FORM 2
THE PATENTS ACT 1970 (39 of 1970)
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THE PATENT RULES, 2003 COMPLETE SPECIFICATION
(See section 10 and rule 13)

1.TITLE OF THE INVENTION

GENDER IDENTIFICATION BY USING CNN AND SVM

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FIELD OF INVENTION:

This invention pertains to the intersection of biometric analysis and gender classification, focusing on the utilization of fingerprint-based data for the precise determination of gender. By introducing a novel combination of deep

learning and traditional machine learning techniques, the invention harnesses the power of a pre-trained convolutional neural network (CNN) to extract intricate fingerprint features, followed by support vector machine (SVM)-based classification to predict gender with improved accuracy. This method surpasses existing biometric classification systems by leveraging unique fingerprint characteristics to achieve reliable and scalable gender prediction. The invention finds relevance in domains such as personalized security authentication, forensic identification, and advanced biometric solutions for gender-specific services.

BACKGROUND OF INVENTION:

Biometric identification has long been a reliable method for human authentication, with fingerprint analysis being one of the most widely accepted and used techniques due to its uniqueness and permanence. Traditional fingerprint-based systems have focused on verifying identity, detecting fraud, and aiding law enforcement. However, beyond identification, gender classification from fingerprints remains a relatively untapped area of research, with many current methods either lacking accuracy or failing to harness the full potential of advanced machine learning models.

Existing approaches to gender classification often rely on physiological traits such as facial features or voice patterns, which can sometimes be altered or obscured due to environmental conditions, age, or external factors. In contrast, fingerprint patterns are highly stable and consistent throughout a person's life, making them a promising biometric for gender determination. Despite this potential, previous techniques using traditional image processing for fingerprint-based gender classification have not achieved satisfactory levels of precision or scalability, due to the complex and subtle nature of gender-specific fingerprint features.

This invention addresses these limitations by employing a convolutional neural network (CNN), specifically designed to extract deep, complex patterns from fingerprint images that are otherwise difficult to detect through conventional methods. By using a support vector machine (SVM) for classification, the system capitalizes on the CNN's ability to learn and represent fingerprint minutiae, thereby increasing the accuracy and reliability of gender classification. This combination of deep learning and SVM-based classification

represents a significant step forward in the field, offering a scalable solution capable of handling large datasets with high precision.

Moreover, the invention holds potential for application in various industries where gender classification can provide enhanced user experiences, personalized services, or security-based decision-making, including personalized biometrics, security systems, and forensic analysis. This system not only adds a new dimension to biometric analysis but also contributes to the growing demand for gender-specific solutions in both commercial and law enforcement sectors.

SUMMARY:

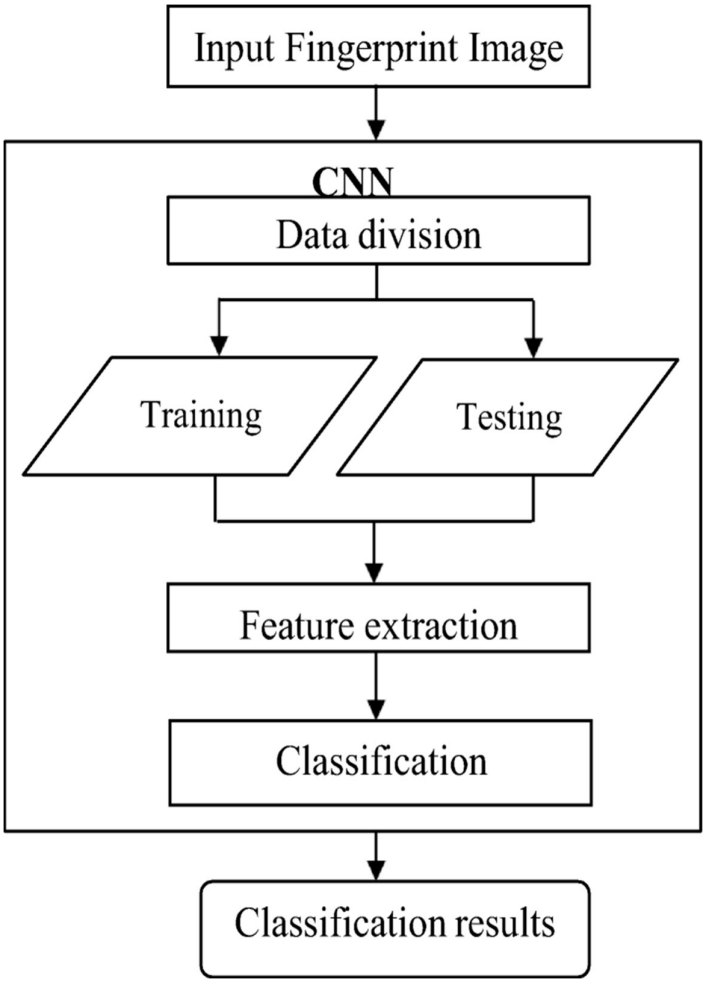
The present invention introduces a novel system for gender classification based on fingerprint analysis, utilizing a combination of advanced deep learning and machine learning techniques to achieve high accuracy and efficiency. The system integrates a pre-trained convolutional neural network (CNN) to automatically extract distinguishing features from grayscale fingerprint images. These features, which are often imperceptible through traditional image processing methods, capture intricate patterns unique to male and female fingerprints.

Once the CNN extracts these deep fingerprint features, they are passed to a support vector machine (SVM) classifier, which has been specifically trained to predict the gender of the individual based on the extracted fingerprint patterns. The fusion of CNN feature extraction and SVM classification capitalizes on the strengths of both methods—leveraging the CNN's ability to learn complex visual representations and the SVM's effectiveness in handling high-dimensional data for precise classification.

This invention addresses the limitations of existing fingerprint-based gender classification techniques, which often struggle with poor accuracy due to the subtle nature of gender-specific fingerprint features. By implementing a CNN for feature extraction, the system ensures that even the most intricate patterns are captured and used to improve prediction outcomes. The use of an SVM for classification ensures that the gender classification process is both efficient and scalable for real-world applications.

The invention is applicable to various fields where gender classification is beneficial, including forensic science, biometric security, and personalized authentication systems. Additionally, it provides a significant contribution to the advancement of biometric identification technology, offering a robust and reliable solution for integrating gender classification into broader security and identification frameworks.

BRIEF DESCRIPTION FOR DIAGRAM:



The diagram illustrates a fingerprint-based classification process using a Convolutional Neural Network (CNN). It begins with the input fingerprint image, which is passed into the CNN for processing. The data division step splits the dataset into training and testing sets. The training set is used to train the CNN, teaching it to recognize essential fingerprint features. The testing set

evaluates the model's accuracy. In the feature extraction phase, the CNN extracts distinguishing features from the fingerprint. These features are passed to the classifier, which performs the final classification, outputting the predicted result (e.g., Male or Female).

DETAILED DESCRIPTION:

This project focuses on fingerprint-based gender classification using deep learning techniques. A Convolutional Neural Network (CNN) is employed for feature extraction from fingerprint images. The system begins by preprocessing the fingerprint image, then passes it through the CNN, where important features such as ridge patterns and minutiae points are extracted. These features are then classified using a Support Vector Machine (SVM) or another classifier to predict the gender, either male or female. This method is highly accurate, scalable, and can be applied to biometric authentication, forensic identification, and demographic studies, offering an efficient approach to gender classification.

1. Input Fingerprint Image:

The process begins with the acquisition of a fingerprint image, which is the raw input data for the system. This image typically comes from a fingerprint scanner or a stored fingerprint database. The quality of the fingerprint image is crucial, as it directly impacts the accuracy of subsequent steps. Preprocessing may include removing noise or distortions from the image, ensuring that the input is ready for further processing.

2. CNN (Convolutional Neural Network):

The CNN is the core of the process, responsible for automatically learning to identify and extract key features from the fingerprint image. This deep learning model is composed of multiple layers, each designed to capture different levels of detail:

- **Convolutional Layers**: These layers apply filters (kernels) to the input image, capturing important patterns like ridge flows, minutiae points,

and ridge bifurcations within the fingerprint. The convolution process highlights essential spatial hierarchies within the fingerprint data.

- **Pooling Layers**: These reduce the spatial dimensions of the convoluted images, helping in retaining the most important features while reducing the computational complexity.
- **Fully Connected Layers**: After several convolutional and pooling operations, the high-level extracted features are flattened and passed through fully connected layers. This transforms the feature map into a form suitable for classification.

3. Data Division:

Once the CNN architecture is defined, the dataset is divided into two distinct parts:

- **Training Set**: This subset of the data is used to train the CNN. During training, the CNN learns to recognize patterns and features from the fingerprint images that are associated with male or female classes. The learning process involves adjusting the model parameters through a backpropagation algorithm based on how well it classifies the training images.
- **Testing Set**: This subset is kept aside and not exposed to the model during training. It is used after training is complete to evaluate how well the model can generalize and classify new, unseen fingerprint images. This step is critical for measuring the performance of the model in real-world scenarios.

4. Feature Extraction:

Once the CNN is trained, it can extract meaningful features from fingerprint images during the testing phase. Feature extraction involves capturing the distinct characteristics of a fingerprint that can differentiate between male and female. These may include:

- **Texture patterns**: Fine textures in the ridges of the fingerprint.

- **Minutiae points**: Specific points where ridges split (bifurcations) or end (terminations).
- **Ridge flow patterns**: Overall directionality and curvature of the ridge patterns. These features are critical as they reduce the high-dimensional image data into a lower-dimensional, meaningful set of features that can be used by a classifier.

5. Classification:

After extracting features, the next step is classification. The extracted fingerprint features are passed to a classifier, which could be one of the following:

- **SVM (Support Vector Machine)**: A supervised machine learning classifier that finds the optimal hyperplane to distinguish between male and female classes based on the input features.
- **Neural Network-based Classifier**: In some architectures, the CNN is followed by fully connected layers that directly output a probability for each class (male or female). A softmax function may be applied to convert these scores into probabilities.

The classifier processes the features and predicts whether the fingerprint belongs to a male or female individual. This is essentially a binary classification problem.

6. Classification Results:

The final step involves outputting the results of the classification. Based on the prediction made by the classifier, the system will display or return one of two possible outcomes:

- **Male**: If the extracted features align with patterns learned from male fingerprints, the classifier predicts male.
- **Female**: If the extracted features match those of female fingerprints, the classifier predicts female.

These results are either displayed to the user in a graphical user interface or returned to an external system for further processing, such as biometric verification or forensic analysis.

WE CLAIM:

1.System for Fingerprint-Based Gender Classification:

The present invention provides a system for gender classification using fingerprint images, which consists of a Convolutional Neural Network (CNN) for feature extraction and a Support Vector Machine (SVM) classifier for gender prediction. The CNN is trained using a labeled dataset of fingerprint images, allowing it to extract relevant features from the input images. Once the features are extracted, the SVM classifier processes these features to classify the fingerprint as belonging to either a male or female individual. The system also incorporates a data processing module that resizes and normalizes input fingerprint images to a fixed dimension of 96x96 pixels, ensuring uniform input for the model.

2.Method for Fingerprint-Based Gender Classification:

The invention also describes a method for fingerprint-based gender classification, which involves extracting features from fingerprint images using a trained CNN model. The extracted features are then passed to the SVM classifier, which categorizes the fingerprint into male or female. This method ensures accurate and efficient gender classification by utilizing both a CNN for feature extraction and an SVM for classification. The training process is optimized through techniques such as early stopping, model checkpointing, and learning rate reduction, which contribute to the stability and improved performance of the CNN model.

3.Training Process for Gender Classification

The invention further claims a training process for the CNN model, where the data is divided into training and validation sets to monitor model performance during training. Validation accuracy is carefully tracked to ensure the effectiveness of the model in classifying gender. Once features are extracted from the dense layer of the CNN, they are further processed by the SVM

classifier to enhance the classification results. This hybrid approach improves overall classification accuracy and robustness of the model.

4.Enhanced Classification Process

To further improve the user experience and classification accuracy, the system allows for real-time visualization of input fingerprint images alongside the predicted gender labels. Additionally, tools such as confusion matrices and accuracy plots are integrated into the system to help monitor and evaluate the model's performance throughout the classification process. These visual aids provide clear insights into the strengths and weaknesses of the model, helping in ongoing refinement and optimization.

ABSTRACT:

This invention presents a novel system and method for gender classification using fingerprint images, combining the strengths of Convolutional Neural Networks (CNNs) and Support Vector Machine (SVM) classifiers. The system begins by preprocessing fingerprint images, resizing them to a uniform dimension, and converting them to grayscale. A CNN is then used to automatically extract deep features from the fingerprint, learning intricate patterns such as ridges and minutiae specific to gender. These features are passed to an SVM classifier, which categorizes the fingerprint as male or female based on the learned patterns. The training process is optimized through early stopping and learning rate reduction techniques, while real-time classification results are provided. The system also integrates visualization tools, such as confusion matrices and accuracy plots, for continuous performance evaluation. This invention addresses the limitations of traditional fingerprint-based classification systems, providing a scalable, efficient, and highly accurate solution for gender classification with applications in biometric authentication, forensic analysis, and personalized security systems.

ARCHITECTURE DIAGRAM: