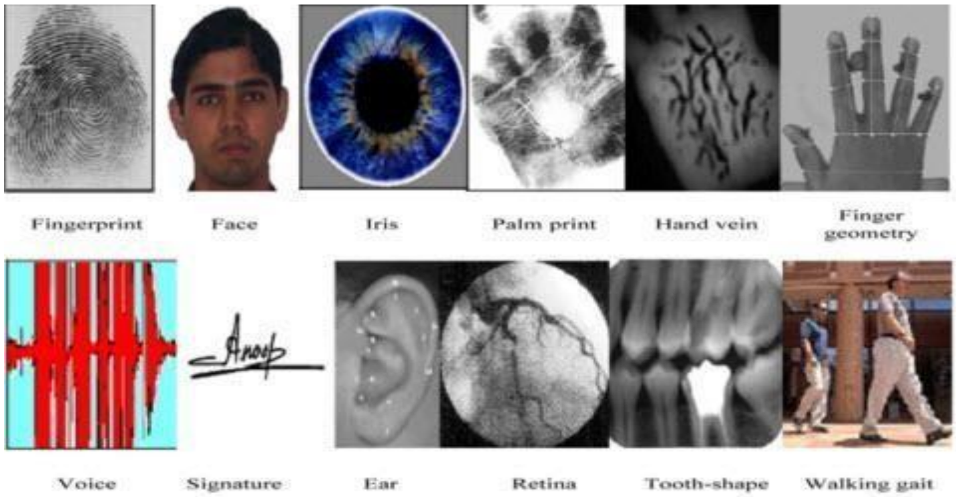

Figure I.1. Types of Biometrics

1.4 Biometric modalities

Biometric methods are the biometric characteristics by which an individual's identity can be verified As Figure 1.1 illustrates some of them

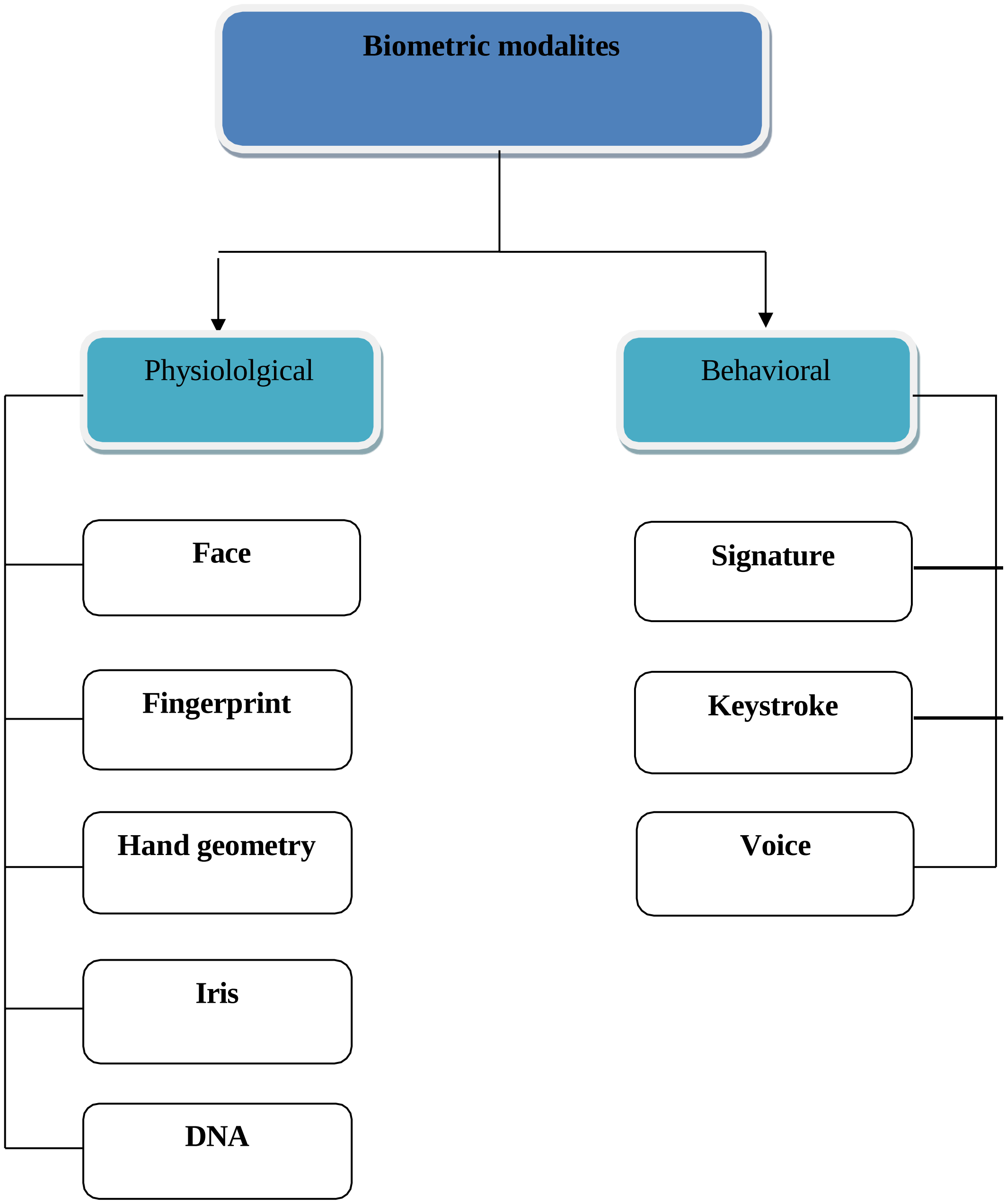

Figure I.1. Principal biometric modalities

At present, many competitive biometrics methods and techniques have been proposed, and the selection of one method using a known technology depends on the target application and required performance. Some methods and techniques, such as iris and retina, are preferred for their high reliability.Others are chosen based on user acceptance and applicability such as fingerprint and face

Table I.1 summarizes the most used modalities in recognition systems in terms of principles, advantages and disadvantages. This table shows that fingerprint is a trade-off solution between all the other modalities in terms of accuracy, user acceptability, speed and cost.

Biometrics modality	Biometric characteristics ensuring individuality	Advantages	Disadvantages
Face	· Location and shape of facial attributes.	· Can operate on simple 2D images or 3D in static or movies images.	**· sensitive to simple changes (glasses, face hair, emotions, age, …)**
Fingerprint	· Texture pattern determined by the interleaved ridges and valleys on a fingertip.	· Most used biometrics.	**· Dedicated sensor that requires to be touched and maintained.**
Voice	· distinctive aspects of the voice	· Ease of use.	**· Low accuracy**
Signature	· The manner that a person signs: hand movement + signature image	· Accepted in government, legal, and commercial transactions.	**· Significant inter-user variability**
Iris	· Texture pattern of the Iris (the colored part of the eye: IrisCode, Over 200 points).	· High accuracy.	**· Cost tend to be high.**
DNA	· genetic code	· Most used for forensic applications.	**· Two twins have the same DNA sequence.**

Table I.1. Comparison of some leading biometric technologies

1.5 Biometric characteristics

A biometric characteristic (or trait) is a measurable physical or behavioral characteristic of an individual that is distinguishable. It determines how an individual is going to be recognized[5].

1.5.1 Universality: Every individual accessing the application should possess the characteristics.

1.5.2 Uniqueness: The underlying characteristics should be sufficiently different across individuals to be able to distinguish between two persons.

1.5.3 Permanence: The biometric characteristics should be resistant to changing in time at least with respect to the operating recognition system period.

1.5.4 Measurability: The biometric characteristics must be quantitatively measurable to be further processed by a machine.

1.5.5 Performance: The application that uses the biometric characteristics must ensure an acceptable degree of performance.

1.6 Applications of the biometric system

Biometrics has successfully convinced wide range of applications to be adopted not only as a fundamental component in their security architecture, but as an economical tool that can lead directly or indirectly to saving costs and reducing financial risks Among these applications, we mention them ..

1.6.1 Governmental applications: biometric national identity card, biometric passport, border control, social security, e-voting …

1.6.2 Access control: it can be physical such as time-attendance systems and door security, or logical such as accessing remote computer resources and information systems.

1.6.3 Mobile applications: recent mobiles are equipped with biometrics technologies that allow identifying the owner, to unlock the device, to make commercial transactions

1.6.4 Military applications: these include identification systems for use in the field, access control and monitoring applications to sensible areas, as well as large database deployments.

1.7 Biometric system architecture

A typical biometric system is constituted of four principal modules [5]. (**Figure I.2**):

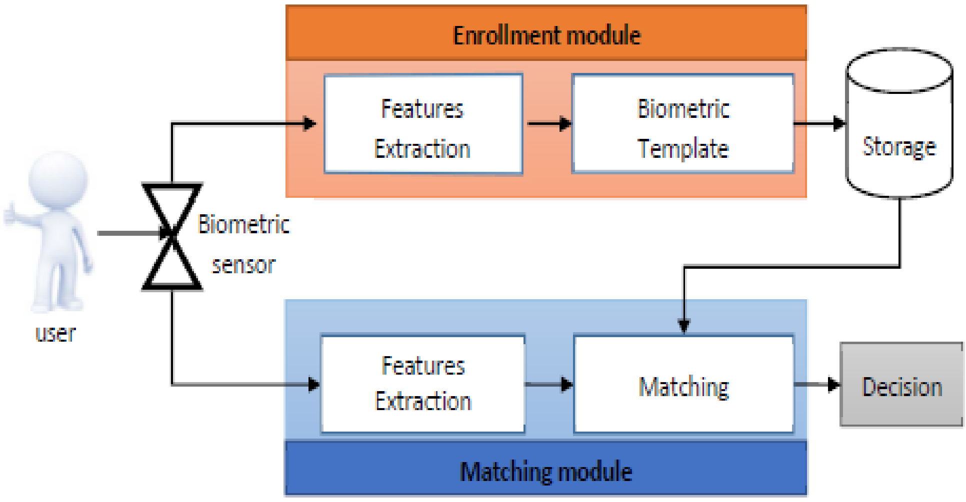

Figure I.2. A typical biometric system architecture

1.7.1 Biometric sensor: it is responsible for capturing the biometric characteristics from the biometric subject and converting it to a digital form to be transferred to the subsequent module. The performance of the overall process depends heavily on the quality of the acquired raw data.

1.7.2 Enrollment: the acquired raw data is first preprocessed to enhance its quality. After that, some relevant discriminatory features are extracted, by the extractor sub-module, to generate a compact representation called “template” that efficiently resumes the biometric characteristics. The generated template is then sent to the storage system.

1.7.3 Storage system: the storage system can be a simple file in a simple smartcard as it can be a big database managed by an SGBD. In association with the generated template, some biographic information (name, passwords, address, etc.)

1.7.4 Matching module: during the operating phase, the system is requested to identify a person. It proceeds to extract his discriminatory features using the extractor sub-module in the same manner that it has been done in the enrollment step. These extracted features are called query features. After that, The comparison aims to confirm that both the query and the template features originate from the same biometric subject (person). Generally, the comparison result is a degree of similarity ranging between 0 (total mismatch) and 1 (perfect match) that allows the system to take the suitable decision about the identity of the user.

1.8 Types of biometric systems

1.8.1 Mono-modality:

Monomodal biometrics is a person authentication technology based on a single biometric modality. Before proceeding to propose a biometric system, it is necessary to choose the most appropriate modality for the application[6].

1.8.2 Multi-modalit :

Multimodal biometrics consists of combining several biometric systems, which increases the amount of information discriminating the people to be identified. Indeed, it makes it possible to reduce certain limitations of unimodal biometric systems.

Multi-modality is an alternative that makes it possible to systemically improve the performance of a biometric system [7].

1.9 Performance evaluation

Two classes of users are intended to be identified by the recognition system. Users who are enrolled in the system constitute the “genuine” class. They already have biometric templates stored in the database. The second class, “imposter” class, is constituted of all other users that are not genuine.

1- Imperfections related to the sensor: that directly influence the quality of sensed data such as noise and resolution.

2-Acquisition of environmental conditions: Any change in the conditions of the environment, such as lighting, distances or techniques, leads to differences between the samples obtained

3- Interaction of the users with the sensor: the manner that the user interacts with the sensor can change from one acquisition to another. This is the case

1.9.1 False rejection rate FRR (False Rejection Rate):

Proportion of legitimate user transactions rejected in error. These transactions are rejected, by the matching algorithm, due to false mismatch as well as those rejected due to an acquisition failure

1.9.2 False acceptance rate FAR (False Acceptance Rate):

This rate determines the probability that a system will recognize a person who normally should not have been recognized. It is a ratio between the number of people who were accepted when they should not have been and the total number of unauthorized people who tried to be accepted

1.9.3 Equal Error Rate

The Equal Error Rate (EER) is the most important indicator to evaluate the performance of a recognition system. It guarantees the same false acceptance and false rejection errors. It is common in the biometrics literature to compare the efficiency of proposed matching algorithms in terms of this indicator. An algorithm efficiency is as better as lower the EER is. However, the EER, as a single criterion, doesn't summarize all the system characteristic

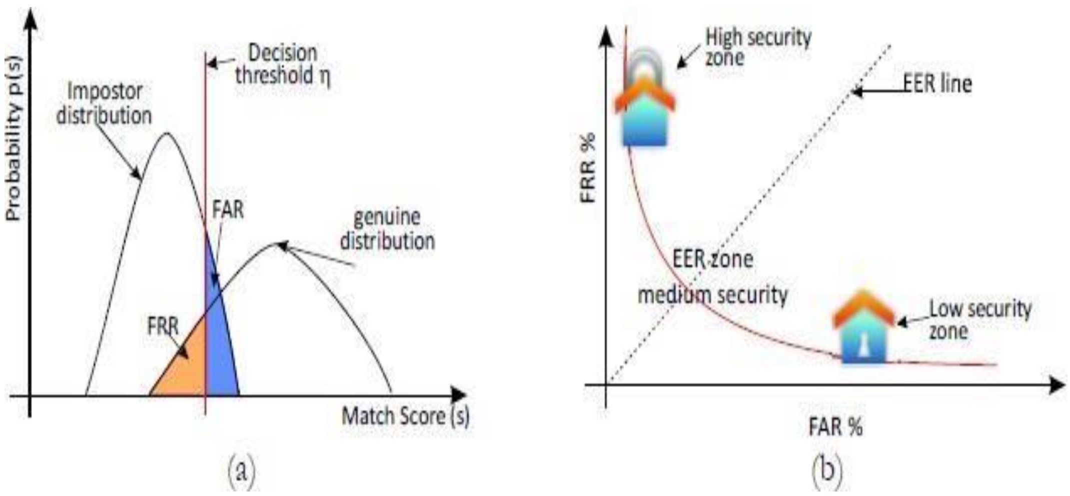

Figure I.3. (a) Genuine and imposter distributions defining the FAR and FRR rates. (b) The ROC curve illustrating the three different security zones.

. Figure I.3-(a) illustrates an example of genuine and imposter score distributions and the associated FAR and FRR for a given threshold η. Note that both FRR and FAR are functions dependent on the variable threshold η. Decreasing the value of this threshold to make the system tolerant to handle some genuine users intra-variations and noises, and so to decrement the FRR, results in increasing FAR. On the other hand, if η is increased to exclude some small inter-users variations, and so to more secure the system with low FAR, then the FRR raises. It is impossible to decrease both the values. In practice, one has to make a trade-off between these two rates so that the parameters are optimized based on the targeted application.

1.10 Conclusion

Biometrics aims to imitate the mental pattern recognition process in the manner that it identifies persons. It is a more secure and reliable alternative to the classical authentication schemes based on secrets and tokens. Biometrics technologies use human physiological and behavioral characteristics to recognize individuals in an automated process. These characteristics have to fulfill some requirements in particular universality, performance and applicability.

Chapter 2: face analysis

2 Introduction:

In this chapter, we introduce the background information and the notions required for understanding the thesis. After introducing the main face analysis tasks, we enumerate their extensive applications which justify the ongoing research interest in the topic. Next, we present a generic face analysis ow chart and detail its difierent components. We also overview the challenges related to face analysis and present the main remedies proposed by state-of-the-art works. Throughout the sections of the chapter, a brief survey pointing out the major achievements will be provided.

2.1 Face analysis tasks:

A wide range of information can be automatically inferred from human faces. This section overviews the main face analysis tasks.

2.1.1 face recognition:

Face recognition [9] is the most researched task and it has a big inuence on other face analysis tasks. As a biometric, a face has many advantages above the other modalities. Capturing a face image is a non-intrusive process since usually less, or even no, cooperation of the person is required. Another important reason making face among the top biometric modalities is the omnipresence of cameras, which facilitates the face acquisition. Face recognition encompasses two different operational modes:
verification and identification. The former, also known as authentication, is the process of checking whether a given face corresponds to a claimed identity.

2.1.2 expression classification:

[10] expression classification is also an important research topic in automatic face analysis facial expression can reflect different information about the person in cluding emotions mental activities social interaction and physiological signals psychologists identified six prototypic primary facial expressions called basic emotions : happiness , sadness , fear

2.1.3 age estimation:

Automatic age estimation of facial images due to a variety of potential applications in law enforcement, and security monitoring Despite advances in automatic age estimation, it remains a challenging problem. This is because the process of facial aging is not determined solely by internal factors, such as genetic factors Given the importance of human facial aging in biometric systems, age estimation has become an attractive area for researchers. The latter presents the presentation of age by means of a face image

2.2 Generic face analysis framework

The process of face analysis starts by capturing the face using a sensor (e.g., camera, depth camera). Then, the face needs to be located within the captured image. This step is called face detection (or localization). In case of video data, the detected face can be tracked along the video sequence. Once detected, the face region is segmented from the image and forwarded to the next component.

- In the preprocessing step, the face image undergoes a number of treatments in order to enhance it and to mitigate different artifacts. Usually, this step involves photometric and geometric normalizations. Next, a feature extraction method is applied to characterize the face in a distinguishable way.
- A mathematical model is afterward built for the extracted descriptors, where the aim is to categorize the descriptors in a specific class depending on the face analysis task being performed. In the training step, the specific parameters of each component of the system are optimized on a given database according to certain performance metric. The output of the training stage are the models and the optimal parameters for the whole system components. In the operational stage (Fig 2-1), the system captures new instances of faces

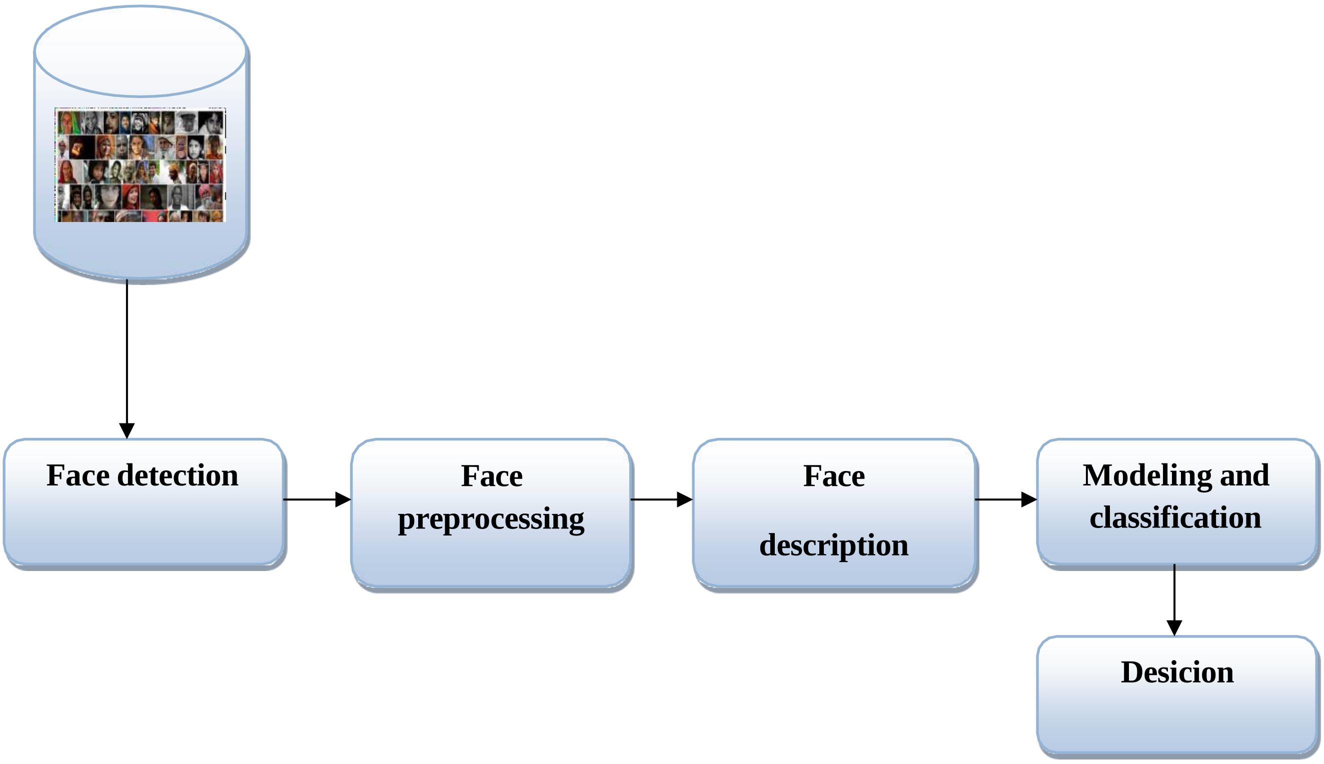

Figure 2.1 : Training phase of face analysis system.

which are submitted to face detection, preprocessing and description components successively. All these three steps are executed with the optimal parameters obtained at the training stage. Once the face features are extracted, they are matched to the trained models and attributed to the most likely class the input face may belong to. According to the performed face analysis task, the output of the system this time is the predicted class

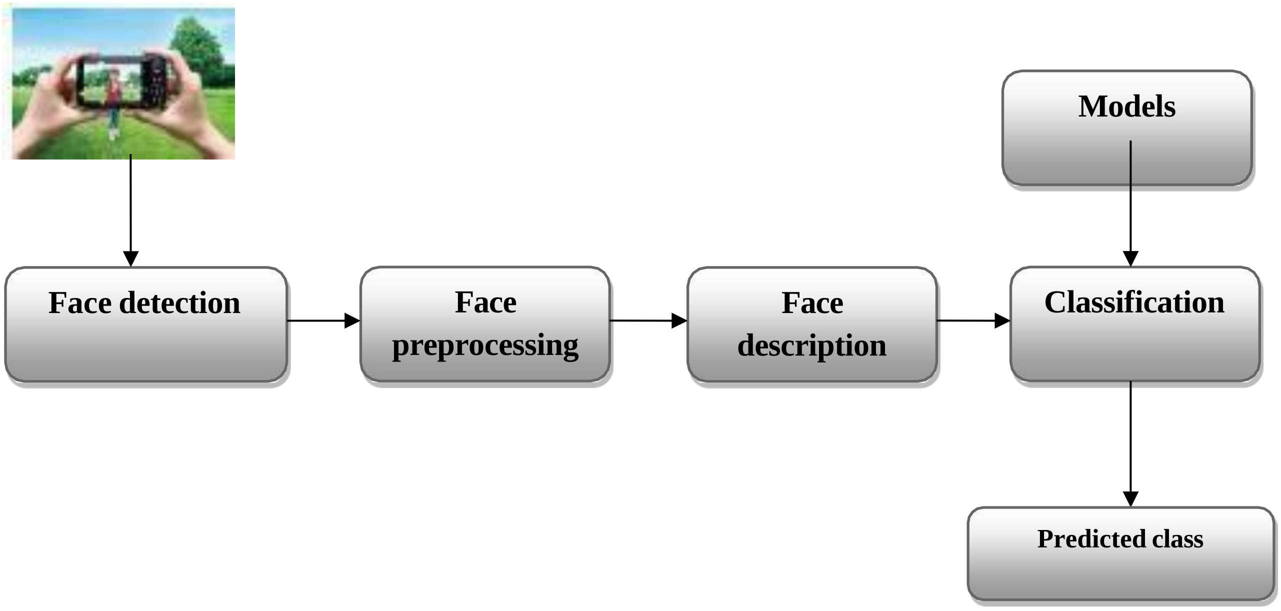

Figure 2.2 : Operational phase of face analysis systeme

2.2.1 Face detection and tracking

Face detection [11, 12] knew a tremendous progress during the past years thanks to the availability of in-the-wild data (i.e. faces captured in unconstrained conditions), collected from the Internet, with its publicly available benchmarking and the development of robust computer vision algorithms. The goal of face detection is to predict whether or not an image contains one or more human faces. The face detection algorithm returns the rectangles indicating the location of each detected face in the image (see Fig 2-3).

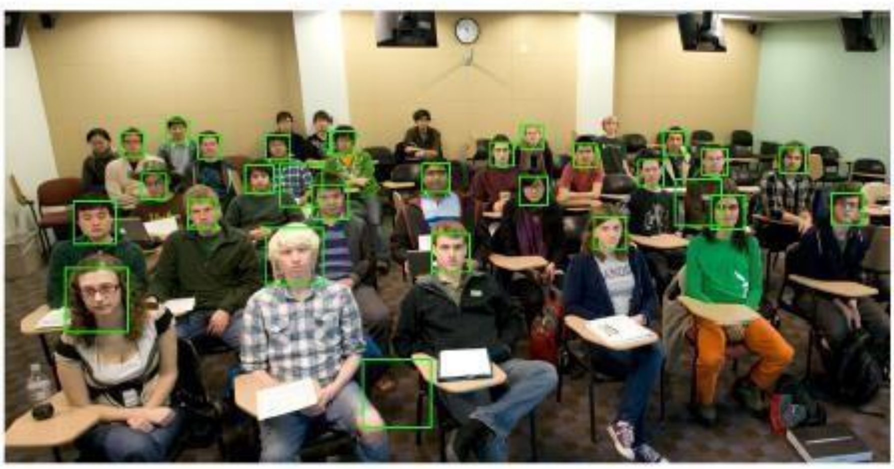

Figure 2.3 : Illustration of face detection output

2.2.2 Face description

The literature overview reveals a plethora of face descriptors that have been investigated for various face analysis tasks. There are several ways to categorize different face description approaches [13] . One of the most widely used divisions is to distinguish whether the method is based on representing the feature statistics of small local face patches (i.e. local) or computing features directly from the entire image or video (i.e. global or holistic). Typical holistic features include subspace methods, which project the data into a low dimensional space, such as the Eigenfaces and Fisherfaces . The former approach is based on Principal Component Analysis (PCA), which aims to represent the data by minimizing its reconstruction error. The PCA seeks a data representation

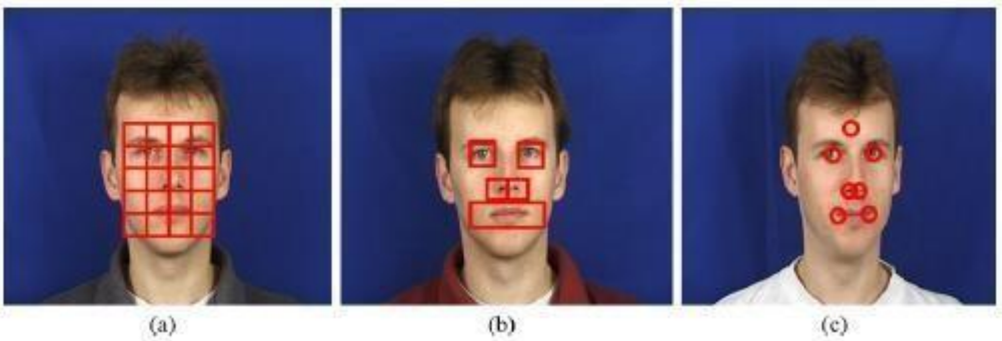

Figure 2.4 : Different strategies for extracting local face features from: a) face grid, b) face regions, c) face landmarks

2.2.3 Face modeling and classification

The classifiers that have been investigated for different face analysis tasks are far beyond the coverage of this part. However, in this section, we mention the most commonly used classifiers and face models, especially those which have made a remarkable advance in face analysis research. Firstly, the nearest neighbor classifier is commonly used for classifying similarities, usually computed with a distance function, between face feature vectors. The face sample to classify is attributed to the class with the nearest training samples. Support vector machines (SVM) are also among the most frequently used classifiers for face analysis. SVM builds optimal separating hyperplanes which maximizes the margin between different classes in high dimensional spaces. Other powerful classification tools are artificial neural networks, which automatically leran different classes based on a brain inspired process. The recent findings achieved by employing very deep neural network architectures highly impacted face analysis, thus making impressive advances

2.3 Challenges and remedies:

While in real life human face is subject to a huge variety of intrinsic and extrinsic changes, face analysis systems are trained with a limited number of face samples usually captured under controlled conditions. Fig illustrates some challenging face images captured in the wild. It is practically impossible to cover all the face variations in the training stage making the face analysis systems fail processing unseen faces with new variations. Furthermore, it has been demonstrated by literature studies that variations (in terms of illumination, head pose,) in different face images of the same person can be larger than variations of faces from different persons. Therefore, face analysis performance degrades remarkably in adverse environments. This section reviews the main challenges that hinder face analysis and refers to the main solutions proposed in the literature. Illumination change in uncontrolled environments is one of the biggest challenges to face analysis. Even in controlled environments, illumination is still a big challenge to deal with. Face images are sensitive to the direction of lighting as well as the resultant pattern of shading that alter informative features and lead to fake contours. Specular reections on eyes, teeth and wet skin are also a type of illumination to count for.

Figure 2.5 : Examples of challenging face images

• Odd expressions Human face in an image may have odd expressions unlike normal, which is challenge for face detection

• Face occlusion Face occlusion is hiding face by any object. It may be glasses, scarf, hand, hairs, hats and any other object etc. It also reduces the face detection rate.

• Illuminations Lighting effects may not be uniform in the image. Some part of the image may have very high illumination and other may have very low illumination.

2.4 Illumination

Photometric normalization techniques such as histogram equalization and gamma intensity correction are usually the first preprocessing steps to be applied to face images in order to compensate for face illumination. Among other literature solutions to the problem of illumination is the development of face descriptors robust to illumination change. However, the study by, which involved several relatively illumination-insensitive image representations under changes of viewpoint and illumination, demonstrated that no method is completely sufficient to address the problem. Some researches resort to other sensing technologies which are less prone to illumination change than intensity images. Therefore, 3D sensors have been used to capture face range images which describe the depth of the scene objects. An alternative to 3D sensors is to reconstruct the face from 2D images by means of computer vision techniques and apply synthetic illumination to the 3D face model. Near infrared (NIR) sensors have also been investigated to overcome the face illumination problem. Thermal imaging is another sensing technology for handling face illumination change.

Both NIR and thermal images are inherently less sensitive to illumination change however the former is less efficient in outdoor strong NIR illumination conditions while the latter is affected by the temperature change and opaque to eye glasses.

2.4.1 Head pose and viewpoint change

Face analysis in uncontrolled situations is very di_cult because of uncooperative users. In face recognition for example, the uncooperative subjects try to fool the system by intentionally disguising. The face or parts of it may be covered using sunglasses, scarf, hat, fake face hair, etc. Many researchers attempted to handle such situations by proposing approaches that are robust to partial face occlusion. Subspace methods have been used to project the face into a new space and discard the occluded parts. Local face descriptors are shown to be more robust to partial face occlusion than the holistic approaches. Faces are usually partitioned into small blocks and each block is modeled separately. Since, the corresponding blocks are matched, only blocks spanning the occlusion will be affected. The sparse representation has been found to cope well with occlusions. Some other methods attempted to reconstruct the occluded face parts, while others (e.g.,) detect the occlusion and use only non-occluded parts for face analysis.

2.5 Applications and motivation

A key issue that motivates the ongoing and growing research on face analysis topics is the wide range of their important applications. This section gives an overview of current and potential face analysis applications.

2.5.1 Security

Security is a crucial concern of todays world with cross-countries terrorism threat. Face plays an important role in establishing security. One of the most important and worldwide spread applications is biometrics which aims at identifying or authenticating persons based on their physiological or behavioral traits. Along with _ngerprint, face is the most widely used biometric modality. Face biometrics are used in identity documents, such as passports, national identity cards, driving licenses, etc. Border control of immigrants is an other important issue for many countries where face-based identification is used to prevent illegal immigration. Other applications for face as a biometric include secure access to buildings, electronic devices,
e-commerce services,etc.

Surveillance is another important security issue where face analysis and recognition plays an important role. Surveillance cameras are today deployed everywhere and the automatic analysis of the huge data collected by these cameras is crucial. For instance, face recognition has been applied to identify the suspects of Boston Marathon bombings [14] by inspecting the data collected by the surveillance cameras around the place.

Face analysis finds also important applications [15] in forensics by analyzing evidences collected from crime scenes in order to reconstruct and describe events in a legal setting. For example, facial sketches created based on eyewitness description are of great use in law enforcement to help identifying suspects involved in a crime. Automatic matching of the drawn sketch against criminals databases may accelerate capturing dangerous criminals and hence preventing more crimes.

2.5.2 Social media analysis

Today, social networks are powerful tools that inuence many aspects of human life including culture, economy, politics, etc. Automatic analysis of the huge amount of daily shared data on social networks is very important for building strategies and future visions in various fields. Photos and videos of individuals, family, friends, group of people, etc. are among the most shared types of data in social networks. Therefore, developing effective automatic face analysis tools for analyzing, understanding and exploiting these data gained a remarkable attention these last years [16, 17, 18].

2.5.3 Human computer interaction.

To make human computer interaction more natural face [19], gesture and speech analysis have been extensively considered. Robots that read the facial expression of the person, deduce the actual emotion and react accordingly have been recently developed. Moreover, face analysis has been useful for user immersion in virtual reality and game applications. In another application, fatigue detection by analyzing car drivers face has been investigated to prevent car accidents.

2.5.4 Automatic health assessment

As human face holds information about the health status of the person, there were an interest in automatically assessing a person health by analyzing the face. Many works are inspired by traditional Chinese medicine. Automatic pain detection, which is useful for elderly people surveillance, has been the subject of many studies [20]. Researchers have also estimated the heart rate from face videos by inspecting the change in the face color [21]

2.6 Occlusion

Face analysis in uncontrolled situations is very di_cult because of uncooperative users. In face recognition for example, the uncooperative subjects try to fool the system by intentionally disguising. The face or parts of it may be covered using sunglasses, scarf, hat, fake face hair, et

2.7 Conclusion

In this chapter, we presented an overview of automatic face analysis. We discussed some exciting applications and attractive motivations for the continuous research in this topic. The generic face analysis owchart is depicted and its components are explained. We have also enumerated a number of practical challenges that restrain the face analysis problems. Throughout the chapter, the main milestones that marked the history of face analysis are briey presented.

Chapter 3: age estimation

3 Introduction :

As each person unique biometric features and since information like gender, approximate age, ethnicity, mood can be extracted, automatic age detection from facial images has uses in soft-biometric application, video surveillance for secure network system. Face recognition is a feature used in identification of documents like passports verification, driving license or student identity card. Age estimation can be used in human computer interactive system, like providing advertising content based on recognizing age groups of clients or in field of entertainment to sort people by age groups.

Age estimation process involves four steps: Pre-processing, feature extraction, clustering and age estimation.

3.1 literature review:

1. Age Estimation from Face Images: Human vs. Machine Performance[4] To lessen the influence of inconsistency facial images are converted to gray-scale. As there can be in-plane and out-of-plane face images non–reflective similarity transformation is done to normalize. Then images are cropped to same size and interpupillary distance. For facial component localization ASM (Active shape modal) is used to detect facial landmark. Pre- processing scaling is applied to compensate for differences in absolute component sizes. They have then extracted biologically inspired features from given images. Each facial component is then classified into four age group using SVM
2. Age Estimation from Face Images: Challenging Problem for Audience Measurement Systems[1] Once face detection is done color space transformation is done, image normalization is performed by histogram equalization and scaling is done then transformation to LBP feature space and SVM training is used for binary classification. Through binary output classifier direct age is detected. Metric like MAE (maximum absolute error), cumulative score (CS), probability density function for age estimation error is calculated.
3. Automatic Age Detection based on Facial Images[2] Images in database were converted to gray scale and then equalization. Parameterization was carried out by DWT (discrete wavelet transform), discrete cosine transform or local binary pattern (LBP). Here LBP shows good result in classifying other kind of samples by textures. The final step involves classifying, training, testing through SVM by inserting obtained parameters.
4. Automatic Age Estimation from Face Image[3] This paper has implemented age estimation of a person by analyzing wrinkles part in face. From dataset face part is cropped and part of face like eye, mouth, and nose region is extracted. Similarly forehead, Mid-eyebrows and eyelids

region is extracted. On this extracted region canny edge detection is applied so information about wrinkles can be known which will be edges in extracted region. Then feature value is calculated from faces and are classified using C-Means clustering algorithm. From this we get membership value through which age estimation is done.

5. Gender and age classification of human faces for automatic detection of anomalous human behavior[5] In this paper they used pre-trained CNN (convolutional neural network has 5 convolutional layers and 3 fully connected layers) as feature extraction and linear SVM (Support vector machine) as well as multi-layer neural network. This design contains 60 million parameters. Hence it is time- consuming and problematic.

3.2 APPROACH USED(ALGORITHM)

This project involves five stages: Face detection , feature extraction, clustering and SVM

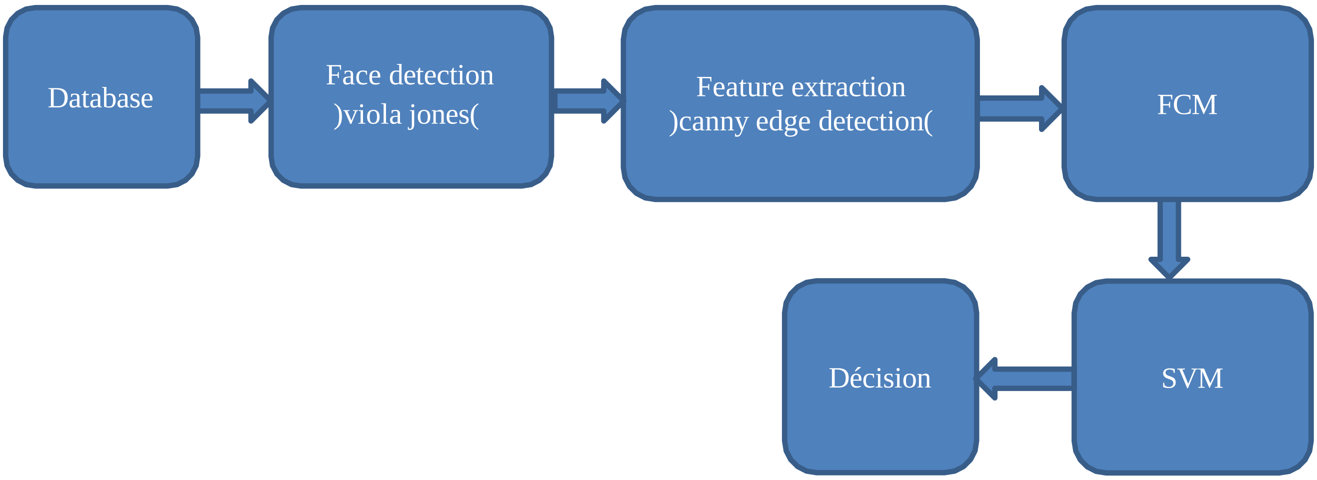

Fig. 3.1. Face recognition processing flow

3.2.1 FG-NET

FG-NET contains 1002 colored or gray images with variations in the resolution, quality, illumination, point of view and expression. There are 82 different topics including the age varies between newborns and 69 years. The average number of images per topic is 12 [22][23]

The picture also shows several people of different age groups

Fig.3.2 sample Images from FGNET dataset with age values

3.2.2 Preprocessing

Face is detected from given dataset and then are converted to same size that is 128x 128 pixels. Color transformation is done by RGB to grayscale transformation. Wrinkle area from are detected from face .

3.2.3 Feature extraction

To extract feature, through canny edge detection the wrinkles get detected in form of white pixels as canny edge detection gives binary image as output. Feature value is calculated as F= (number of white pixels in forehead area / number of pixels in forehead area) + (number of white pixels in left eyelid area / number of pixels in left eyelid area) + (number of white pixels in right eyelid area / number of pixels in right eyelid area) + (number of white pixels in mid eyebrow area / number of pixels in mid eyebrow area) [24]

3.2.4 Clustering

Using Fuzzy C-means clustering algorithm, wrinkle features are clustered. Each face image is assigned to a cluster based on maximum membership value. Then, estimated age is calculated from their membership values and average age of each cluster[24].

3.2.5 Support Vector Machine (SVM)

Support-vector machines or wide-margin separators (SVMs) are a set of supervised learning techniques for solving discrimination and regression[25] problems. SVMs are a generalization of linear classifiers.

3.3 Experiment results :

We have the entrance to the program is a picture and we first did the Preprocessing , and face detection by Viola John and the features extraction , and after that FCM logique flow, which gives us an age estimation , and in the end we introduced the support of vector machines in order to do this classification

- The results of detection on the face using Viola jones, As follows

Fig 3.3 The results of face detection using Viola jones

Depending on the figure 3.2 , We took different age groups and the purpose of work FCM I the face detection , We get the results as follows :

- **A** : Correct
- **B** : Wrong

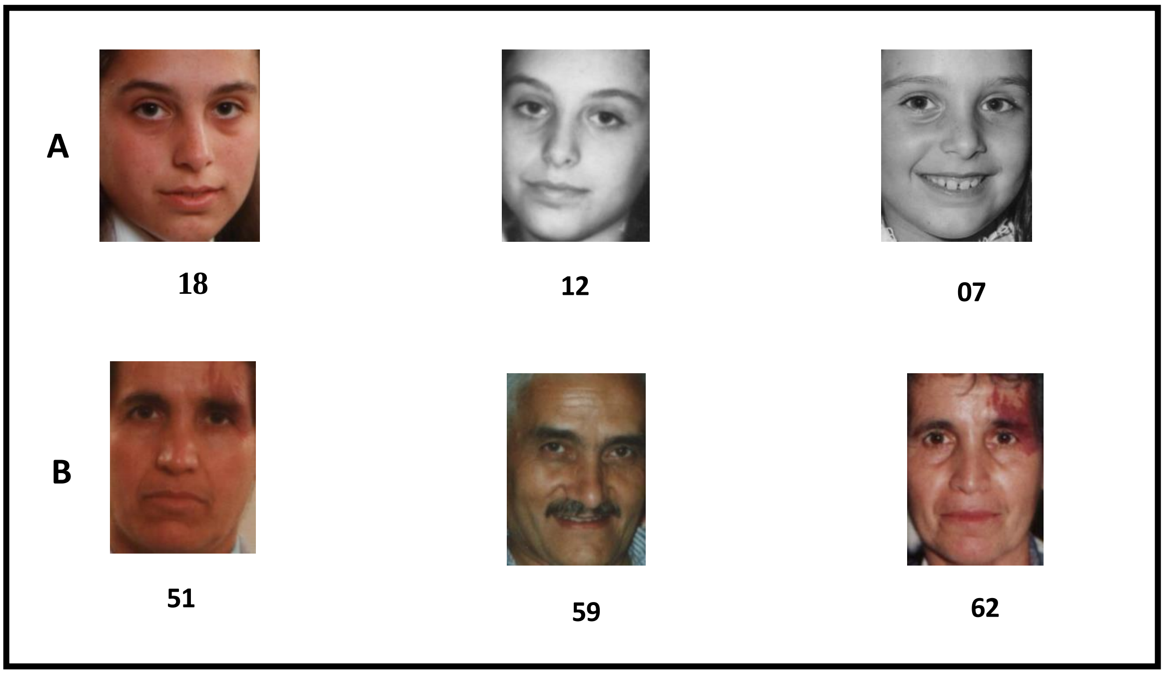

Fig 3.4: Results FCM

The purpose or objective is to assess the accuracy of the program in determining age

We divided the age groups into three :

- From 1 to 14
- From 15 to 29
- Bigger than 30

As shown in the table 3.2

Category	Accuracy
From 1 to 14	**95.34 %**
From 15 to 29	**90.96 %**
Bigger than 30	**85 %**
All	**90.12 %**

Table 3.1: Age estimation accuracy

3.3.1 Note :

- We note that the first from 1 to 14 category is the accuracy of determining age 95.34 %
- We note that the second from 15 to 29 category is the accuracy of determining age 90.96 %
- We note that the last bigger than 30 category is the accuracy of determining age 85 %

3.3.2 Extraction :

Hence, we conclude that the higher the age, the lower the accuracy of the age estimate

3.4 CONCLUSION

In this work, we propose age estimation and set up a system that determines age from front-face images. We evaluated the system and achieved the following percentages: the first category 95.34 %, the second 90.96 %, and the third 85 % .

The results obtained so far prove that it is feasible to produce in the short-term systems that incorporate automatic age estimation in their functionality, resulting in more efficient human machine interaction systems.

General conclusion

Biometric systems are proposed as a more secure alternative to classical authentication system based on knowledge or tokens. Behavioral and/or physiological characteristics, unique to each person , are collected to build the biometric data used in identification) facial analysis (. As a leading biometric identification modality since centuries , is widely adopted in many identification system thanks to its trade-off between other modalities in terms of acceptability, accuracy, security and low-cost technology. It largely enhanced their security aspects . In this master thesis , we were particularly interested in automated facial analysis systems. Although, these systems are now of mature technologies, some challenging issues need further improvements.

The generic face analysis owchart is depicted and its components are explained. We have also enumerated a number of practical challenges that restrain the face analysis problems. Throughout the chapter, the main milestones that marked the history of face analysis are briey presented.

The age estimate can be approached as either an age group estimate or an exact age estimate. The age range estimate approximates the approximate age range in which a face image can fall. That is why we have prepared a program that allows me to determine the age and we obtained acceptable results

The results obtained so far prove that it is feasible to produce in the short-term systems that incorporate automatic age estimation in their functionality, resulting in more efficient human machine interaction systems.

ANEXXE

Viola jones detection :

Viola-Jones' face detection algorithm was jointly proposed by Paul Viola and Michael Jones. Although it realized face real-time detection to some extent, its false detection rate is not low. Because the block features in the Viola-Jones algorithm can't handle purely rigid objects, such as chopsticks and cups, so if there are rigid objects in the face image, Viola-Jones' face detection algorithm is prone to generate false detection of faces. Viola-Jones technique [26] is based on exploring the input image by means of sub window capable of detecting features. This window is scaled to detect faces of different sizes in the image. Viola Jones developed a scale invariant detector which runs through the image many times, each time with different size. Being scale invariant, the detector requires same number of calculations regardless of the size of the image

The system architecture of Viola Jones is based on a cascade of detectors. The first stages consist of simple detectors which eliminates only those windows which do not contain faces. In the following stages the complexity of detectors are increased to analysis the features in more detail. A face is detected only if it is observed through the entire cascade. These detectors are constructed from integral image and Haar like features shown in figure 3.4

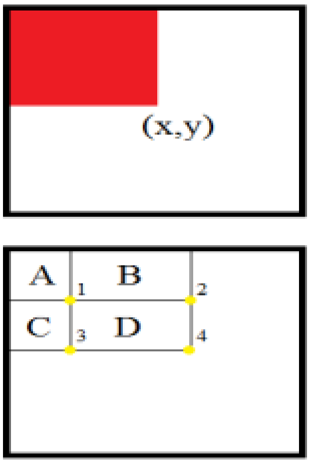

Figure 3.5 : Viola Jones integral image construction.

SVM :

A support vector machine (SVM) is a computer algorithm that learns by example to assign labels to objects. For instance, an SVM can learn to recognize fraudulent credit card activity by examining hundreds or thousands of fraudulent and nonfraudulent credit card activity reports. Alternatively, an SVM can learn to recognize handwritten digits by examining a large collection of scanned images of handwritten zeroes, ones and so forth. SVMs have also been successfully applied to an increasingly wide variety of biological applications. A common biomedical application of support vector machines is the automatic classification of microarray gene expression profiles. Theoretically, an SVM can examine the gene expression profile derived from a tumor sample or from peripheral fluid and arrive at a diagnosis or prognosis. Throughout this primer, I will use as a motivating example a seminal study of acute leukemia expression profiles. Other biological applications of SVMs involve classifying objects as diverse as protein and DNA sequences, microarray expression profiles and mass spectra.

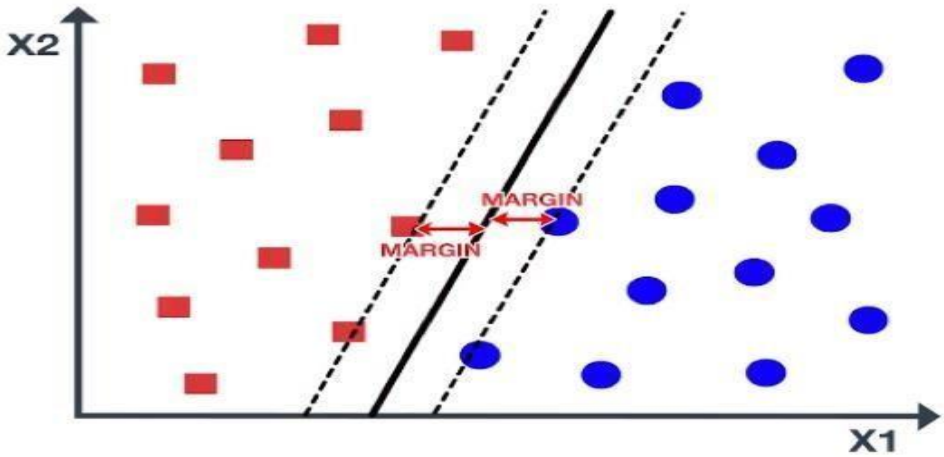

Figure 3.6: support vector machine

FCM :

Fuzzy c-means (FCM) is a clustering method that allows each point to data to belong to several clusters with varying degrees of membership.

In general, cluster analysis refers to a broad spectrum of methods which try to subdivide a data set X into c subsets (clusters) which are pairwise disjoint, all nonempty, and reproduce X. via union. The clusters then are termed a hard (i.e., nonfuzzy) c-partition of X. Many algorithms, each with its own mathematical clustering criterion for identifying "optimal" clusters, are discussed in the excellent monograph of Duda and Hart (1973). A significant fact about this type of algorithm is the defect in the underlying axiomatic model that each point in X is unequivocally grouped with other members of "its" cluster, and thus bears no apparent similarity to other members of X. One such manner to characterize an individual point's similarity to all the clusters was introduced in 1965 by Zadeh (1965). The key to Zadeh's idea is to represent the similarity a point shares with each cluster with a function (termed the membership function) whose values (called memberships) are between zero and one. Each sample will have a membership in every cluster, memberships close to unity signify a high degree of similarity between the sample and a cluster while memberships close to zero imply little similarity between the sample and that cluster. The history, philosophy

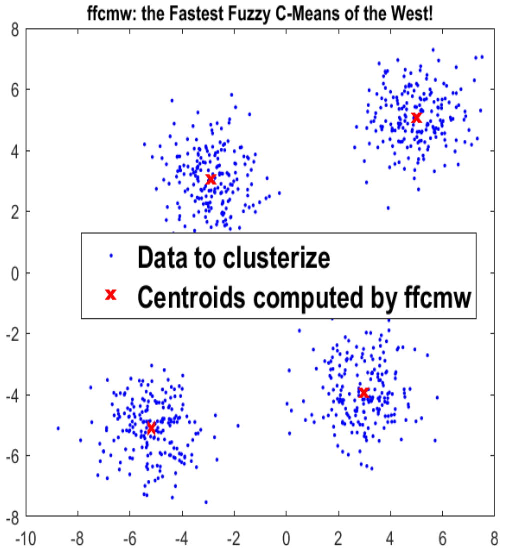

Figure 3.6 : The fastest fuzzy C-Means in the west

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