

A SURVEY ON FACE RECOGNITION TECHNIQUES

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ABSTRACT

The face is a significant part of the human body, recognizing people in enormous gatherings. Subsequently, on account of its all inclusiveness and uniqueness, it has turned into the most generally utilized and acknowledged biometric strategy. The space of face acknowledgment has acquired the consideration of numerous researchers, and subsequently it has turned into a standard benchmark in the space of human acknowledgment. It has ended up being the most profoundly concentrated on region in PC vision for over forty years. It has a wide exhibit of utilizations, including security observing, robotized observation frameworks, casualty and missing-individual recognizable proof, etc. This audit presents the expansive scope of techniques utilized for face acknowledgment and endeavors to examine their benefits and disservices. At first, we present the fundamentals of face-acknowledgment innovation, its standard work process, foundation and issues, and the likely applications. Then, at that point, face-acknowledgment techniques with their benefits and limits are talked about. The finishing up area presents the conceivable outcomes and future ramifications for additional propelling the field.

I. INTRODUCTION

The face is a fundamental piece of individuals that uncovers their novel personality, their feelings and their age, and through which cultural correspondence becomes conceivable. Biometric-based techniques, including facial acknowledgment, have arisen as the most encouraging and vigorous method for perceiving individuals as of late. The field of biometrics considers an individual's organic highlights, which are novel to that individual, and the data acquired is possibly helpful in human distinguishing proof. While it is generally simple for individuals to lie, biometric identifiers - that is, individual organic highlights, for example, imprints, faces, irises and fingerprints - are nearly safer and harder to take on the grounds that 'the body never lies', and it is undeniably challenging to adjust the biometric qualities.

Biometrics can be grouped into two sorts: conduct and physiological. Physiological biometrics differ from one individual to another and incorporate fingerprints, the iris, the face and hand math. Social biometrics, as the name recommends, are worried about the propensities and practices of an individual. Models incorporate their scent, signature, PC keystroke elements and their voice. The investigation of a few physiological and conduct biometrics, like ear, nose and keystroke elements, is currently at a somewhat beginning phase, and substantially more should be done to further develop innovations concerning them. Be that as it may, different biometric measures really do have a few downsides. For example, iris acknowledgment is profoundly precise yet isn't exceptionally financially savvy, while fingerprints can be effortlessly acquired yet are not appropriate for non-cooperative people. In contrast with other biometrics, the face is broadly acknowledged as a dependable biometric boundary. The degree of exactness of acknowledgment through biometrics with respect to a few properties, like collectability, all inclusiveness and agreeableness, is high for the face when contrasted with other biometrics, a key explanation being that everybody has a face, and it is by and large promptly in plain view.

In face acknowledgment, an individual is perceived utilizing a computerized facial picture, this having been the focal point of exploration for over 10 years, inside an exceptionally dynamic examination local area. An individual is perceived based on specific facial elements which are interesting to them. As indicated by a report by the National Institute of Standards and Technology (NIST) on the various biometric assessments of the 2010 Face Recognition Technique, which is viewed as the most exact procedure for face acknowledgment, the pace of distinguishing an obscure subject is around 92%. This level precision is arrived at when the inquiry is done against an information base considering of 1.6 million faces.¹ However, in a new update in 2018, NIST recommended that the exactness of facial-acknowledgment programming is expanding extraordinarily, with

the precision of programming to recognize the photo of an individual with an alternate photo of a similar individual in the data set appearance a decreased mistake pace of 0.2%.

There are a few elements liable for the quick development of face acknowledgment, including the dynamic creation and accessibility of enormous face data sets, the advancement of calculations for face acknowledgment and the development of techniques utilized for approving the exhibition of these calculations.

II. METHODOLOGY

BACKGROUND

Mechanized facial-acknowledgment innovation is a generally new idea. It emerged in 1960s, when the primary semi-mechanized framework for facial acknowledgment was created. It depended on a technique by which facial highlights were situated by the spectator on the photos of the subject. In the subsequent stage, explicit to a reference point, distances and proportions were determined, which then, at that point, empowered correlations with be made. The reference point was normal for all facial highlights.

The space of computerized facial-acknowledgment innovation was established by Woody Bledsoe, Helen Chan Wolf and Charles Bisson. In 1964-1965, they cooperated to perceive human faces utilizing a computer. In the 1970s, 21 subject-explicit elements, for example, lip thickness and hair tone, were utilized for computerized facial recognition. The issue with this methodology, nonetheless, was that the estimations were taken and determined physically. In 1988, the main part investigation (PCA) technique was applied by Sirvoich and Kirby to attempt to tackle the facial-acknowledgment issue. This was believed to be a defining moment in the realm of face acknowledgment, as it demonstrated to code and standardize a facial picture precisely, and less than 100 qualities were required. In 1991, Turk and Pentland found that while executing Eigenfaces technique, the remaining blunder could be utilized for facial acknowledgment. This disclosure empowered the unwavering quality of a computerized facial-acknowledgment framework, albeit the methodology was confined by natural conditions.

In 1997, ZN-Face programming was created and popularized. The product did what was necessary perceive facial pictures with impediments, in any event, including pictures that were not entirely front facing. In the present field, this innovation is generally utilized in picture handling and example acknowledgment, and has turned into an area of dynamic exploration.

Today, a few endeavors are likewise being made to concentrate on true facial-acknowledgment challenges. In addition, the effect of side appearances on facial acknowledgment has additionally as of late turned into a functioning area of examination, albeit the exactness of this is simply half to date. Notwithstanding, in one ongoing review, the significance of one profile of the face was featured, showing that the responsiveness and particularity of human recognizable proof through this approach has expanded altogether.

Workflow of a facial-recognition system

1. Catching a picture: The caught picture is otherwise called the test picture. The picture might be caught through a still or CCTV camera, with or without the subject's information.
2. Face recognition: In this progression, the substance of the subject is distinguished from the whole picture caught.
3. Highlights extraction: In this progression, from the distinguished face, the particular and exceptional elements are extricated to coordinate them with the relating pictures in the data set. In this progression, a face layout is produced.
4. Coordinating: The coordinating of the layout picture with the information base pictures is finished. Assuming the facial highlights match, confirmation of the individual is finished.
5. Check/ID: These are the two primary errands of face acknowledgment. The last advance includes distinguishing the person. On the off chance that check is the point, a 1:1 match is done, and for distinguishing proof, a 1:N match is finished.

After face discovery, the distinguishing proof of the individual is the last advance in face-acknowledgment frameworks, and 1:1 matching is done to empower individual ID. In one review, the face-acknowledgment framework was proposed to distinguish an individual with regards to an instructing help. The framework

depended on the correspondence between a static server and a moveable gadget, and gave a precision pace of >95%. The strategies given by Open Source Computer Vision Library were utilized for the face-location acknowledgment. The individual distinguishing proof depends on the face-discovery capacities of the pre-owned acknowledgment calculations.

Applications of face recognition

Face acknowledgment has been, and stays, the main examination area of PC vision, having caught the consideration of the two analysts and industrialists. Law authorization regions: So-called mug-shot collections (static coordinating) and video reconnaissance (continuous matching by video picture successions).

1. Security access control: Face acknowledgment is profoundly taken advantage of in regions where access is exceptionally secure and allowed uniquely to explicit individuals. To acquire section to such places, face-acknowledgment innovation is utilized. Chui - the facial-acknowledgment doorbell - is being created by Trueface.ai using the methods of profound learning for misrepresentation recognition and separating a human face from a photo.
2. Reconnaissance frameworks: Nowadays, countless CCTV cameras have been sent at significant areas to help with distinguishing guilty parties. From recordings caught by CCTV cameras, the individual can be perceived from their face. In a few superstores, for example, Walmart, levels of robbery have diminished by practically 30% as advancements, for example, Face First can identify a client's face from a distance of 100 feet.
3. General character confirmation: Today, various significant individual records, for example, public distinguishing proof cards and identifications, utilize facial pictures of the individual, which have been caught to lay out their personality.
4. Picture data set examinations: For the situation of missing-individual distinguishing proof, photos can measure up to existing information bases to lay out a singular's character.
5. Portable and PC applications: Face-acknowledgment innovation is broadly involved these days in cell phones and PCs, instead of pin numbers and passwords, to get a singular's information.
6. Measurable science: Facial acknowledgment is an important instrument and a fundamental subject of study in the field of scientific science. It is a significant errand completed physically by criminological researchers when no robotization is free. This can be useful for law authorization, as well with respect to reasons for correlation.
7. Different: This remembers the distinguishing proof of individuals for medical clinics, police offices or courtrooms as a wellspring of proof.

Problems with face-recognition algorithms

Since it was created, the area of facial acknowledgment has frequently needed to conquer deterrents, there being a few elements which make exact acknowledgment a difficult undertaking, as laid out beneath:

1. Brightening: Variable lightning conditions can have various impacts on an individual's facial picture.
2. Represent: The issue of posture has been recognized as a central point of contention in face acknowledgment, and it has been the subject of much interest among the exploration local area in ongoing many years.
3. Impediment: Amongst many issues related with precise facial acknowledgment, taking care of facial impediment is one of the serious issues. When any piece of the face is blocked, facial elements can't be completely seen, and hence validation by the facial-acknowledgment framework is in danger.
4. Looks: Human faces generally contain demeanors of some sort, these being for the most part supported by the passionate condition of the person. Face-acknowledgment frameworks are additionally impacted by human appearances, which result from development of the facial muscles, prompting changes in facial pictures. Nonetheless, some face-acknowledgment frameworks can't handle various demeanors by a similar individual, implying that an issue can emerge with recognizable proof.
5. Hair: Hair frequently covers the temple. Henceforth, in most face-acknowledgment frameworks, information base pictures have hair killed to keep it from going about as a hindrance to the acknowledgment of countenances. Research is being attempted to attempt to tackle this issue.

6. Age: With the movement old enough, the facial elements can change massively. This area of examination is, notwithstanding, currently at a beginning phase, and substantially more should be finished.

The Project performed at The Bundeskriminalamt

The undertaking 'Face acknowledgment as an inquiry device - Foto-Fahndung', completed in 2007, meant to utilize facial-acknowledgment innovation to distinguish people. Its primary points were to survey industrially accessible face-acknowledgment frameworks for extricating faces from the group, and to evaluate the acknowledgment capacities of the accessible face-acknowledgment calculations as respects their capacity to contrast live caught pictures and static reference pictures progressively. The tests uncovered that the outside natural states of enlightenment and development impacted acknowledgment capacity undeniably, and acknowledgment precision of up to 60% was accomplished in the basic task, with a bogus acknowledgment pace of 0.1%. The outcomes likewise show that higher acknowledgment rates could be accomplished assuming the caught pictures were front facing. Accordingly, the consequences of the task plainly show that acknowledgment accuracy and likelihood are exceptionally reliant upon outside factors. In addition, the end-product of the task featured that 3D mechanized facial acknowledgment can contribute in further developing the imaging innovation and limiting the impacts of elements, for example, head slant and turn, which to a great extent impede the framework's acknowledgment capacities.

The 3D Face Project

Under the particular program 'Coordinating and fortifying the European examination region') in 2006, and it proceeded until 2009. The fundamental point of the undertaking was the combination of 3D face-acknowledgment innovation with the 2D face-acknowledgment strategies to further develop by and large biometric execution. The undertaking additionally planned to safeguard the security of 3D biometric formats.

Face-recognition methods

A few face-acknowledgment calculations have been created in the beyond couple of many years. A portion of the usually utilized techniques are talked about beneath. Notwithstanding, crossover approaches for face acknowledgment should be followed and applied for further developed face acknowledgment.

Information based strategies

These are likewise well known as the 'rule-based strategies'. In these strategies, endeavors are made to catch the information on countenances and afterward thusly they are converted into a bunch of rules. For example, there are facial highlights that are evenly found and furthermore regions on the face that contrast in power. The greatest trouble with information based techniques is in the definition of a proper arrangement of rules, which should be neither too broad nor too detailed. A conceivable answer for conquering these issues is to foster various leveled information based strategies. Nonetheless, on account of intricate pictures, this technique can't work productively. A hearty technique ought to be utilized to beat this trouble.

In specific past calculations that have been created, a triumph pace of 94% was shown, even in complex photos having numerous faces. It turned out proficiently for basic info pictures. Nonetheless, in specific circumstances where the face invariant highlights are not apparent, this strategy neglects to work effectively. The accompanying boundaries were picked to recognize skin shading pixels

$$0:4 \leq r \leq 0:6; 0:22 \leq g \leq 0:33; r > g > (1-r)/2 \quad (1)$$

$$0 \leq H \leq 0:2; 0:3 \leq S \leq 0:7; 0:22 \leq V \leq 0:8 \quad (2)$$

where r and g determine the red-green-blue shading model, and H, S and V indicate the tint immersion esteem shading model. Nonetheless, as to enlightenment, skin tone can change extensively. Thus, the strategy can't be viewed as an ideal face-acknowledgment calculation.

Layout coordinating

This is an underlying endeavor to recognize faces by taking into account just specific areas addressed in layouts. The pixels of the information picture are analyzed against a layout picture utilizing a measurement measure, for example, Euclidean distance. In the underlying endeavors, a bunch of four elements - eyes, nose, mouth and entire face - were chosen from a format and applied to all the accessible faces. In format coordinating, the area of the info picture is contrasted with the pictures in the data set for every layout. At long last, the matching scores are determined, and the acknowledgment choice is made based on it. High exactness

paces of 90% have been accounted for, furthermore one vital benefits of this strategy is that its 134 Medicine, Science and the Law 60(2) execution is straightforward, despite the fact that it is unseemly for varieties in posture and brightening.

Appearance-based strategies

This strategy is a type of layout matching in which formats are taken from the arrangement of models in the pictures. By and large, this strategy depends on procedures from measurements and AI to observe the particular attributes of face pictures.

Eigenface-based strategies PCA calculation

The most notable and broadly acknowledged strategy for perceiving faces is known as the Karhunen-Loeve technique. It is the most completely read up strategy for face acknowledgment, with its primary convenience being a decrease in the dimensionality of the picture. It was first utilized for face acknowledgment and afterward applied to confront recreation. For PCA to be utilized, the layout and the display pictures should be of a similar size and should initially be standardized to agree with the eyes and mouth of the subjects in the pictures. Then, at that point, utilizing the nuts and bolts of information pressure, the components of the information are decreased. In this progression, the data that isn't helpful is diminished, and the face structure is precisely reduced into uncorrelated parts known as Eigenfaces, which has less dimensionality space. Each facial picture might be addressed as a weighted total (include vector) of the Eigenfaces, which are put away in a one-layered exhibit. Then, at that point, the examination is made between the display and the test pictures based on the distance between the component vectors. The essential benefit of this strategy is that it decreases the information by the 1000th time. In addition, this strategy is extremely quick, as it is utilized distinctly for preparing the example. Notwithstanding, this approach requires a full front facing picture of the subject's face, and continuously circumstances, this seldom occurs. Moreover, the inside class helpless separation power is perhaps the most serious issue with the PCA technique.

Linear discriminant study

linear discriminant study, additionally commonly known as Fisher's discriminant examination, is the dimensionality decrease procedure. Among appearance-based techniques, LDS is utilized for highlight choice. The impediments of PCA technique are utilizing this strategy. Of all appearance-based strategies, LDS is the most generally involved and reasonable method for include choice. Like PCA, it depends on Euclidean distance. It is a regulated technique, and dissimilar to PCA, it involves the mark data for improving distinguishableness between various classes. Moreover, it additionally plans to limit the variety inside class. In a few LDS-subordinate face-acknowledgment draws near, at first, PCA is utilized for dimensionality decrease, and afterward LDS is applied to augment the separation force of element choice. This technique has demonstrated its worth in face acknowledgment, following and identification. This technique doesn't address high-request measurable conditions, for instance relationship among numerous pixels. However, LDS experiences the issue of little example size. It ought to without a doubt have huge examples for great separation of highlights extraction. Thus, the extraction of segregating highlights is poor.

Discriminant normal vectors

This strategy is essentially the following stage to LDS. The idea driving discriminant normal vectors is that it targets gathering the likenesses among the components which have a place with a similar class and limiting the dissimilarities. Henceforth, as such, each class can be addressed by a typical vector, which is figured from inside the dissipate grid. For acknowledgment of an obscure face, the component vector is registered, and it is related to that class which has the closest normal vector.

Independent part study

This strategy is reasonable for tracking down factors from multivariate factual information. In frameworks that generally existed, there was a hole, in that they were not reasonable for facial pictures which had various conditions, for example, factor facial directions, stances and brightening conditions. This approach searches for parts that are non-Gaussian and measurably free. In autonomous part investigation (IPS), prior to ascertaining the free parts, every facial picture is at first changed into a vector. This technique has been utilized with a few different models for face acknowledgment. IPS has demonstrated to be a more impressive technique than PCA,

as it intends to give autonomous picture deterioration and portrayal, not at all like PCA where the facial picture parts are isolated into uncorrelated individual parts. Free head part investigation/autonomous part examination (IPCA-IPS) has been illustrated, and it ended up being exceptionally productive. IPCA-IPS additionally had a higher achievement rate contrasted with a few different strategies, for example, Eigenface, Fisher face and Fast IPS techniques. IPS is considered as a speculation of PCA, however it gives a few benefits over PCA, which incorporate prevalent characterisation of information and catching separating factors by thinking about high-request measurements. For facial character, most likely IPS outflanks PCA, however among IPS, IPS design II has worked on the presentation of IPS

engineering I.

Elastic bunch graph matching procedure:

This procedure depends on unique connection structures. In flexible bundle chart coordinating (EBGM), a diagram is produced for every individual face. On the face, explicit hubs, known as fiducial places, are chosen. These are portrayed by frequency parts (jets). Each fiducial point is named with Gabor channel reactions applied to a window around each fiducial point. Such charts are consolidated into a stack known as a face bundle diagram. Whenever this is produced, new face pictures can be created utilizing EBGM. In the acknowledgment stage, two picture diagrams are basically looked at. The upside of EBGM over previously existing direct examination techniques is that it considers a few non-straight qualities, like enlightenment, posture and articulation. The acknowledgment rate can reach up to 98% utilizing this strategy, and a few varieties of this approach have likewise been given. The localisation of tourist spots with precision is very troublesome utilizing this strategy. It requires huge facial picture sizes, which can be hard to acquire in genuine circumstances. For instance, in reconnaissance frameworks, the region of the face in the picture is minuscule. In an as of late proposed a technique, manual arrangement of the chart isn't needed. This is finished by utilizing parametric models in view of deformable formats.

Neural networking:

The answer for the issues experienced in straight strategies was given by a few non-direct techniques like neural organizations. Essentially, a net is considered with a neuron in each pixel. The element extraction step is more effective than direct strategies in view of the non-linearity of the organization. Utilizing this technique, a precision pace of 96.2% was accounted for. The preparation time is more contrasted with characterization time. Neural organizations have been joined with various models, like Hidden Markov Models (HMM) and Gabor channels. A semi-directed technique was utilized for perceiving the human face. The specialists involved solo strategies for include extraction and managed techniques for observing those highlights which can diminish grouping blunder. They utilized feed-forward neural organizations for arrangement. The probabilistic choice based neural organization was displayed for three unique perspectives: face identification, eyes localisation and face recognition. A crossover approach was presented in which PCA was at first utilized for highlights extraction and afterward the result was utilized as a contribution to a spiral premise work neural organization. This technique turned out effectively for face acknowledgment. The over-fitting issue was experienced by the creators. The specialists proposed another class of convolutional neural organization. In this, the handling cells are shunting inhibitory neurons. Prior, these neurons have been utilized in customary feed-forward engineering for order and non-direct relapse. They had been ended up being more remarkable than fluffy multi-facet perceptrons (MLPs). A methodology was proposed for face acknowledgment carrying out the idea of a fluffy MLP. The principle point of the methodology was to catch choice surfaces in non-direct manifolds. This work wasn't possible by a straightforward MLP, and subsequently it was joined with the neural organization. The essential and the main benefit of the neural organization is its capacity to catch the mind boggling class of face designs. Notwithstanding, when the quantity of classes expands, it becomes hard to carry out neural organizations. Also, this approach isn't appropriate for a solitary model.

DL AND AI:

In this innovative field, the procedures of ML, DL and AI consciousness have therefore affected and impacted the wide exhibit of everyday administrations and sensible tasks. Indeed, even in the area of facial acknowledgment, they have hence demonstrated to have a vital effect. In a new report, a calculation to decide the experience of clients at a café with no staff was created. Based on articulations, the food and climate are

evaluated. The framework uses the pre-prepared convolutional neural organization (CNN) models. In a comparable report, utilizing CNN models and by applying profound learning draws near, feeling acknowledgment was performed from general media enthusiastic large information.

Support vector machine

Support vector machines (SVMs) are by and large the straight classifiers which expand the edge between the choice hyperplane and the preparation set. This is accomplished by finding a hyperplane that isolates and augments the separation from any of the class to the hyperplane, where a bunch of focuses have a place with two distinct classes. Subsequently, an ideal hyperplane should work by limiting the grouping mistake of the concealed test designs. In the first place, include extraction is finished utilizing PCA, and afterward segregation between the elements is cultivated utilizing SVMs. The benefit of SVMs over other old style approaches is in the way that they can accomplish further developed execution.

Different strategies:

- Notwithstanding these fundamental strategies for face acknowledgment, a few other different techniques and models have additionally been proposed by different specialists. These strategies have involved a combination of a few standard methodologies for face acknowledgment.
- A MATLAB-based strategy for face acknowledgment was created in the current ten years. In this technique, a picture based methodology is introduced, which eliminates repetitive information from the facial pictures. This is accomplished utilizing 2D discrete cosine change (DCT), a well known procedure applied first for picture pressure. When applied on an info arrangement, DCT disintegrates it into a weighted amount of cosine groupings. The fundamental benefit of this technique is its low computational prerequisite and high handling speed.
- SVM is likewise being utilized for the assignment of facial acknowledgment, as it gives the answer for issues of little direct example and non-linearity. Fundamentally, a strategy was proposed in light of SVM and molecule swarm improvement (PSO-SVM). It was demonstrated that face-acknowledgment exactness of PSO-SVM is higher than ordinary SVM and a few different models.
- A clever technique for face acknowledgment was proposed in which the first picture is incorporated with the perfect representation for facial acknowledgment. The principle thought behind the strategy is that the utilization of identical representations defeats the issue of facial misalignment, which is an issue in face acknowledgment. Additionally, it is likewise ready to outperform the impacts of posture and enlightenment, which are the primary issues in face acknowledgment. Tests demonstrate that this idea enormously works on the accuracy of portrayal based grouping (RBC) strategies.
- A review proposed a technique for face acknowledgment in light of polynomial coefficients, covariance lattice and normal Eigenvalues. A particular benefit of this technique is that it doesn't need computing genuine Eigenvalues and Eigen vectors. It has ended up being successful in highlight extraction and in invalidating issues of brightening and posture.
- Another review showed a strategy for face acknowledgment which melded two virtual examples for little example face acknowledgment. This technique defeated the issue of the little example and has been demonstrated to have the best acknowledgment exactness among RBC strategies.
- Analysts additionally proposed a technique for combination of discrete wavelet change and DCT approaches. The proposed plot utilizes the numerous extraction instruments for the component extraction from the information (for example 2D face profundity information), and the acquired blunder scores are combined to get a higher acknowledgment rate.
- Another methodology known as the scanty unique mark order calculation shows that when the size of the informational index is little or medium (for example not more noteworthy than 100), this calculation is productive in managing the fluctuation in a few boundaries like light, impediment, posture, articulations, etc contrasted with other present status-of-the-workmanship calculations.
- One-state HMM models have additionally diminished the intricacy of computational techniques and ultimately prompted an improvement in face-acknowledgment frameworks, giving 100 percent precision, demonstrated by research facility reproduction results in spite of the presence of 25% and half commotion levels.

III. CONCLUSION

This paper has portrayed ongoing turns of events and progressions in the area of facial acknowledgment, as well as talking about a few facial-acknowledgment calculations. The face has arisen as a helpful biometric in view of its wide scope of uses. Individual recognizable proof through facial acknowledgment has gone through significant advancement in late many years, including a proposition with respect to confront acknowledgment from human DNA. Facial-acknowledgment innovation proceeds to create, and simultaneously, a few human face writing information bases have additionally been creating. A few face-acknowledgment calculations and models have likewise been created, with a lot more in progress. As issues of safety and validation are expanding step by step, face acknowledgment fills in as one arrangement. Albeit a few face-acknowledgment calculations have been proposed, powerful face acknowledgment stays a difficult undertaking, and further examination is expected around here.

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