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FACE DETECTION AND TRACKING TECHNIQUES IN COLOR IMAGES USING WEIGHED QUANTUM WOLF OPTIMIZATION

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ABSTRACT

A person may be automatically identified from an image or video source using a face recognition system. The work of facial recognition is accomplished by extracting facial characteristics from an image of the subject's face. The primary goal of video-based face recognition is to recognize a video face-track of renowned persons using a vast lexicon of fixed face images, while rejecting unfamiliar individuals. Current approaches detect faces by using probability models on a frame-by-frame basis, which is computationally costly when the data set is huge. For face identification and tracking in color images, a weighted Quantum Wolf Optimization is presented in this study. The suggested technique is compared to current approaches, and the test results show that superior categorization efficiency and high confident value are attained owing to little error.

Keywords: Face Recognition, Video Face Tracking, WQWO, frame-by-frame, classification.

1 Introduction

Face detection is a demanding and complex problem; yet, it is vital for developed man-machine systems [1]. Among the monitoring systems that are available, there are driver monitoring systems that are used to check the attention and condition of drivers [2]. In consideration of these considerations, a wide variety of approaches, such as NN, SVM, color information, and many more, have been presented. The information provided by one's skin tone is both helpful and essential for this endeavour. In addition, color enables quick processing and is extremely resistant to the geometric alterations in the face pattern that might arise as a result of shifting locations. There are functional and non-functional models that may be used to represent skin color; however, for the purposes of this research, a quantitative skin color model will be investigated. Some scholars [3] [4] [5] have attempted to predict the color of skin using multidimensional probability functions. To be more specific, they employ functions of the normal distribution. In order to do this, we experimented with a variety of distributions, and we compared them among themselves using a variety of color spaces.

A great number of different strategies have been suggested as possible methods for face detection. - The early study on face detection [6] concentrated mostly on the creation of handcrafted features and made use of typical machine learning methods to develop effective algorithms for face identification and recognition. These kinds of techniques have a number of drawbacks, including the fact that developing an efficient feature design is difficult and that the detection accuracy is only average [8]. In recent years, face identification algorithms based on deep CNN [9] have been the subject of much research. These approaches are more reliable and effective than handmade feature methods, which were previously the industry standard. In addition, a number of powerful object recognition algorithms are used in the process of face detection in order to enhance the efficacy of the detection.

There are numerous ways possible for face tracking. Several of these methods include the connection of various equipment to the body of the user, which is generally seen as an invasive practice [10]. Vision-based solutions do not call for any physical links to be made to the body of the user, are seen as being less invasive, and have a greater likelihood of being acceptable by end users. Since it has produced such encouraging outcomes, vision-based face tracking is now widely regarded as one of the most interesting research topics in this domain.

The remaining aspects of this research are organized according to the technique that is detailed below. In "Section 2," a condensed synopsis of the essential work is offered. In the section 3, we presented an architecture for face detection, categorization, and tracking. In Section 4, you will find a description of the proposed approach in addition to the results of the experiments. In the last part of the report, a conclusion is drawn from the study that was done.

2 Related works

The approach that was utilized in this study [11] was enhanced in comparison to the standard AdaBoost method using the skin color technique in order to increase the degree of security that was present for network information as well as to identify and recognize faces. The image is analyzed using AdaBoost detection, which helps to lower the risk of an incorrect identification being made. The model that was proposed [12] it detects faces in real time from camera photos. Next, for personal identification, it utilizes the unknown person's profiles face image and well-known face-recognition algorithms. Ultimately, the forecasts from both models are integrated to provide a more matured prediction.

The study of face recognition is still in its early stages of development. The primary objective of the system that was suggested [13] is to enhance the characteristics that were obtained by utilizing the SAE approach on the Gabor filter bank. These approaches are more reliable and effective than handmade feature methods, which were previously the industry standard. In addition, a number of powerful object recognition algorithms are used in the process of face detection in order to enhance the efficacy of the detection. [14]. Facial recognition in videos from smart homes or autos is emerging an increasingly significant component of human-computer interaction [15]. Variations in light, subject movements, differing skin hues, or camera distances may all be problematic for face identification. Nonetheless, face detection is still possible.

The currently known approaches are helpful for identifying solitary face pictures; however, it is quite difficult to get these images using these methods. The primary objective [16] of face detection is to take a picture at a certain moment in time and then look for that picture in a dataset that is already accessible. This research [17] provides a fully operational system that is able to recognize individuals and follow their movement in both live video feed or pre-recorded visual sequences. The system can do this successfully in both scenarios. The system may be broken down into its two primary components, which are the detecting and tracking modules, respectively.

The processes of face detection and acknowledgment are used often in a wide range of applications [18], including biometrics, CCTV surveillance, private security, illegal investigation, law enforcement, national defense, and a number of other areas. This article [19] provides an explanation of the notion of color space, which assists in gaining an understanding of the color proficiencies of a given device. The findings of this research [20] could provide technical support for biometric facial recognition of sheep.

The hybrid descriptors use the combination of several pieces of information and their optimization [21]. The primary hypothesis of this investigation [22] is predicated on the observation that the effects of aging on various aspects of the face, such as the lips, eyes, and nose, vary. The approaches that are fairly powerful-baseline styles in the subcategory for future research; second, one may also utilize acceptable ways for constructing a state-of-the-art end-to-end face recognition systems from the ground up [23].

From this research [24] the accuracy of recognition is found dependent on image and diversity of database. In order to detect face photos with high noise and occlusion, this research [25] creates an Optimal Face Recognition Network (OPFaceNet). The extraction of relevant elements from the photographs of the face is a vital part of the face recognition model [26]. This is done in order to minimize the intrapersonal variances that are caused by factors such as lighting, expression, stance, age, and so on.

It has been shown that the recently suggested system [27] performs better than earlier methods on a number of general and customized face recognition benchmarks using a variety of Federated Learning situations. When facial recognition tasks are handled in the cloud, face pictures that are substantially smaller than the whole video frame are used. Both of these devices are able to connect with one another via the use of the wireless communication protocol known as TCP/IP in this system [28].

The resolution of the image patches is lowered by the max pooling layer in the convolutional neural network (CNN) in the current study [29], which is also employed to make the model more resilient than other classic feature extraction techniques termed local multiple pattern matching.

3 Proposed Methodology

A face identification, classification, and tracking system using video frames is developed, implemented, and optimized in this research. The suggested algorithm of the WQWO method is used during face identification.

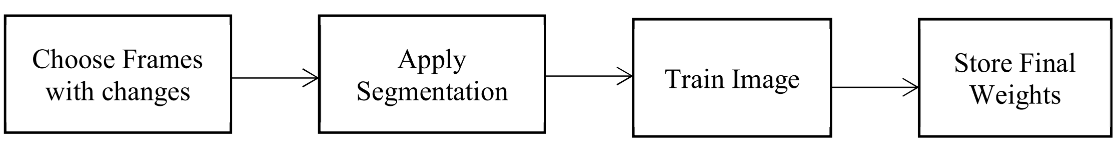

Figure 1: Training Images

Figure 1 illustrates the optimization and training technique. The video frames are extracted. Segmentation is used on the faces localized and globally objects. The segmentation image's mean values are utilised to train the WQWO. The results are saved in a file.

Algorithm 1: Face Tracking System

In summary, the face tracking algorithm follows the procedure outlined below.

Step 1: Wait for just a face or faces to appear in the frame.

Step 2: Start the initialization process. To prevent paying interest to individuals who occur to pass by, wait for a challenges of the project) to seem so for a predetermined amount of time.

Step 3: Enter reporting method and select the nearest face.

Step 4: Follow the face till it exits the frame. To prevent loss track of the tracing face because of minor head movements, exit tracking mode only after the tracked face has vanished for a predetermined amount of time.
Step 5: Go to step 1.

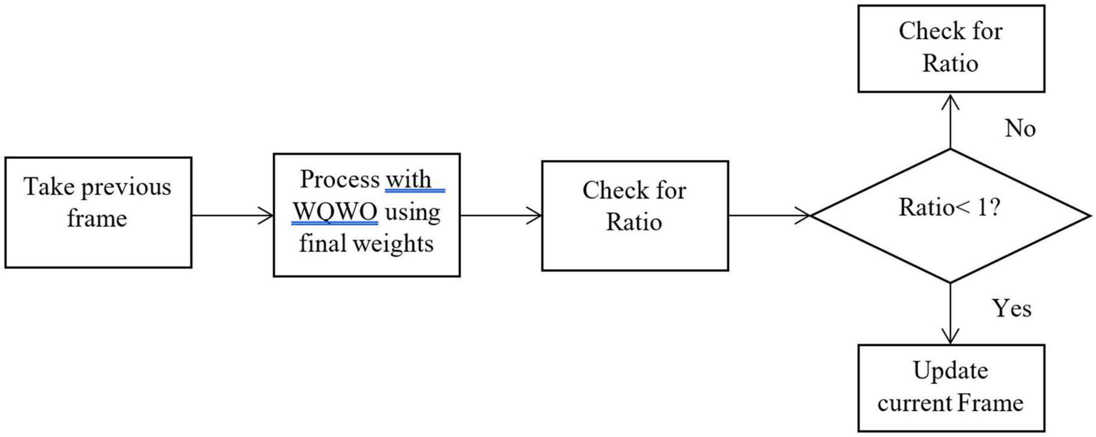

Figure 2: Testing Images

The technique for upgrading the images in the receiver system is shown in Figure 2. It updates the images in the receiver using the final weights gained during training. The WQWO idea, with face tracking algorithm for determining the transformations occurring in the current frame in relation to the preceding frame. This is accomplished whenever there is substantial change in output, indicating a change in the location of the objects in the current frame. To identify a change in the location of an item, the network must first be trained in supervised mode with the helpful of segmentation process as shown in fig 3.

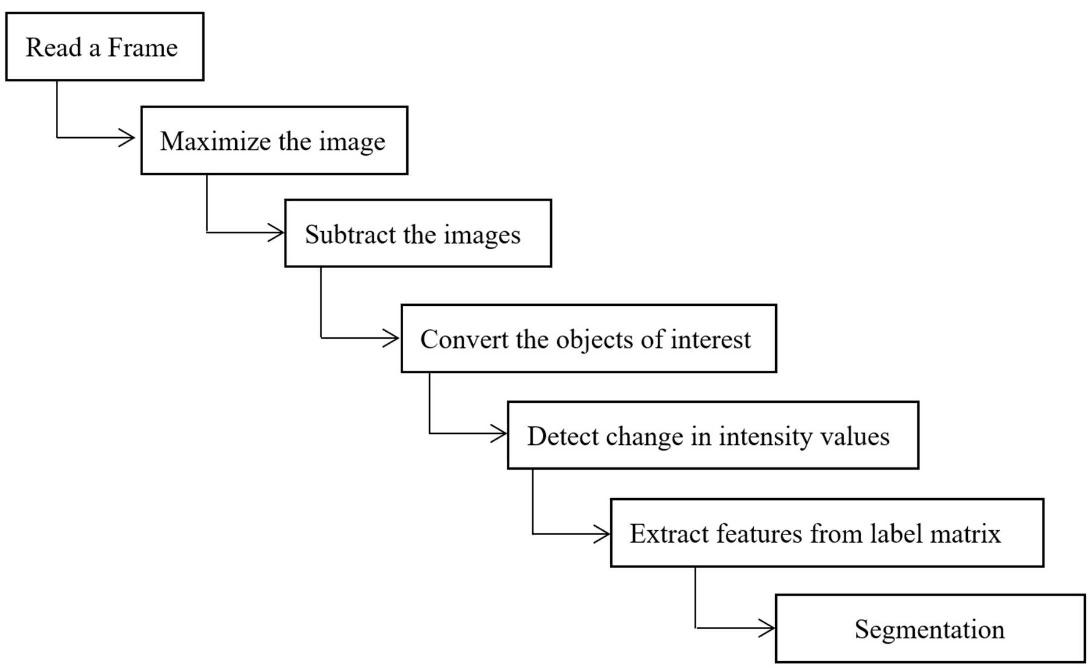

Figure 3: Segmentation process

3.1 Motion Estimation Using the M-Estimator

The following is the definition of inter-frame movements:

$$f(a, s+1) = f(a - v(a; x), s) \qquad (1)$$

With f(a, s) representing the brightening function at time moment s, a=(a, b) representing the pixels coordinate, and v(a; x) representing the motion vector. The affine transformation is used as the motion again without losing generality.

$$v(a; x) = \begin{bmatrix} v(a, b) \\ u(a, b) \end{bmatrix} = \begin{bmatrix} x_0 + x_1 a + x_2 b \\ x_3 + x_4 a + x_5 b \end{bmatrix} \qquad (2)$$

Where

x = (x0, x1, x2, x3, x4, x5) T are seems to be the proposed model's elements.

3.2 Representation for quantum

In the suggested algorithm, the weighted Quantum representation is utilised, in which every quantum individuals q correlates to a phase vectors of Qθ, this is a sequence of phase angles θi (1 ≤ i ≤ n), that may be supplied by

$$Q\theta = [\theta 1, \theta 2, \ldots, \theta n], \theta i \in [0, 2\pi] \qquad (3)$$

where n represents the specific quantum bit's wavelength. Each quantum particles Q is composed of a set of Qubits:

$$Q = \begin{bmatrix} |\cos(\theta_1), & \cos(\theta_2) \ \ldots\ldots \cos(\theta_m)| \\ |\sin(\theta_1), & \sin(\theta_2) \ \ldots\ldots \sin(\theta_m)| \end{bmatrix} \qquad (4)$$

A pair of integer is often used to denotes the probabilities amplitudes of a quantum bit. It is a representation of the likelihood that item x_i will be chosen, while $|cos(\theta_i)|^2$ is a representation of the probability that item x_i would be rejected.

The following is one way to explain it:

With a constant Wt multiplied by n times, Wt = (a1, a2, a3,…., an). Wti represents for the weight of item ai, while qi refers to the profit that ai generates. The amount of weight that may be carried by the backpack is denoted by Z. The goal is to locate, Among the collection of m items, the subsets Xoptimal that maximizes overall profit while keeping the overall weight of the selected items from exceeding Z.

WtQ can be defined as:

$$Maximize\ f(x) = \sum_{j=1}^{n} q_i a_i \qquad (5)$$

$$s.t. \sum_{i=1}^{n} wt_i a_i \leq Z, ai \in \{1, 0\}, \forall i \in \{1, 2, \ldots, n\} \qquad (6)$$

In this case, ai may have the value 1 (which is what was chosen), or it can have the value 0. According to the principle of quantum composite, a quantum phase may be thought of as a superposition of all of the possible standard model. The quantum measurement will cause the superposition state of quantum mechanics to collapse into a stationary state. The quantum persons who are responsible for representing the quantum superposition states inside the QWO algorithm are binary individuals, whereas the quantum individuals that are responsible for representing the stationary states are quantum individuals. As shown in Algorithm 1, quantum observations and restoration for quantum individuals' q are required in order to obtain binary persons X before judging the fitness of people. After the completion of a quantum experiment, the fitness of the binary individuals X may be evaluated as follows:

$$f(X_i^t) = \sum_{i=1}^{m} p_i x_i^t \qquad (7)$$

3.3 Pipeline for Implementation

Figure 4 depicts the study's development process. According to the diagram, each image passes through a sequence of preprocessing steps, followed by feature selection and, eventually, characteristic optimization. Such optimised features are then used to train for feature matching.

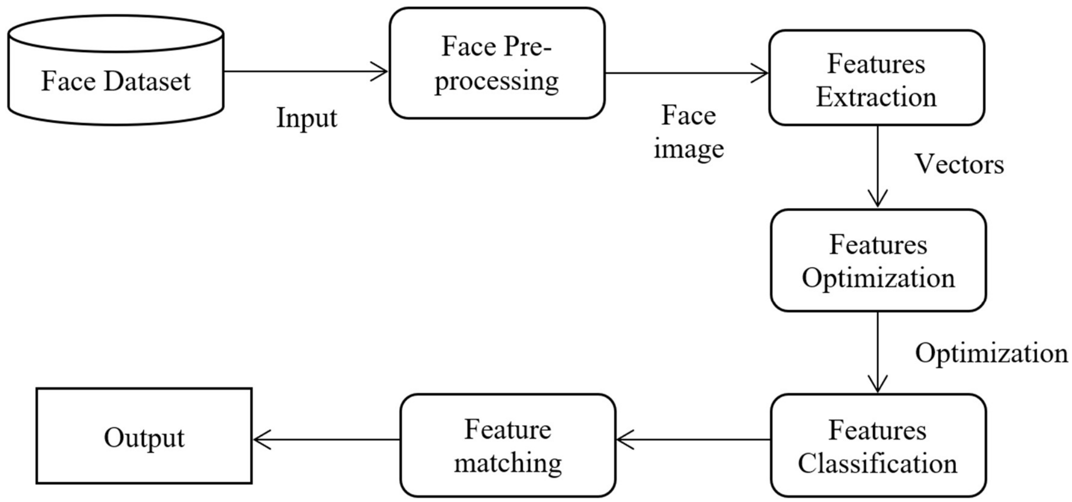

Figure 4: Overall Architecture of our proposed system

3.3.1 Image Preprocessing.

The initial step in image analysis is to remove any unwanted noise from the image. These elements are deleterious to image inspection and are consequently deleted during preprocessing. Any photos with a resolution greater than 96 by 84 pixels are downscaled. After that, all colorful photos are converted to grayscale. The image outputs are divided into training and test sets. 80 % of the images were designated training sets, while the remaining twenty percent are called test sets. This preprocessing is done in order to minimize complexity and enhance computing time.

3.3.2 Feature Extraction. This section expands on the feature extraction method utilized in this investigation. One of the goals of this research is to develop an offline face recognition system with an enhanced and robust feature extraction approach employing optimization methods.

3.3.3 Feature Selection. As an element-wise operator, the binary singleton extension functional is implemented to the training data's calculated mean face. To lower the coefficient used to describe the image, the resulting image is decomposed using the single value decomposition function. To obtain the main component, the cumulative sum of the squares of the diagonal matrix is multiplied by the first k eigenvalues of the component chosen.

Algorithm 2: Weighted Quantum Wolf Optimization

Input: Individual Quantum (Q) elements

Output: Weighted individual elements (W)

W_i ←0 // Initialize an element w to 0

```
W_total←0 // assigning total weight as 0 initially
while (W_total ≤ Q) do
        i←random(n) // Generating (n) as random integer
        if (Wi = 0)
        then random (n) ← random ( )
        if (random > sinθ) then
        Wi ← 1
end if
end if
end while
Wi ←0
W_total ←W_total_Wi
```

The controlling factor for differentiating, denoted by the letter D, assigns a weight to this variance.

The quantum mutant vector at the generation tth stage may be produced via the following methods:

$$Q_{\theta i}^{Mt} = q\theta\alpha + D^t(q\theta r1 - q\theta r2) \qquad (8)$$

We present an adaptive technique for determining the differentiated control factor D using evolution iteration to enhance the effectiveness of differential processes in various phases:

$$D^t = D_0 + D_1 . 2^{\omega} . rand(0,1) \qquad (9)$$

$$\omega = e^{1-\frac{T_{max}}{T_{max-1}}} \qquad (10)$$

where D_0 refers to the differentiation controls factor while where D1 is the adapting differentiating control factor. The highest number of iterations the algorithm will iterate is denoted by the variable Tmax.

3.4 Loss Function

The suggested networks were trained using a multitasking loss function composed of a categorization as shown in below:

$$l(\{c_j, r_j\}) = \frac{\lambda}{N_{cls}} \sum_j l_c(\{c_j, c*_j\}) + \frac{1}{N_{reg}} \sum_j \left(c*_j\, l_r c*_j\, l_r\left(r_j, r*j\right)\right) \qquad (11)$$

where j represents the index of the anchor. Where anchor j is a face, the likelihood that it will be predicted is denoted by cj. The predicted bounding box is denoted by the vector ri, whereas the position and dimensions of the ground-truth box for the face are represented by the vector r* j. The classification loss, denoted by lc, is a softmax loss that differentiates between backgrounds and faces. A smooth-1 loss is what is meant when people talk about the regression loss, abbreviated as lr. The sum of all the positive and negative anchors is represented by the notation Ncls in the numerator. Just the positive sample's regression loss is used into the normalization process. Given that Ncls and Nreg are not equivalent to one another, the parameter is applied so as to strike a balance between the two loss factors.

4 RESULTS AND DISCUSSIONS

Implementing the WQWO Algorithm, Face Detection and Tracking using feature points, a face may be automatically recognized and tracked with the help of this demonstration. This method

continues to recognize the face of the subject even if they bend their head, move closer to or farther away from the camera, or look in a different direction than the camera.
Detecting and following objects is an essential component of a wide variety of computer vision applications, including surveillance, activity identification, and driving safety. In this demonstration, you will learn how to build a simple face tracking system by breaking down the tracking issue into its three component parts:

1. Identify a person's face
2. Locate distinguishing characteristics of the face to record.
3. Face tracking

Figure 5. Video sequence to frame conversion

4.1 Detect a Face

Initially, you must recognize the face. Make use of your vision. To detect the position of a face in a video.CascadeObjectDetector object. The Viola-Jones detection method and a learned classification model are used by the cascade object detector to identify objects. The detector is set to identify faces by default, but it can also recognize other sorts of objects.

Detected Face

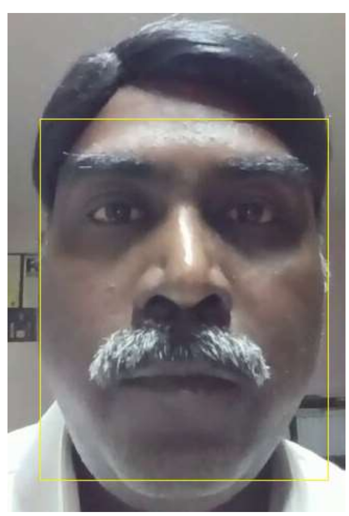

Figure 6: face detected

This example employs the WQWO algorithm to monitor the face over time. Although the cascade object detector may be used on every frame, it is operationally costly. When the subject moves or tilts his head, it can also fail to identify the face. The kind of trained segmentation model employed for detection contributes to this constraint. The face is detected just once in the example, and then the KLT algorithm tracks it throughout the video frames.

4.2 Determine Facial Characteristics to Monitor

The WQWO algorithm follows a predetermined number of feature points as they move across each video frame. When the face has been located using the detection method, finding characteristic points that can be effectively monitored is the next stage in the example. This illustration makes use of the typical "excellent qualities to monitor".

Figure 7: Identify feature points on the face.

4.3 Initialize a Tracker to Track the Points

You are now able to utilize the vision since the feature points have been detected. They may be tracked using the PointTracker System object. The point tracker makes an effort, for each point in the frame before it, to locate its matching point in the frame that is now being processed. After that, the estimateGeometricTransform2D function is used to make an educated guess about the amount of translation, rotation, and scaling that should occur between the old points and the new positions. The bounding box that surrounds the face will have this modification performed to it.

To construct a point tracker that is more resilient in the face of noise and clutter, you should activate the bidirectional error constraint after creating the point tracker.

4.4 Face Tracking

Follow the points as they move from one frame to the next, and then use the estimate Geometric Transform 2D function to determine how the face is moving. Create an additional copy of the points that will be utilized in the computation of the geometric transformation among the points in the preceding frame and the positions in the current frame.

Figure 8: Face Tracking System

IoU, which stands for intersection over union, is usually used when determining whether or not a certain bounding box has been constructed accurately by making use of the data produced by the detector. In terms of specifics, the intersection area refers to the space created when two boxes overlap one another, whilst the union area refers to the whole region that is covered.

$$IoU = \frac{Intersection}{Union} \quad (12)$$

A True Positive (TP) is obtained in detection when the model properly predicted bounding boxes, indicating that they reflect the objective truth. This is also referred to as a match. If this is not the case, the prediction will be classified as a false positive.

When a detection intended to detect an object or a ground-truth has a value less than the threshold, the result is known as a false negative (FN). On the other hand, if a detection is not expected to detect an item with a magnitude that is lower than the threshold, then the circumstance might be referred to as a True Negative.

The proportion of the total number of accurately predicted samples in relation to the total number of predictions is the accuracy. Just using the accuracy results to evaluate the model is an insufficient method since the results cannot cover the performance of a classifier in the face of a growing number of wrong classifications. As a result, having an understanding of the concepts of accuracy and recall is very necessary.

4. 5 Accuracy of solution

The experimental results presented in Table 1 show that the solution accuracy of the improved algorithm is lower than that of other algorithms when the dimension is set to 100.

Table 1: A Comparison of the results of Proposed algorithm with different existing algorithms

Func	PSO		GWO		Proposed	
	Mean	Variance	Mean	Variance	Mean	Variance

F1	1.20	5.91	3.24	7.53	6.36	6.22
F2	4.44	4.15	5.14	7.93	3.52	3.45
F3	2.59	7.92	3.10	1.87	1.45	6.28
F4	5.37	3.45	5.45	7.91	1.08	6.11
F5	1.23	1.16	6.15	5.69	1.20	1.04
F6	1.74	8.53	6.82	7.20	4.41	6.73

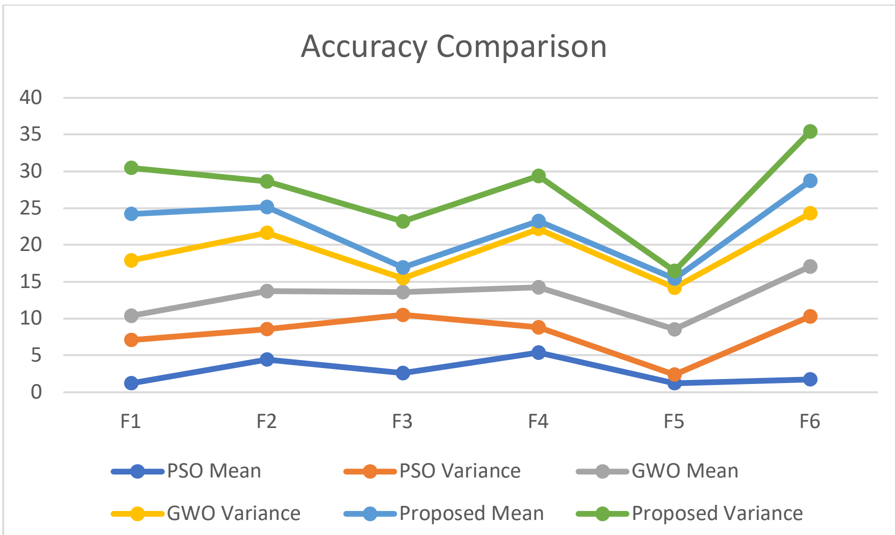

Figure 9. Accuracy Comparison

Above fig indicates that the proposed algorithm is more stable than the other algorithms because it demonstrates that the improved algorithm has a lower variance. While other algorithms are disrupted by a dimension catastrophe, the proposed algorithm maintains its stability and robustness.

5 CONCLUSION

In this example, we created simple face tracker devices that automatically detect and track a single face. Alter the video input and check whether we may still detect and trace a face. Make sure the subject is facing the cameras in the initial frame of the detection step. Current approaches detect faces by using probability models on a frame-by-frame basis, which is computationally costly when the data set is huge. For face identification and tracking in color images, a weighted Quantum Wolf Optimization is presented in this study. The suggested technique is compared to current approaches, and the test results show that superior categorization efficiency and high confident value are attained owing to little error.

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