AN IMPROVED MSVM-BASED ARCHITECTURE AND SWARM OPTIMIZER USED FOR GENDER CLASSIFICATION

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Abstract- Nowadays, the task of gender classification (GC) has gained importance in analyzing the characteristics of individuals in social media, customer preferences, business settings, and more. An automatic gender classification task for reviewing face images has become a main motive in this economic world. In this article a real-time gender classification using an improved MSVM classification method using a combination of PSO with MSVM model. Gender classification has become significant to a developing array of uses, especially with the emergence of web networks like Facebook, Twitter, etc. An improved MSVM classifier is trained using a target database to attain a good classification performance. We have calculated the classification performance on the PETA database for gender estimation using improved MSVM, CNN, LBP, HSV, etc models. The simulation was completed on GC databases and implemented classifier method formed better outcomes than the current techniques. The proposed classification model achieved maximum accuracy that is 97.7%, 96.7 % AUC on the PETA database. The results of widespread simulations carried out on existing standard databases establish that the implemented framework outdone existing GC approaches, and acceptable outcomes prove the implemented method as a robust method.

Keywords - Gender Classification (GC), Improved MSVM classifier model, particle swarm optimization (PSO), Convolutional Neural Network (CNN).

I. INTRODUCTION

Gender is a critical aspect that plays an essential part in public interfaces. Creating a gender assessment from a facial picture is a crucial task in innovative applications. There are enormous applications dependent on gender, such as computerized human interfaces, promoting smart and womanly protection. Gender classification (GC) is essential and acute for different uses in profitable sectors, for example, human-computerized interaction (HCI) and automated supportive functional or sensitive analysis. It consists of a large amount of data about features of masculinity and femininity. The GC was significantly observed as a problem in psychophysical training. The GC is constructed on considerate human graphical processing and detecting suitable properties required to classify specific men and women [1]. The GC observation and perception have been explored from psychosomatic and statistical viewpoints.

In contrast, the GC is highly concerned with existing psychosomatic research [2][3]. The main objective of the GC is to identify the sexual category of individuals with the help of isolated properties or features [4]. In Artificial intelligence (AI) the GC is reflected as one of the vital applications of pattern detection [5]. Different possible applications drive the development of GC research. For example, computer vision using GC operations is a widespread application as an essential and practical research domain consisting of HCI [6]. The safety and investigation trade [7], the scientific study [5], the profitmaking growth [8], and portable mobile apps and audio-visual games [9]. Also, different experts constructed multiple tools to improve the performance of gender detection in accuracy and proficiency [10] [11]. The identification of men or women is a simple process that humans to identify. Still is challenging for machines or robotic. The GC is based on face, hands, posture, and speech. The GC is helpful in different filed, such as observation systems, directed publicity, HCI, content-based guiding, biometrics, finding, and demographic group. The GC is significant in identifying facial gesture detection to meet the safe, reliable, and adapted facilities [12]. Previously, the GC was built on the intellect and sensibility areas [13] [14]. Still, individuals have begun to jump sophisticated regarding challenging issues of GC. So, the GC is getting additional consideration [15].

In GC exploration unrestricted, different methods have been constructed. For example, the facial, gait, clothing, iris, hand movement, posture, hairstyle, etc. figure 1, describes gender classification organization in two basic forms such as appearance and non-appearance-based, identifies the sexual category based on characteristics consequent from the exterior records of specifics. The organization of GC consists of static body structures like posture, dressing, hand contour, and finger attributes such as nails, color, etc. An active human body appearance such as style, indication and movement. The dressing material such as clothes and footwear. The non-appearance constructed method requires genetic characteristics and human-being

utilized social sites for email, blog, script, etc. The bio indications feature consists of deoxyribonucleic acid, electrocardiogram, etc [11].

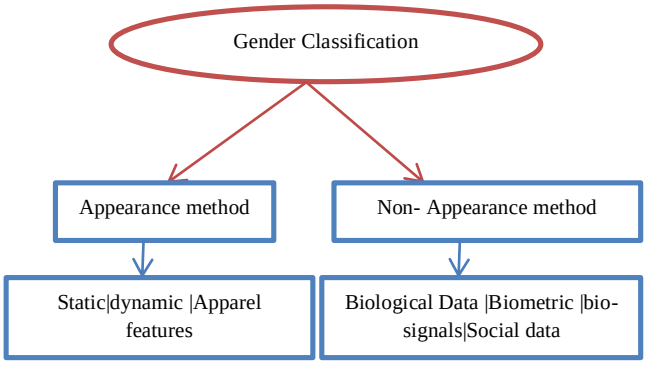

Fig 1. Human GC Taxonomy [11]

In existing work, a novel CNN-based classic of four branch subnets using a modified AlexNet backbone (BSMAB) was built, necessary for feature extraction. The experts organized the ant colony system (ACS) system for a collection of feature selection and softmax classifiers recycled to train the proposed classical using the existing dataset of CIFAR-100. The features reached from standard conventional datasets. The enhanced features group achieved using the ACS method was delivered to different classifiers such as SVM and KNN for pedestrian gender classification. The researchers also used a five-fold variety of cross-validation for the training and testing of the existing dataset. The existing method enhanced feature groups using a hundred features advanced and completed with different parameters.

In this proposed paper, the section group is as tracks: section 2 signifies various research papers about human gender classification. It defines the dissimilar tools, methods, and performance metrics utilized by several researchers for human gender classification. Section 3, describes the proposed methodology of the proposed methods such as SVD, PSO, and multi-class SVM method. Section 4 represents the result analysis of the proposed method such as the simulation tool MATLAB) and several performance metrics. At last, section 5 represents the conclusion and upcoming scope of the proposed method.

II. LITERATURE REVIEW

This division describes the various existing study papers regarding gender classification methods. Several techniques, methods, performance parameters, and tools are utilized by several researchers explained. **K.C. Santosh et al. (2022) [16]** described the procedure of digital healthcare images raised using innovative computational control that contributed to rising highly refined machine learning (ML) methods. The gender and age determination of people were performed manually by medical researchers using their specialized aids. That took some days to achieve outcomes. An automatic model was constructed that detects the age and gender of humans from digital medical data of teeth. As teeth were a powerful and exclusive subpart of the human body, they displayed a slight matter to danger in a natural arrangement. Its residues were static for a long time, and the development of gender and age growth-related data from human beings. That was analytically approved by analyzing the orthopantomogram (OPG) image dataset. An aggregate digital 1142 x-ray-based teeth images were accessed from dental colleges from the people of India's mid-east Karnataka national state. The dataset was split into two parts such as 80% was used for training and 20% was used for testing. The proposed age and gender recognition model broadly found its usefulness in predicting fast and effective outcomes in the medical zone. The estimation model was approved for multiple class support vector machine (SVM) classifier methods for age approximation. The LIBSVM classifier for gender classification achieved an accuracy of 96% by the proposed model. **Miss. Vaishnavi Y.Mali et al. (2019) [17]** described human-based gender classification. The gender Classification field was considered as most exciting and acute. In this paper, the authors proposed a comparison over several methods based on computer vision and human interaction that included significant data regarding men and women. Different pattern or shape detection types and ML methods were connected to gender and human face. The authors proposed a comparison of several methods required for gender classification. The human face was considered a unique security feature of specific. The human face images using numerous configurations such as anterior, aligned, laughing, sad, and other reaction images complicate the model. The proposed investigation included human face detection techniques such as geometric methods. The SVM, linear discriminant analysis (LDA), and CNN methods were considered in the geometric approaches. The SVM classification method achieved better accuracy as compared to the other remaining methods. **S. Siraj et al. (2022) [18]** described signatures of individuals reveal considerable regarding their health, professional path, and the existing state of the brain. From the viewpoint of biometrics, an individual's gender was considered in demographical class, such as easy characteristics, whereas manual signature was based on behavioral qualities. Different fields consisted of forensics, sensibility referred to the potential classification of gender over manual signatures. Radical (feminist) aesthetics maybe discover mechanisms scripted by males using a higher rate of intraclass distinction and vice versa. It offered an indication with a signature to determine the specific gender. The extraction of several attributes from men's and women's active feature models practices of the proposed approach. Approximately 535 persons of changing age were measured and these sign instances were compared or transformed into statistical features soft up to sixty sign features for the complete dataset. The authors deployed six ML techniques for this proposed approach implementation. The outcomes of the proposed approach reached an accuracy of 78% using k-mean NN, 83% with logistic regression (LR), and 51% using RBF kernel in the SVM method. A poly-kernel was trained using cross-validation and obtained an accuracy of

91% with a decision tree (DT), 97% with random forest (RF), 85% with SVM, and 98% using deep NN. The deep NNs achieved overall better performance monitored strictly with the RF method. **Sahra Tilk et al. (2021) [19]** described gender classification initialized on human face images as critical because of composite contextual object constriction and differences in light conditions. The human face pictures were exploited for different applications such as reaction detection, classification, and tracking. The authors proposed binary methods using deep learning (DL) for gender classification, such as CNN and AlexNet. The outcomes of the proposed methods achieved better performance for identifying the men or women classes from human face images. Furthermore, a qualified analysis was conducted among these dual methods and different wide-ranging approaches for gender classification. **Veena N.V. et al. (2022) [20]** described widespread applications in various human-face research, automated gender and age analysis from facial images lately increased additional attention. The authors leverage the methods considered to determine the specific's gender on a unique preview from a webcam, picture, and audio-visual. The author proposed a CNN-based framework using DL methods and techniques for gender classification. The importance of the latest technologies was predicted and defied the use of these methods to achieve better performance. The main motive of this proposed framework was to utilize the DL method to construct age and gender recognition. It can be incompletely detected the human age and gender from a dataset. Additionally, the proposed framework's recorded outcomes represented massive application domains required from CCTV cameras, smart activities, and controlling service websites. **Farhat Abbas et al. (2021) [21]** described pedestrian detection of gender as considered the most significant task of ordinary investigation. Gender prediction offered real-world applications in contextual image retrieval, people statistics, HCI, medical care, microscopic groups, several recovery models, demographic groups and visual observation. The authors used the DL approach to construct a sixty-four layered model known as four BSMAB derivatives over the proposed AlexNet method. The proposed method was accomplished on the CIFAR100 medical image dataset and required the softmax classifier. The needed features were accessed from practice datasets using pre-processing of the proposed method. These achieved feature vectors or group was optimized using an ant colony optimization (ACO) method. Several SVM and KNN classifier methods were utilized to implement the human gender analysis and achieve optimal features. Extensive experimental outcomes of the planned method attained better performance. The recommended model reached an accuracy of 85.4% and an AUC of 92% with the MIT dataset. Furthermore, the classification outcomes achieved an accuracy of 93% o and an AUC of 96% using the PKU-Reid dataset. The results of the planned technique on current essential ordinary datasets reveal that the proposed method outcompeted the current standard classification of the human gender techniques, and practical effects verified the proposed method was a robust model.

III. PROPOSED METHODS

This research paper describes the feature extraction, selection, and classification process. For feature extraction, the singular value decomposition (SVD), and feature selection process are completed with a particle swarm optimization (PSO), and classification is achieved with multiple support vector machine (MSVM). All these methods are described as;

A. Singular Value Decomposition (SVD) using Feature Extraction (FE)

It is the development of detecting critical structures in the existing dataset. It is a subpart of the measurement decline procedure in which the primary images are segmented into different adaptable sets [22]. The SVD is a statistical method for factoring any quadrilateral matrix in multiplying triple performance metrics. Statistically and generally, this method is mainly associated with the principal components analysis (PCA) and also offers a perception of the symmetrical analysis of the PCA method. For example, as distinguished earlier, this method has proacted been essential to the acceptance of the PCA. This method is factorized with any number of the matrix into triple metrics, all of which have significant features. Any quadrilateral matrix B of m rows using q columns must be factored into M, N, and O using eq (i).

$$B = MNO^T \text{.....(i)}$$
$$M = BB^T \text{.....(ii)}$$
$$O = B^T B \text{.....(iii)}$$

Every singular weight is the genuine root of a single Eigen weight composed in Equation (ii) and Equation (iii). The distinct consequences are systematic in that the highest values are placed in the upper left and the remaining values are located in the lower right. Between triple quadrilateral matrices, B is an oblique matrix consisting of the square-root eigenvalues initialized from M or O downward. These [23] weights are placed in a vector known as eigenvector (v).

Fig 2, represented the flow chart of the SVD method.

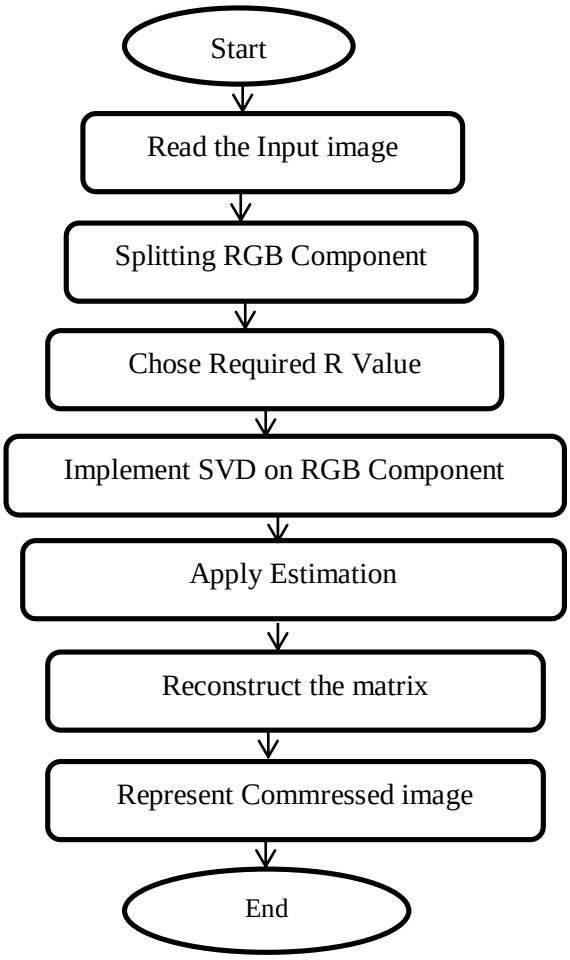

Fig 2. Flow Chart of SVD method [24]

Feature Extraction Using SVD method – Pseudo code
1. **Input** obtain data matrix B
2. **Output** novel size = c.[25]
3. Repeat
4. Relating the SVD method to B as $B = MNO^T$, $M = BB^T$, O = eigenvectors, N= diagonal matrix.
5. Build the covariance matrix using $BB^T = BB^T \leftarrow (MNO^T)(MNO^T)^T = (MNO^T)(MON)^T$
6. O = orthogonal matrix $(O^TO = 1), BB^T = MN2M^T$
7. Calculate the square root of BB^T .
8. Unit re y(t)i.
9. Display each transaction based on the delay as vector y(t)i.
10. Return M^TB

B. Feature Selection Using Particle Swarm Optimization (PSO)Method

This method is based on the population and is a stochastic-optimized method. Kennedy and Eberhart [26] constructed this method. The subdivision in the search location may be measured as a particular bird of a flock and to bargain an optimal solution using the PSO method as global and local image data. The adequate resolution requires the fitness function and accuracy of particles. In this method, the particle's location becomes incremented using each particle's global and local roles toward its neighbor. It moves the problem location diagonally, finding for best features. The process is repeated for static delay or up to the lowest error is attained [27]. Fig 3 represents the working procedure of the PSO technique.

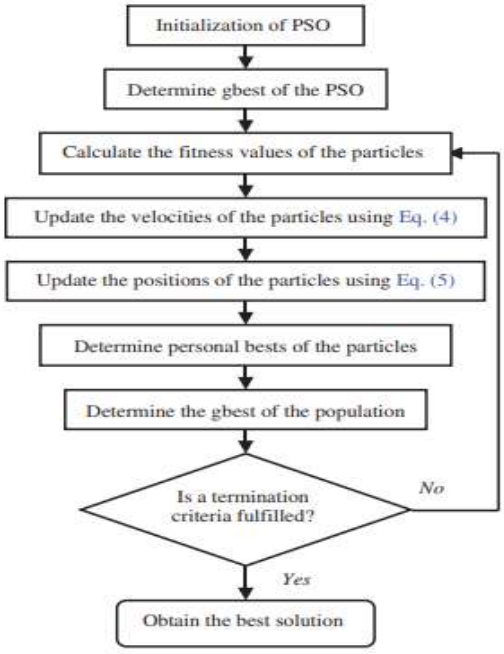

Fig 3. Flow Chart Of PSO Method [28]

Pseudo Code of the PSO Method
1. Prepare the amount of Generation T =0;
2. Prepare a swarm residents dimension.
3. Prepare the swarm [29] location of y and velocity V_E.
4. Evaluate the initial fitness function weight f(y).
5. Search local optimal P and global optimal G, then prepare altered the PSO metrics such as C1, C2, and W.
6. **While** (T<maximum_iterations)
7. Increment velocity V_{E1} using eq. (iv)
8. $VE1 = W * VE + C1 * (best_P) * rand(P) + C2 * (best_G) * rand(G);$…….(iv)
9. Increment location y1 = y+ V_E
10. Verify the margin settings of evaluating the novel fitness function and increment the existing local best_P and best_G(T) = G(T) +1.
11. **End While**

C. *Multiple Support Vector Machine (MSVM)*

The support vector machine (SVM) is a technique for learning-splitting operations in gender classification and pattern detection tasks. Unlike the traditional detection methods that operate in local1 and local2 normalization and exploit the entire weight of an error and error square. It achieves mathematical outcomes that construct a model using reduced dimensions [30]. The multiple-class SVM works suitably for massive datasets within minor training samples and is better than classical realistic risk-based standards in neural networks (NNs). The SVM is a multi-class classification method required for multiple-class issue resolution. It converts the combination of multiple class issues that are widely deployed for implementation [31].

$$dj(y) = WjW_j^t \varphi(y) + aj \ldots\ldots\ldots\ldots (v)$$

In equation (v), Wj = l size vector, $\varphi(y)$= mapping function. Figure 5 represents the working process of the MSVM method[32].

IV. EXPERIMENTAL RESULT ANALYSIS

This section describes the result analysis of the planned method for human gender classification. For human gender classification, MATLAB [33] is used as a simulation tool to perform experimental calculations and graphical representations of the outcome of the planned human gender classification technique. Then the performance parameters of the proposed human gender classification techniques are explained.

A. Performance Metrics

For gender classification methodology, different performance parameters such as accuracy, mean square error rate, specificity, specificity, and AUC are used. It is described as;

- **Accuracy:** It is described as the fraction of a total number of true classified values and equivalent to the addition of true positive (Tp) and true negative (Tn) divided by the complete number of values "N". It represents in equation (vi), Tp = true positive, Tn = true negative, N = total value of classifiers [34].

$$Accuracy = \frac{Tp+Tn}{N} \ldots\ldots\ldots\ldots\ldots\ldots (vi)$$

- **Mean Square Error Rate:** It is defined as basically binary intervals of the regular cost or average. It is represented as a formula form in equation (vii).

$$MSE = \frac{\sum_{x=0}^{p}\sum_{y=0}^{n}(Dxy-Rxy)^2}{Np} \ldots\ldots\ldots\ldots\ldots (vii)$$

In equation (vii), P = total output, n = total instances, Rxy = network output, dxy = desired outcome.

- **Specificity:** It is described as the ratio of true negative is equivalent to the rate of true negative (Tn) to the addition of true negative (Tn) and false positive (Fp).

$$SP = \frac{Tn}{Tn+Fp} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (viii)$$

In equation (viii), Tn = true negative, Fp= false positive.

- **Sensitivity:** It denotes the ratio of true positives and is equivalent to true positives distributed by adding a true positive and false negative.

$$SN = \frac{Tp}{Tp+Fn} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (ix)$$

In equation (ix), Tp = true positive, Fn = false negative.

- **AUC:** The area under the curve (AUC) has several benefits, such as it provides the freedom to choose sensitivity in the investigation of alteration, tests, freedom to select threshold, static to a preceding probability and distribution, etc. It is widely utilized for ML methods [34].

B. Dataset (CIFAR-100)

The PEdesTrian Attribute (PETA) et thus consists of 19000 imageries, with a resolution of 17*39*169*365 pixels. This type of dataset is not organized as straightforwardly. Initially, it eliminates the repeated or copied images from a dataset. Then, every image is labeled as a novel with sixty-one binary and four multi-class attributes. The binary attributes protect a comprehensive collection of interest features, with demographics like as gender and age level, appearance such as hairstyle, clothing style such as casual or formal, and accessories. The four multi-class attributes include 11 simple color names [36] for footwear, hair, and clothing. The circulation of a binary attribute is measured for balancing if the large to the small ratio of the class is not more than 20:1. So, thirty-one images are balanced out of the sixty-one binary attributes, Fig. 4 shows the dissemination of some attributes with sample images.

Fig 4. PETA Dataset [35]

C. Result Analysis

This research work is implemented in MATLAB simulator tool and operating desktop application using GUIDE environment. The result analysis used the sex category which is MALE and FEMALE. In this research work, we are using 200 images of each category 100 images for male and 100 images for female images. These images are used for the training set and 68 images for testing purposes. Test the system performance of the human GC system, enduring MIT, PET, CIFAR-100 dataset images of person were selected for testing phase.

The research methodology is generally concerned with distinct eyebrows, eyes, body shape, face postures, etc. Classification plays an important role in the implementation of this system. Several performance metrics are calculated in digital image processing techniques. The proposed work has enhanced the performance metrics such as accuracy, specificity, sensitivity, etc., and compared with existing methods.

Fig 5. Upload Test Samples

Fig. 5. represents the test person sample uploaded and it converts the RGB channel to the grayscale image. It reduces the dimensionality of the converted image sample in the form of 3D to 2D.

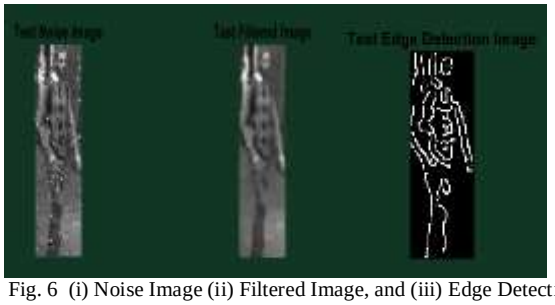

Fig. 6 (i) Noise Image (ii) Filtered Image, and (iii) Edge Detection Image

Fig. 6 (i), (ii), and (iii) define the noise image or attack image. The identification of unwanted noises and implemented median filter. The median filter is a filtering method utilized to remove noise from an image. Noise reduction is a pre-processing phase to enhance the outcomes of processing. After that, it applied the canny edge detection method to detect the edges. It extracts image features without altering the properties. It is widely utilized as an optimal edge detection method.

Fig. 7 Improved MSVM classifier

Fig. 7 defines the performance of improved MSVM classification. Initially, FS (feature selection may help as a pre-processing phase of the main significance before resolving the classification issues. The main motive of the FS is to optimize the maximum no. of unrelated feature sets while managing an acceptable classification accuracy rate. FS approach can optimize the cost of feature calculation, and improve the classifier effectiveness and classification accuracy rate. The major tasks are the selection of the feature sets and the selection of the MSVM classification approach. This proposed work used the PSO method to perform FS and then calculated fitness values (FVs) with MSVM that was merged with a multi-class approach with kernel function (KF). An improved MSVM classification model simplified FS and the total no. of metrics required efficiently, thus attaining a maximum classification accuracy compared with the existing models. The proposed model has classified the gender i.e. Male or Female category and evaluated the performance metrics such as accuracy, AUC, specificity, sensitivity, etc.

Table 1
Proposed Performance Metrics

Parameters	Values
MSE	0.0023
SP	0.977
SN	0.944
Accuracy	97.7
AUC	96.73

Table 1 defines the proposed performance metrics such as the MSE value of 0.023, SP value of 0.97 %, SN value of 0.94%, Accuracy value of 97.7%, and AUC value of 96.73%. The proposed model has improved the accuracy rate, AUC, SP, and SN, and reduced the total sum of error rate (MSE).

Table 2
Comparison Analysis with Proposed and existing models: Accuracy Rate (%)

Methods	Accuracy Rate (%)
CNN[55]	80.4
HoG[56]	78.9
LBP [56]	76.1
HSV [56]	71.3
LPB-HSV [56]	77.6
HoG-HSV [56]	80.9
HoG-LBP [56]	79.8
HoG-LBP-HSV [56]	80.1
CNN-e [57]	81.5
Fully Body CNN [58]	82.0
HDFL [59]	74.3
SSAE [60]	82.4
J-LDFR [61]	82.0
4BSMAB [25]	85.4
Proposed Model (Improved MSVM Classifier)	97.7

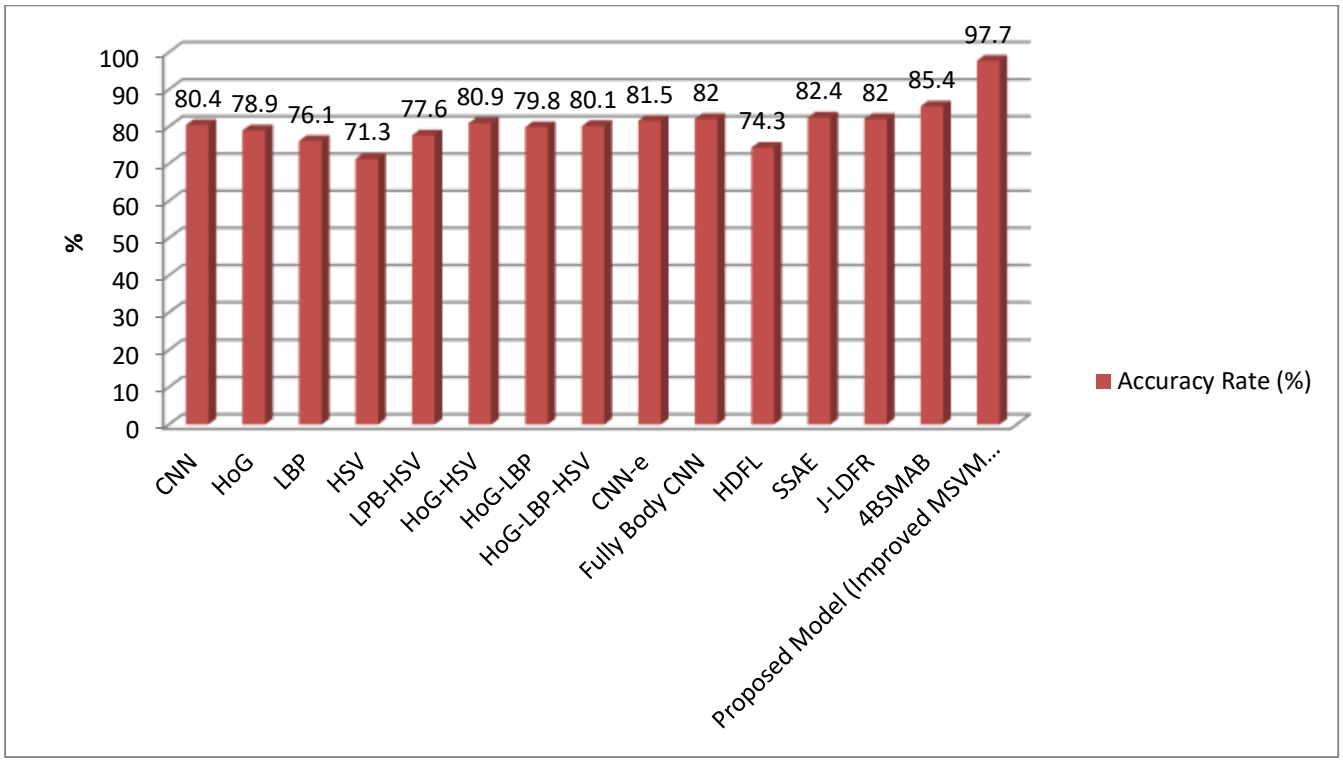

Fig. 8 Comparison Analysis with different classifiers: Accuracy (%)

Table 2 and Fig. 8 show the comparative analysis of the proposed model and existing models. The proposed model has improved the accuracy rate as compared with the existing model. The proposed model has a 12.3% improvement as compared with existing methods such as HoG, CNN, Fully Body CNN, LBP, HSV, etc. The comparative analysis of the outcomes with the existing and proposed models in terms of accuracy rate is defined in Fig. 8.

Table 3
Comparison Analysis with Proposed and Existing Model: AUC (%)

Parameters/Models	Improved MSVM model	4BSMAB Model[25]	J-LDFR Model [61]
AUC (%)	96.73	92.0	86.0

Table 3 represents the comparison in the form of AUC(%), and attained outcomes define that the proposed model outperformed the existing model 4BSMAB [25] Model with a 4.7 percent enhancement.

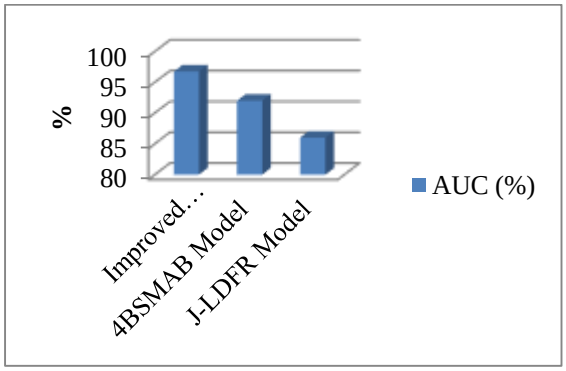

Fig. 9 Comparison Analysis with different classifiers: AUC (%)

Fig. 9 represents the AUC attained by the researched model using several classifiers with different samples of the GC database, and it can be considered which improved the MSVM classifier's highest AUC of 96.7 percent on different views of the HGC database.

V. CONCLUSION AND FUTURE SCOPE

The proposed work has improved the MSVM-based model developed for gender classification. It eliminates the problem mentioned above and improves the system's performance. Initially, images are accomplished by illuminating a scene and gripping the energy reflected by the objects defined in the scene. Several methods are utilized to perform GC based on developed properties. Next, a pre-processing step is required to upgrade the data quality, where training and analyses of images are normalized to mitigate noise from images. It comprises several phases

such as grayscale conversion, etc. The median filter is used to remove noise that exists in the uploaded image. With complete preprocessing phases, the reliable data is changed from raw data, enhancing the accuracy rate. After that, it applied the canny edge detector. An edge detection operation uses a multiple-stage method to detect images' wide range of edges. It is a method to extract reliable data from different vision objects and dramatically optimize the amount of data to be managed. Then, the feature extraction step is utilized to optimize various resources by extracting the features of the pre-processed data for classification. It is the procedure of dimensionality reduction (DR) that interchange the raw data into manageable classes. Face features are a leading technology utilized in various applications that classifiers human faces using DIs. The SVD method is used for feature extraction. For the feature selection process, the PSO method utilizes a data-sharing mechanism that gives individuals to learn from each other to help the growth of a complete swarm. It has global search ability even in HD solution spaces. Then, an MSVM classifier is required for gender classification. The experimental outcomes of the proposed model reached an accuracy of 96.73%, a specificity of 0.977, a sensitivity of 0.944, an MSE of 0.0023, and an AUC is 96.73 performance as compared to other methods.

In the future, it is intended to improve the composed recommendation model for a collection of manipulators in public locations. The proposed model can be enhanced with various classifiers for instance softmax function and ReLU. A further well-organized model can be developed for human GC using Belief Rule Based Expert Systems (BRBES). Thus, for further enhancement, we will implement all these for human GC.

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