An Efficient Gait based Recognition using Bat Algorithm

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ABSTRACT
Gait is the walking style of a person. The gait recognition method uses the concept of extracting the features from the video sequence. These features can be used in surveillance systems to identify the individual. In this paper, gait recognition using Multi objective Bat algorithm is proposed in which the shape descriptor features are included to improve the accuracy of gait recognition. Gait recognition of individuals is done by considering the shape features along with the best informative less effective part and most effective parts which are extracted from silhouettes by considering the effect of various cofactors. The shape of the movable parts of human body varies with motion and hence only the most informative movable parts with fixed movement are considered. The shape features can be extracted by angular radial transform and FFT is used for converting them from frequency domain. The results are evaluated using Multi objective PSO and Multiobjective Bat algorithm and it is observed that the proposed gait recognition using Bat algorithm achieves better results when compared to that of the PSO method.

Keywords
Gait recognition, Multi-objective PSO, BAT algorithm, Shape feature.

1. INTRODUCTION
Biometric surveillance is very important to differentiate the authenticated persons from the unauthenticated persons. The biometric identification is very important in national security as it is highly reliable identification system. There have been many security threats in which the installed cameras have recorded the incidences. But the identification of the criminals has not been efficient as the video sequences obtained in the scenes are not very clear. The Gait biometrics [1] has been proposed as an advanced approach to provide better identification since the method has gained upward development. The gait recognition is a technique that identifies individuals by their walking movements.

Gait recognition is generally a difficult process as the appearance varies with various co-factors. The gait actually considers the most effective parts and the less effective parts for recognizing the persons. But many techniques have never used the less effective parts as it meant that these parts do not contain necessary information. The human identification using gait [2] does require these less effective parts as they contain some vital information. The normal procedure is collecting these features from the video sequence by segmenting it to many blocks. The features extracted are maintained as training set. This training set contains the biometric set of different persons in a locality. Using these data the original video sequence is compared and the human identification is performed efficiently.

Gait recognition is more advantageous over the other biometrics like face recognition, finger or iris identification. The other techniques become inefficient when the distance varies and it is not sure that the subject would reveal their appearance through the direct contact approaches. The gait approach forms different classes by using different gait styles like walking (slow/fast), running, jumping, crawling, etc. Using these classes the training data are constructed. Thus the gait recognition has two parts, the training and the testing parts. The human identification is done accurately by this verification.

Gait recognition has also many applications other than the threat (criminal) identification such as automatic authentication of users, tracing lost persons, etc. The machineries and gadgets have authentication in the form of pin or passwords. These passwords and pins might be lost or forgotten and hence the alternate approach of gait recognition can be implemented [3]. The introduction of additional sensors in the movable parts of the person and monitoring may be an efficient technique but the subject’s cooperation is the greater problem.

In this paper, the efficiency of using the multi-objective PSO for gait recognition is analysed and it is found that the performance can be further improved if additional features are included in the recognition. The shape of gait has the potential in efficient identification. As a result, the shape features from the human body are considered especially from the lower parts including feet, knee, thigh, etc. Since the shape of human body that can be traced from camera images varies due to noise in the images and also due to motion, it becomes complex to extract these features. Moreover, some parts like fingers can move in different shapes and hence cannot be used for identification. As a result only selective parts as mentioned above are consideredin this work and BAT algorithm is introduced to select optimal features

The remainder of the paper is summarized as: section 2 explains the related researches briefly. Section 3 presents the methodologies utilized in the paper. Section 4 provides the performance metrics used in this work, Section 5 discusses the experimental results and Section 6 gives the conclusion and section 7 gives the references.

2. RELATED WORKS
Gait recognition has been a big topic of discussion among the researchers in the biometrics field. In the recent past many biometric techniques have been presented and various researchers have discussed the features and the characteristics of the gait.

Human movement or walking has gained importance among the medical and physiological research community. According to Saunders et.al.[4], the translation of centre of mass of the body from one point to another such that it requires least energy is defined as human walking. It was also determined that gait is influenced by six factors like pelvic rotation, knee flexion at mid-stance, pelvic tilt, foot and ankle motion, knee motion and lateral pelvic displacement. It was also discussed that [4] the ability to recognize human gait is much more than these six factors discussed above. The importance of spatial and temporal features for recognition using PCA was given by Das et.al.[5].Their experiments showed that even though temporal components determine the phase of the gait, it is only the spatial components which provide the word for distinguishing between running and walking. Both dynamic and static features for gait recognition were used by Wang et.al.[6].The static features were obtained using Procrustes shape analysis and dynamic features were obtained by recovering joint angle trajectories of the limbs using condensation algorithm. It was indicated that using static features the accuracy was 83.75%., which in turn shooed up to 87.5% in case of dynamic features. Wang et.al.[7] also indicated that by using dynamic information, the recognition provides better results than using static information.

A comparison between using shape and kinematic features for human recognition was done by Veeraraghavan et.al.[8] and it showed that the information required for recognition resides in the shape features. According to Green and Guan[9] static features used for gait recognition is not discriminatory for gait recognition when compared with dynamic features.

RubenVera-Rodriguezb et.al.[10] discussed footstep recognition and the fusion of the spatio-temporal information. According to them, footstep recognition is similar to the gait approach the difference being it uses the spatiotemporal data extracted from the floor level sensors. This approach enables the extraction of the spatial and the temporal information. This approach does not identify the persons directly but uses support modules like speech, face, iris, even the gait to identify the persons.

The gait recognition is normally done by using the extracted temporal information. This may not be possible in some types of images or the extraction may be tricky. Hence Muhammad Shahzad Cheema et.al. [11] presented a gait approach that uses non temporal information. In this method, a set of non temporal key poses are modelled into a gait pattern. These key poses are distributed over the walking sequence as these poses are determined without estimating the gait cycles. The key poses are derived from different gait phases and a model free contour feature is used for its representation.

The static key poses are used in the activity prediction but the gait implementation is not that easy. The learning distribution is utilized as when the person wears different clothing, different weights or carry objects. The gait effectiveness is maintained by the use of non temporal information.

Arihant Kochhar et. al.[12] came up with a different technique of gait recognition using the area features. According to this method both model based and model free approaches are used to identify the individuals. The SVM classifier was used to create the training of the gaits from the video sequence and to identify the authorized from the unauthorized persons. The gait based recognition can also be utilized in the health monitoring applications. According to Bogdan Pogorelc et.al. [13] an approach using machine learning with the aid of gait based recognition to detect the health conditions of the elderly people was used. This method was similar to remote monitoring the elderly persons. Human recognition using gait energy image is a popular technique but the image may lose the temporal features during the gait. Chen Wang et. al.[14] presented chrono-gait image to overcome this problem. This method of template preserves the temporal information by using a multi channel mapping to extract the contour.

As the techniques presented have one problem or the other, the need for a different extraction as well as fusion technique is required for efficient recognition.

3. METHODOLOGY

Gait recognition methods used earlier considers the effect of various co factors and based on this the whole body is divided into five parts namely 3 most effective parts and 2 less effective parts as given by Rokanujjaman, M. et.al.[15]. According to Rokanujjaman, M. et.al.[16], the less effective parts are discarded and only the most effective parts are taken into account for recognition using gait. In our previous work [17], since less effective parts contain some vital information required for recognition the best informative less effective part is taken and fused with the most effective parts using PSO to improve recognition accuracy.

In this work, recognition is further improved by taking the shape features into account. The shape features are fused along with the most effective parts and best informative less effective part using PSO. This work further explores the possibility of improving the recognition accuracy by using BAT algorithm in place of PSO for adaptive fusion of shape, best informative less effective part and most informative parts. The methodology is discussed in section 3.1.

3.1 Recognition using PSO with shape features

The identification of individuals using gait by considering the most effective parts and best informative less effective part is accurate but the recognition can further be improved when the shape descriptor feature is added. This leads to the inclusion of shape sequence descriptor to extract the shape features in the present recognition. First the silhouette segmentation is performed to derive the human image free of background. A bounding box is placed to fit the motion image and this feature is the complete image feature. From this image, the most effective and less effective features are extracted. The shape of the movable parts varies with motion and hence requires adaptive approach to trace the shape. The presented descriptor is maintained as adaptive to adjust to the features. The shape sequence descriptor presents the angular radial transform that performs the extraction of shape features. These shapes are converted from the frequency domain by using FFT.

The shape features cannot be traced simply by using the extracted regions of the silhouette directly into the angular radial transform as they do not provide changes in shapes adequately. Hence the fixed region is used throughout gait sequence. The centre of region of the silhouette should be made to coincide with their respective silhouette.

The angular radial transform can be represented in amatrix form whose coefficients can be obtained by convolution between transform basis and regions of silhouette. In the silhouette the vertical axis represents the radial component index n while the horizontal axis represents the angular component index m. From the equation (1) and (2),let A_m be the angular component and R_n be the radial component. V_{nm} be the basis function and f (ρ, θ) is the region.

$$A_m(\theta) = \frac{1}{2\pi}\exp(jm\theta) \quad (1)$$

$$R_n(\rho) = \begin{cases} 1, & n = 0 \\ 2\cos(\pi n\rho), & n \neq 0 \end{cases} \quad (2)$$

Then, $$V_{nm}(\rho,\theta) = A_m(\theta)R_n(\rho) \quad (3)$$

From the above equations the nm th coefficient can be given by F_{nm} as given in equation (4) and (5)

$$F_{nm} = \langle V_{nm}(\rho,\theta), f(\rho,\theta)\rangle \quad (4)$$

$$F_{nm} = \int_0^{2\pi}\int_0^1 V^*_{nm}(\rho,\theta) f(\rho,\theta)\rho d\rho d\theta \quad (5)$$

The shapes including the movable parts especially the leg parts are traced. Since noise is also a major factor in deciding the shape feature which increases with motion. only the shape features of the movable parts that vary in a fixed way alone are taken into account. These include the shape of thigh and knee that tend to vary with motion but within a fixed limit which are determined by a threshold. These shape features are used for the gait recognition along with the most effective and the best informative less effective parts.

The fusion of the shape features with the most effective and best informative less effective parts requires unique method. The adaptive PSO is used to fuse the features with shape features. The shape features are not totally required to trace the identity because only some parts retain the same shape while many body parts vary during motion. Hence it is required to choose the best shape features which improve the identification accuracy. The section below explains recognition using BAT algorithm with shape features.

3.1.1 Algorithm

1. Initialize particle
2. Create training data
3. Extract less effective and shape features
4. Use shape descriptor sequence for shape features
5. For each particle
6. Do
7. For each less effective features with threshold t and shape with threshold ts
8. Calculate fitness value(True Positive, True Negative)
9. If calculated fitness value is better than current value take it as local best
10. Choose particle with best fitness value as global best
11. Select feature and threshold for increasing True positive and decreasing True negative
12. Compute particle velocity
13. Update particle position
14. While maximum iteration until the best fitness value occurs with best threshold
15. End
16. Fusion of more effective, less effective and shape features using adaptive fusion
17. Obtained Fused features used for gait recognition

3.2 Recognition using BAT algorithm

As the fusion of the shape features with the effective parts is not sufficiently done using adaptive PSO, a new recognition technique using the BAT algorithm is presented. The effective features are extracted from the silhouettes and the best features are selected using the BAT algorithm. The effective features include the most effective parts, best informative less effective parts obtained by the effect of various cofactors and most informative less varying shape features. The shape features are extracted using the shape descriptor by employing angular radial transform. Thus shape features can be extracted and FFT is used to transform them from frequency domain. The most informative and less varying shape features are alone used in identification as the other parts vary with motion and do not fix in a limit. The features are extracted and the adaptive technique is used to adaptively select the required features. The best features are selected with a threshold value with best fitness value. The efficient features required to identify the person are alone taken for building the training set.

The fusion is done by the BAT algorithm itself in an adaptive manner. The use of BAT to fuse the features together is highly efficient technique provided. The BAT algorithm does its job to perfect because of its productive nature. It initially lists the features and then selects a best among them. After selection, the algorithm compares the efficiency of using a feature other than the best features so that better results can be obtained with reduced effort or input. Thus the feature selection does not depend only on highest parameters but on the sole requirement of efficiency. The section below explains recognition using BAT algorithm with shape features.

3.2.1. Algorithm

1. Initialize N number of video clips
2. Training set {x1, x2, ….. xn}
3. Less effective features and shape features with threshold t_i
4. Objective function f(x), $x = (x_1 . . . x_d)^T$
5. Initialize the bat population x_i for i = 1, ... ,n
6. Define pulse frequency $Q_i \in [Q_{min}, Q_{max}]$
7. Initialize pulse rates r_i and the loudness A_i
8. Fitness value (True positive (TP), True negative(TN))
9. while ($t < T_{max}$) // number of iterations
10. Generate new features with increasing TP and decreasing TN by adjusting frequency
11. update velocities and locations
12. if(rand(0, 1) >r_i)
13. Select best feature with threshold t_i for increasing TP and decreasing TN
14. Generate a suitable feature around the best feature
15. end if
16. Generate a new feature by moving randomly
17. if(rand(0, 1) < A_i and $f(x_i) < f(x)$)
18. Accept the new feature with threshold t
19. Increase r_i and reduce A_i

20. end if
21. Rank the bats and find the current best feature
22. end while
23. Adaptive Fusion of features based on Bat
24. Fused features for gait recognition

4. PERFORMANCE METRICS

The performance of the gait recognition system using BAT is evaluated using metrics such as accuracy, precision, recall and F-measures [17]. The experiments are performed using CASIA Dataset B[18].

Accuracy is defined as the proportion of true positives and true negatives among the total number of features examined.

$$\text{Accuracy} = \frac{(Truepositive\ + Truenegative\ )}{(Truepositive\ + Truenegative\ + Falsepositive\ + Falsenegative\ )} \quad (6)$$

Precision is the fraction of identification of parts that are relevant.

$$\text{Precision} = \frac{TruePositive}{(TruePositive\ + FalsePositive\ )} \quad (7)$$

Recall is the fraction of correct parts that are identified.

$$\text{Recall} = \frac{TruePositive}{(Truepositive\ + Falsenegative\ )} \quad (8)$$

The F-Measure computes some average of the information retrieval precision and recall metrics

$$\text{F-measure}= \frac{2*precision\ .recall}{precision\ + recall} \quad (9)$$

where, True Positive= actual parts which are correctly identified.

False Positive= parts which are incorrectly identified

True Negative= parts that are correctly rejected

False Negative= parts which are incorrectly rejected.

5. RESULTS AND DISCUSSION

The results obtained for recognition using PSO and recognition using BAT are discussed as follows:

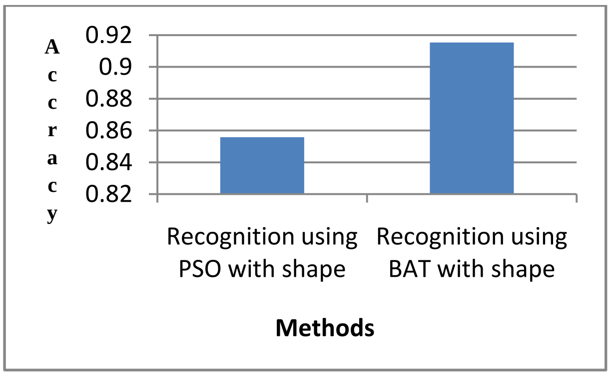

Figure1: Accuracy

The corresponding results of the recognition using PSO with shape and recognition using BAT are evaluated for Accuracy. Figure 1 shows that when compared to recognition using PSO the accuracy is improved in recognition using BAT. When the methods are compared, accuracy using PSO is 85%, whereas the accuracy using BAT with shape is 91.25%.

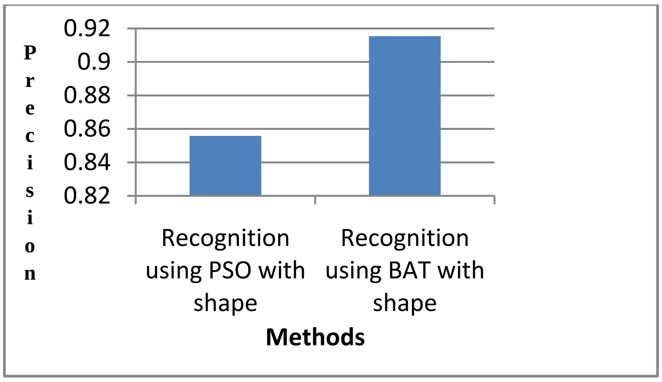

Figure2: Precision

The corresponding results of recognition using PSO with shape and recognition using BAT are evaluated for precision. Figure 2 shows that when compared to recognition using PSO the precision is improved in recognition using BAT. When the methods are compared in terms of precision, the recognition using PSO has 0.8617precision, whereas the recognition method using BAT has 0.9183 precision.

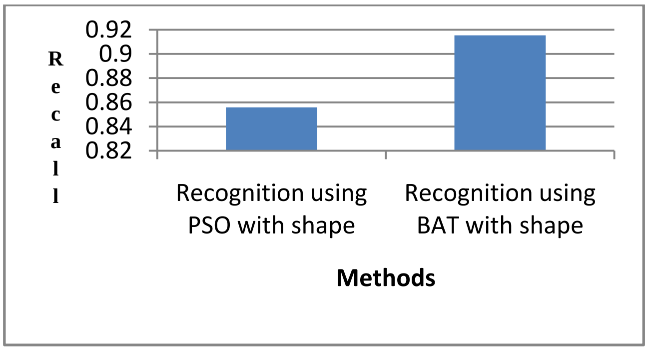

Figure3: Recall

The corresponding results of recognition using PSO and recognition using BAT are evaluated for Recall. Figure 3 shows that when compared to recognition using PSO the recall is improved in recognition using BAT. When the methods are compared in terms of recall, the recognition using PSO with shape has recall at a rate of 0.85 whereas the recognition method using BAT has 0.9125 recall rate.

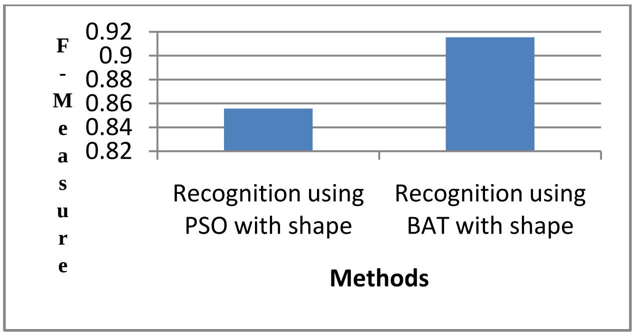

Figure 4: F-Measure

The corresponding results of recognition using PSO and recognition using BAT are evaluated for F-measure. Figure 4 shows that when compared to recognition using PSO the F-measure is improved in recognition using BAT. When the methods are compared in terms of F-Measure, the recognition using PSO has 0.8558, but the recognition method using BAT has an improved F-Measure of 0.9154.

Table 1. Comparison Table

Metric used	Recognition using PSO with shape	Recognition using BAT with shape
Accuracy (%)	85	91.2500
Precision	0.8617	0.9183
Recall	0.8500	0.9125
F-Measure	0.8558	0.9154

Table 1.givesthecomparison of the three methods based on the performance metrics. From the table it is clear that the presented method of recognition using BAT with the shape features has better performance values than the other method. Thus the recognition using BAT with shape is found to be the most efficient method.

6. CONCLUSION

A robust technique for the gait recognition using shape features along with the most effective parts and best informative less effective parts is performed by multi objective PSO. A shape descriptor is used to extract shape features and PSO is used to adaptively fuse them with effective parts. The work also explores the possibility of improving the recognition accuracy by using BAT algorithm. The proposed method shows better accuracy at all levels and further work can be explored by using other optimization techniques to improve the accuracy and further can be improved by reducing the search space for recognition.

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