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A Dynamic Facial Recognition System Using Control Analytics

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Abstract

Advances in facial recognition system as reached the stage where it is capable of matching a person's face from a digital image or a video sequence against a database of unrecognised faces which are typically employed to base authentic user through ID verification services, by mapping facial features from a given image. One of the obstacles related to the angle view of the face is the twenty degrees off of frontal faces, which are obtruded when one goes towards the profile, its low-resolution face images are sometimes difficult to verify. To tackle the problem of inconsistency, this paper adopts the use of a time state-space model for real-time facial recognition as a form of intelligent analytics that produces a pass and the cognitive state of the user during a scan. This process is based on two modules: (1) real-time image capture by the camera port of a PC and (2) embedding a dynamic control to the analytic tool for easy verification and evasion of false case detection.

Keywords: *Facial recognition system, video sequence, low-resolution face images, intelligent analytics, state-space model, real-time facial recognition*

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1 INTRODUCTION

One of the obstacles in the face recognition system is mostly related to the viewing angle of the face, such that it has been proved to exact with full frontal faces at 20 degrees off, but when it's turned towards and off profile, error inset is recorded. The pose variations in its angular settings have a low-resolution facial image and are hard to recognize. In face surveillance systems, this is one of the main obstacles. If facial expressions vary, the face recognition aspect is less effective, for instance, a subtle smile on the face can render the system less effective and in such a case, a neutral facial expression is often allowed for a static face recognition session. Also, there is inconstancy in the input datasets used by some research *(Gilani and Mian (2018); Berretti et al. (2014); Hashimoto et al. (2016))*, due to these obstacles and inconsistencies.

In the early 60s development began on facial recognition systems by using computer applications for rationalizing face recognition series, their inception has seen wider and demographic use of smartphones in recent times and related smart technology that includes robotics. It involves the measurement of human physiological characteristics that recognises certain subtle features of the face based on pattern predictions as a biometric attribute. Though the accuracy of the system as a form of biometric technology is less in iris recognition and other forms of fingerprint, is now widely adopted because of its contactless procedures. The technology in face recognition tools have been deployed in most advanced human-computer interaction (HCI), virtual automatic indexing and video surveillance.

They are employed throughout every region such as government sectors and most private companies.

Some of the systems have previously been ruled out because their effectiveness varies and some have been scrapped due to ineffectiveness. Certain aspects such as violation of citizens' privacy are of its controversial and commonly producing errors in identifications is one of the drawbacks, others such as gender norms and racial profiling cannot be used to protect the biometric data. Some of these errors have led to the ban of these systems in some countries. These give room to encourage and develop a more advanced and reliable system for authentic facial recognition systems embedded with the user's consent.

2 LITERATURE REVIEW

The performance metrics of the latest face recognition models were put to an evaluation in early 2006 when high-resolution facial images in 3D scans were used as test samples *(Gilani and Mian (2018); Berretti et al. (2014); Hashimoto et al. (2016); Deitke et al. (2024); Rai et al. (2024))*. The output indicated that the new model is ten times more accurate than the models of 2002 and also a hundred times more accurate than that of 1995. Most of the algorithms were able to outperform the human subjects used in detecting faces with subtle features and can uniquely detect subjects who are twins *(Fyffe et al. (2014); Crouch et al. (2018); Ramachandra and Busch (2017); Claes et al. (2011))*. The most significant feature of these models is that is can easily perform facial detection and do not require the cooperation of the test participant to work. And it can easily identify individuals in a crowd without passers-by being aware of the system. As compared to other facial recognition methods, it may not be reliable and efficient when it lacks the user's consent.

Quality in the measure is very important since a large degree of variations can be possible in facial images. Illumination in expression, pose and noise during face capture can also affect the accurate performance of the system *(Wechsler (2007); Ferrara et al. (2016); Dantcheva et al. (2012a); Ranjan et al. (2019))*. And it is recently proven to have the highest rate of false acceptance and rejection rates due to some of these drawbacks. The paper tends to look at these aspects and derive a stable method that recognises subtle expression using time-invariant state-space models for physical systems that embed a user consent and authentication, these methods are discussed in section 3. Current weaknesses and shortcomings are discussed briefly in this section that paving the way for the method adopted for this paper. In some research, facial detection systems have been put to criticism for their classification based on a binary gender assumption. That is, when classifying the facial features, its weakness lies in misinformed gender identities such as the gender identity of transgender and binary individuals *(Cheung et al. (2020); Fiani and Han (2020); Galupo et al. (2017); Darwin (2020); Markman (2011); Tatum et al. (2020); Chew et al. (2020))*. The identity of these groups of people is being upheld by the systems information module and hence accidental misgendering of people is false predictions and error-prone to facial recognition concepts.

Criminal identification of often miscalculated and cannot detect a single criminal is detected in a database with a list of criminals and part of criticism made by the London Borough of Newham scheme, despite its operation for several years. Other research centres such as that of the local police department in the region of Tampa, Florida also had similar problems and disappointing results. Despite these shortcomings, other results from Facebook have scored higher accuracy with 974% compared to individuals' benchmark of 98.5%. Sometimes systems having high accuracy of 100% is often misleading since studies often use small sample sizes than necessary for large scale applications such as an embedded standalone of the kind designed in this paper. Since the accuracy in facial recognition systems is not 100% accurate it likewise creates a list of potential matches that feats the input image, which is then accessed by the system operator for potential and accurate matches *(Anwarul and Dahiya (2020); Dantcheva et al. (2012b); Cook et al. (2019); Lohr (2022))*. This also could bring about a mismatch in targeting the wrong suspect. One of the contributions of this work is to try to consider these issues by applying a single time-invariant state-space model for predicting behaviour patterns of real-time images and detecting the best matches from a list of potential matches. The resultant accuracy both in system performance and details about the bits fit is displayed in a separate window (Figure 1).

3 METHOD

For the foreground and background detection, three main cascaded areas are used with a single centroid, the first circle captures the head region to the eyes, the second region captures the head region to the nose while the third region captures the head region to the lower region of the face based on the following equation:

$$f(x) = \left\{ \begin{array}{ll} \iint_{x=i}^{N} dx_e - C & dx_e \leq dx_c \geq h \\ \iint_{x=i}^{N} dx_n - C & dx_n \leq dx_e \geq h \\ \iint_{x=i}^{N} dx_c - C & dx_c \leq dx_n \geq h \quad \forall x \epsilon N \end{array} \right\} \tag{1}$$

Where C is the centroid of the head, x_e is the distance of the eyes from the centroid,x_n is the distance of the nose region to the centroid and x_c is the distance of the centroid to the lower part of the face. This forms the cascaded region in the form of a circle around the

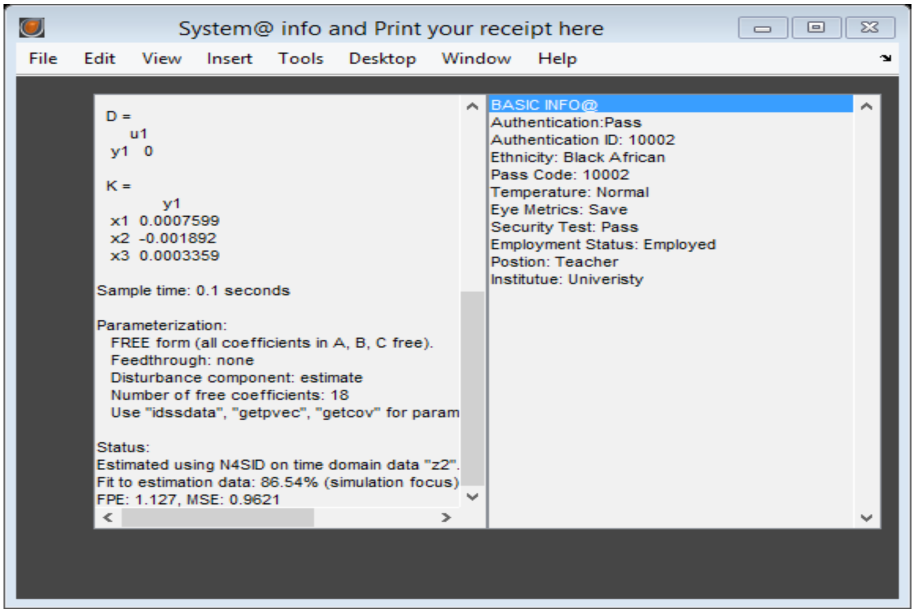

Figure 1: Resultant information about the system's performance and detailed information on the best math.

face from the input matrix. The time-invariant state-space model (Equation 2) predicts these locations with accuracy with minimal error due to its robust nature.

$$\frac{d(y+C)}{dx} = A\frac{du}{dx} + B\frac{dv}{dx} + C; \quad y = D\frac{du}{dx} + E\frac{dv}{dx} \tag{2}$$

Where A, B, C, D and E are constant parameters due to noise and angular position of the face, u and v are the input matrix while y is the resultant matrix for each predicted centroid. The rationale for using this process is that it has been known for its accurate performance on physical systems and can be adapted for both complex problems involving human personality and behaviour analytics. The scanning speed takes up to 64 bits for a 5000 x 5000 *dpi* optical resolution for each input image and this process follows a polar coordinate depending on the speed limit for each image detected.

4 RESULT

Figure 2 shows the resultant image scan for a given input image, the system information also displays the model equation and accuracy for each scan; this is also an additional proof of the authenticity of the result and pass produced by the system. Information produced by the system on the identified image can also be mapped and printed out provided these details are available online. A blank and unknown entry is given for a profile and could be traced to an image with no available information online or with error detection. The polar scan for both the foreground and background images is also likely to be similar with a slight difference in color phase.

The detection resolution of based on polar coordinates, a solution that revolves around the use of multiple angles for polarization (Figure 3) that enhances surface normal collected by the in-depth sensor of the device containing the tool. The link with the camera-less follows a static resolution which is the same as any advanced camera lens used for image capture in real-time. This is also applicable for good detecting focus and obstructing images detected that result in a false image match.

5 CONCLUSION

This paper seeks to investigate real-time facial recognition using dynamic control intelligent analytics that predicts the image match from a database of images online. Details about the exact match are also available if the information about the individual is provided online. As compared to other facial recognition methods, it may not be reliable and efficient when it lacks user consent. Quality in the measure is very important since a large degree of variations can be possible in facial images. Illumination in expression, pose, and noise during face capture can also affect the accurate performance of the system. It is recently proven to have the highest rate of false acceptance and rejection rates due to some of these drawbacks. The paper tackled this by integrating a dynamic control system that can detect with maximum accuracy based on a polar scan. This is one of its main contributions which would be modified for future perspectives.

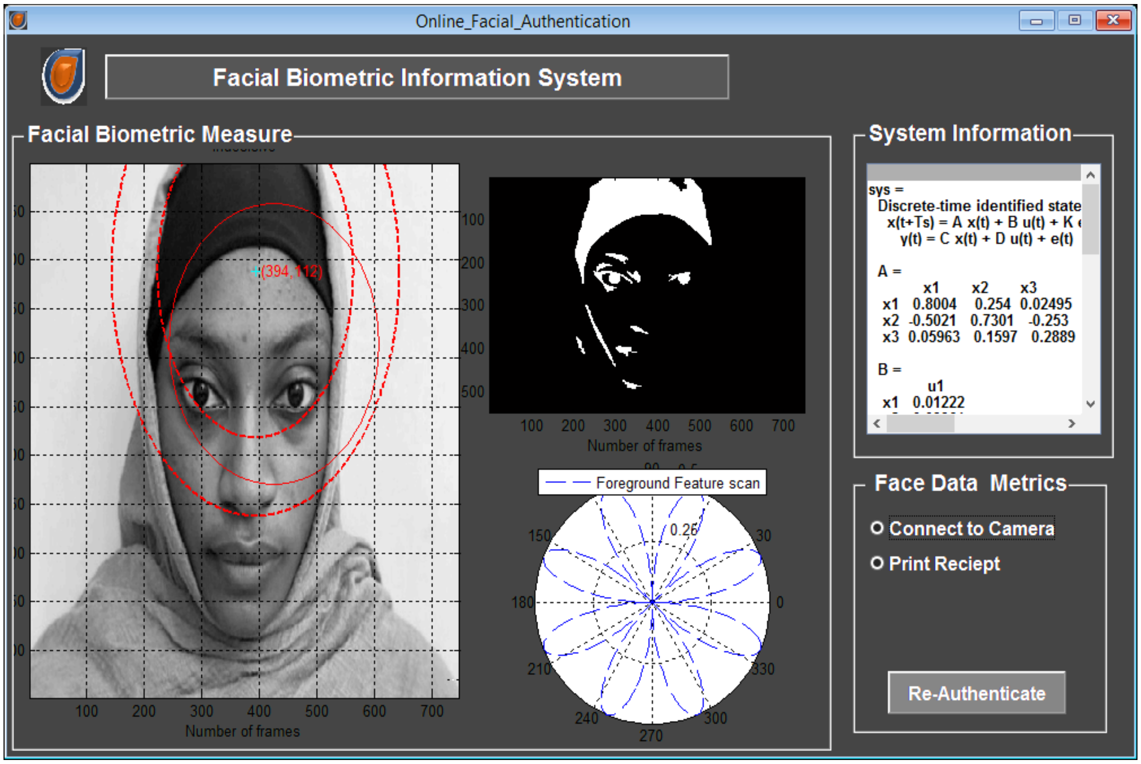

Figure 2: Resultant scan for a given input image at a polar scan with a frequency of 60 herz

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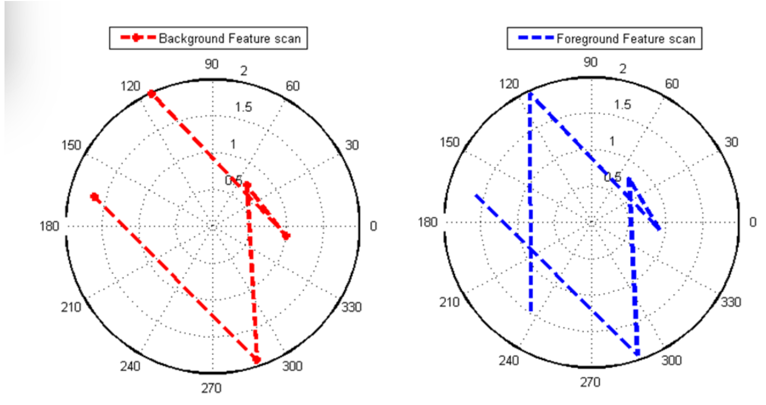

(a) Aggregate Polar scan for background image detection.

(b) Aggregate of polar scan for foreground image detection

Figure 3: Polar scan for both foreground and background image detection

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