FINGERPRINT IDENTIFICATION WITH FUSION GABOR AND MINUTIAE FEATURES USING BPNN CLASSIFIER

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ABSTRACT:

- Fingerprint identification is a task of personal identification and verification.
- Fingerprint Identification system consists of two modules that are training and testing.
- In this project, The feature vector is formed using combined features obtained from Gabor filtering technique and minutiae technique.

Objective:

- The primary objective of this project is to develop an intelligent system for automatic fingerprint identification with fusion gabor and minutiae features using bpnn classifier

Introduction:

- Biometric recognition is one of the promising authenticating systems worldwide.
- It uses a verification process that involves biological feature like face, fingerprint, hand veins, iris, retina etc.
- However, fingerprint identification and verification are widely used as biometric technique due to its simplicity, distinctiveness, and long lasting properties.
- Fingerprint plays a great role in

  1.criminal investigation including forensic investigation

  2. public security

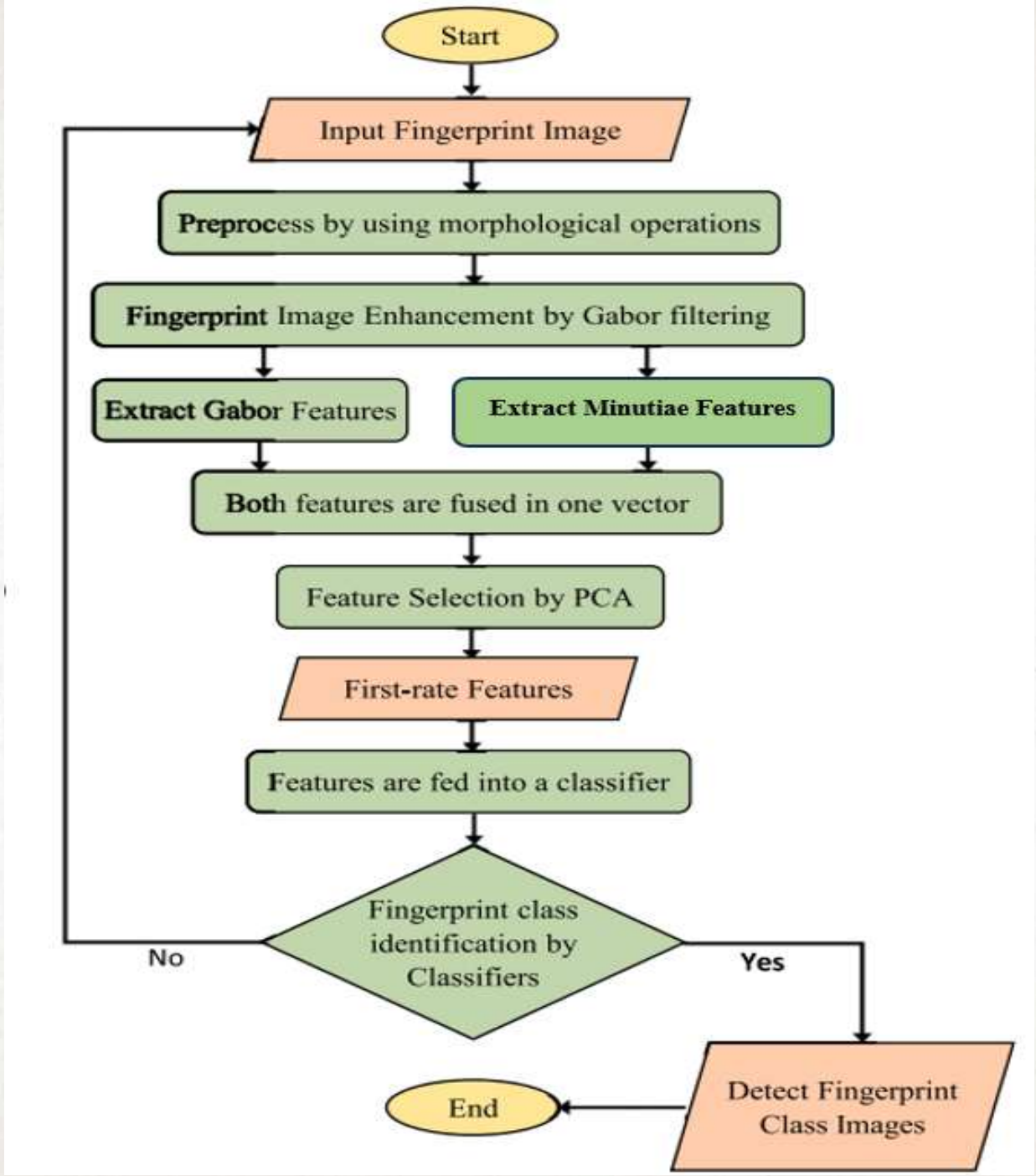
  3. law execution, tax access etc.

Literature Review:

S.no	Paper Title	Proposed Method	Advantages	Drawbacks
1.	An intelligent system for automatic fingerprint identification using feature fusion by Gabor filter and deep learning(2021)	Convolutional neural network (CNN) Gabor filter Principle component analysis (PCA) Deep learning	which deals with a very large number of databases.	Confusion matrix results where 10 failures were found when tested.
2.	Fingerprint classification combined with Gabor filter and convolutional neural network(2022)	Convolutional neural network (DCNN and SCNN) Gabor filter Image Enhancement	Combined with the Gabor Filter and Convolutional Neural Network can better extract the ridge features of fingerprint images	Experimental results show that the proposed model achieved 91.4% accuracy.(Low accuracy)

S.no	Paper Title	Proposed Method	Advantages	Drawbacks
3.	A Fingerprint Matching Algorithm Using the Combination of Edge Features and Convolution Neural Networks(2022)	Convolutional neural networks;	These were processed using Prewitt and Laplace filters to enhance the edges and, in order to reduce the expensive training cost.	The performance of classification is poor.
4.	Fingerprint matching Using Minutiae Extraction Techniques(2016)	ROI (Region of Interest), Minutiae extraction, Euclidean distance, Fingerprint ridge, Termination, Bifurcation, AFRS (Automatic Fingerprint Recognition system)	Use of a particular region of interest (ROI) provides an additional feature to the presented algorithm making it more useful in comparison to some of the existing algorithms.	useful for small database system.

Block Diagram



Morphological Operations

- Before adopting a fingerprint image into the proposed automatic system, it was preprocessed using a window of size 227×227 pixels.
- Then the morphological operations were performed to augment the ridges of the fingerprint images.
- The ridge width should be decreased so that the ridge end and bifurcates in the fingerprint could be detected easily.
- This procedure was performed using erosion-dilation and area opening techniques of morphological operation.

Dilation:

- It was mainly used to grow an object in size by extracting the outer boundaries of the given fingerprint image. Dilation continuously filled the missing pixel of a broken ridge as it added pixels at the boundary of the objects. Having applied this operation, the object enlarged its regions, shrank the single hole and reduced the gap between two regions.

$$[I \oplus S](x, y) = \max (a,b) \in S \{I(x - a, y - b)\} \qquad \text{Eq. (1)}$$

- A dilation can be denoted by $I \oplus S$.
- where I is the input image and S is the structuring element.
- The dilation of image I at position (x, y), denoted by Eq. (1), is the maximum value of the window outlined by S when the origin of S is at (x, y).

Erosion:

- This was used as the complement operation of dilation to smooth the fingerprint image after dilation. It caused to loss of size by extracting inner boundaries of a fingerprint edge. Therefore, it can be used to remove the noisy connections between the two objects.

$$[I \oslash S](x, y) = \min_{(a,b) \in S} \{I(x + a, y + b)\} \qquad \text{Eq. (2)}$$

- It can be denoted as I⊘S.
- Here I is the dilated image and defined by Eq. (2).
- The origin of S visits every pixel in I and replaces the pixel value with the minimum value of I covered by S.

Area Opening:

In the opening operation, the image was first eroded and then dilation was carried out to smoothen the contour of fingerprint image by clearing the narrow bridge and eliminating the minor extension present in the object.

Extraction Of Gabor Features

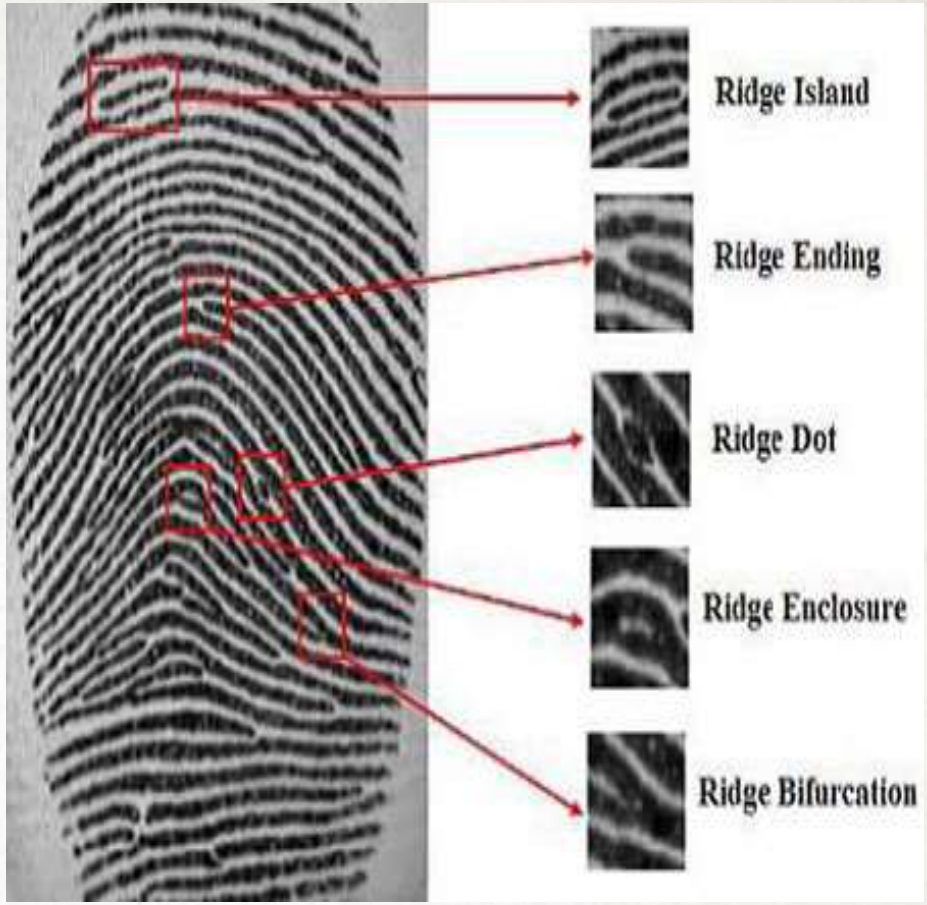
- Gabor filter was used in the system to improve the ridges and relax the valleys by implementing short term Fourier transformation with Gaussian window in a spatial domain.
- It assisted in obtaining the deviations in the textures and characteristics in the fingerprint image for different orientations and scales.
- A set of Gabor filter has been used on image I(x, y) in different frequencies with different orientation using the Gabor function g(x, y) as defined by Eq. (3).

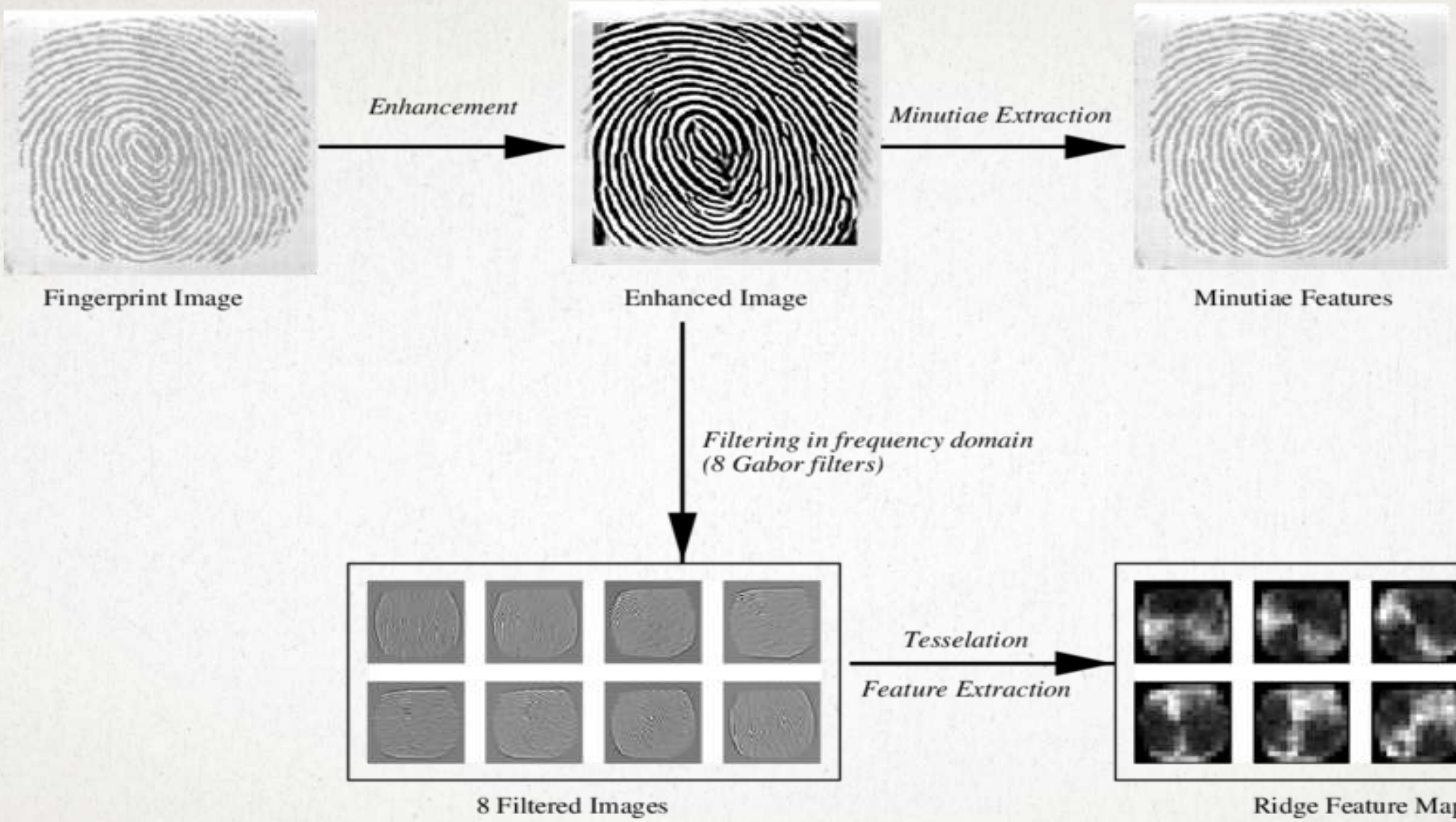
$$g(x, y) = \exp(- x' 2 + \gamma 2 y' 2\ 2\sigma 2) \cos(2\pi x' 1 + \varphi) \qquad \text{Eq. (3).}$$

- Here, $x' = x\cos\theta + y\sin\theta$ and $y' = y\cos\theta - x\sin\theta$
- This Gabor transform was implemented in the Gaussian envelope σ along the x and y directions

Extraction Of Minutiae Features

- The most important step in automatic fingerprint matching is to reliably extract the minutiae from the captured fingerprint images.
- Minutiae points are the major features of a fingerprint image and are used in the matching of fingerprints.
- These minutiae points are used to determine the uniqueness of a fingerprint image.
- A good quality fingerprint image can have 25 to 80 minutiae depending on the fingerprint scanner resolution and the placement of finger on the sensor.




Enhancement
Minutiae Extraction
Fingerprint Image
Enhanced Image
Minutiae Features
Filtering in frequency domain
(8 Gabor filters)
Tesselation
Feature Extraction
8 Filtered Images
Ridge Feature Map

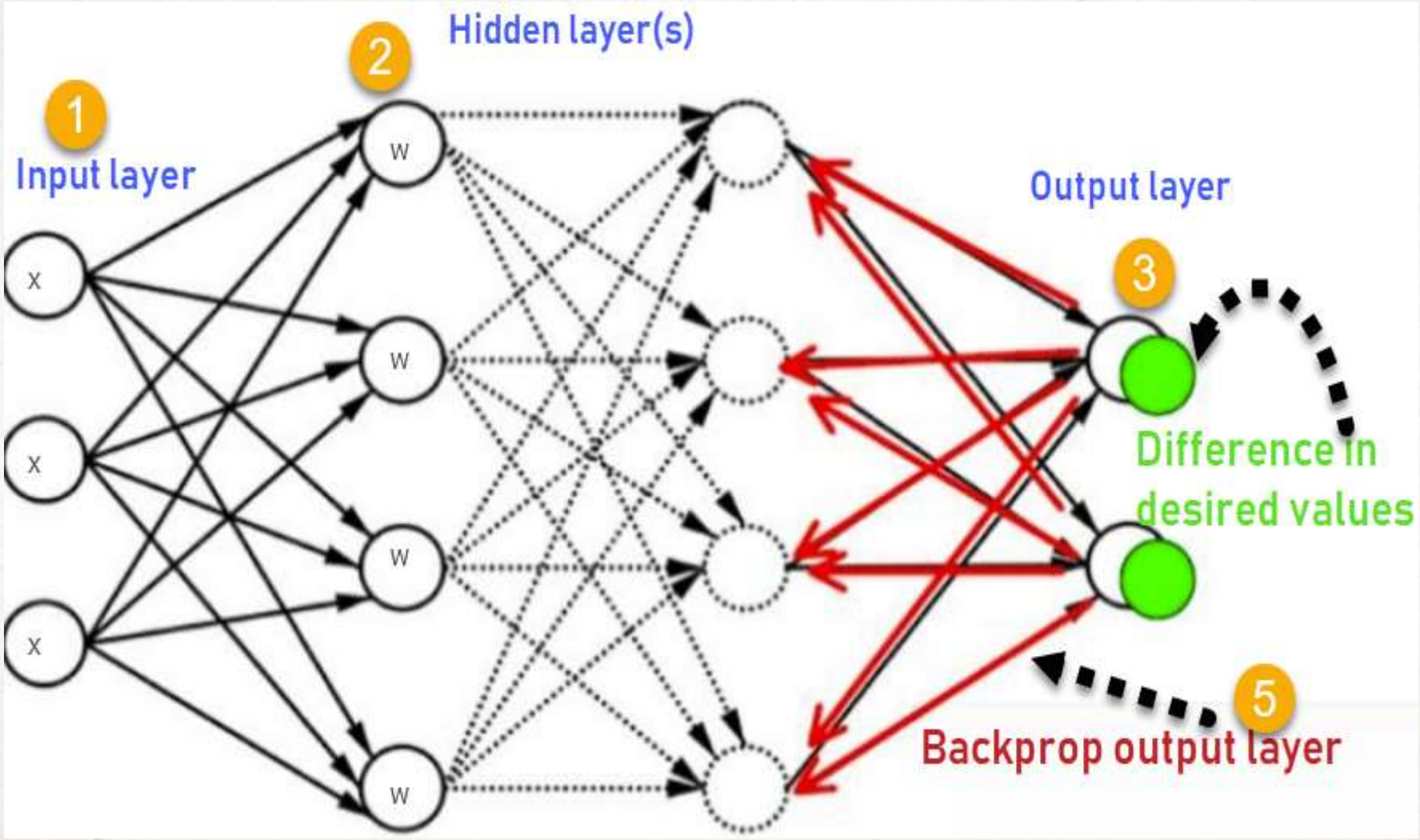
Principal Component Analysis

- The principal component analysis (PCA) is a kind of algorithms in biometrics.
- Principle component analysis is the most popular methods used mainly for dimensionality reduction in recognition problem to extract the region of interest (ROI) features.
- This is done by the removal of redundant and unwanted data economically.
- PCA is employed to map data from a high dimensional space to a low dimensional space by a mathematical procedure using its linear transformation

Back Propagation Neural Network Classifier

- Using the Back-Propagation technique, the algorithm works to match twelve fingerprint parameters and relate them to a unique number provided for each authorized user.
- Upon matching, the algorithm returns the best match for the given fingerprint parameters.
- **Backpropagation** is the essence of neural network training.

Mechanism Of Backpropagation



How Backpropagation Algorithm Works?

1. Inputs X, arrive through the preconnected path
2. Input is modeled using real weights W. The weights are usually randomly selected.
3. Calculate the output for every neuron from the input layer, to the hidden layers, to the output layer.
4. Calculate the error in the outputs.

   Error = Actual Output – Desired Output

5. Travel back from the output layer to the hidden layer to adjust the weights such that the error is decreased.

- Keep repeating the process until the desired output is achieved

Why We Need Backpropagation?

- Most prominent advantages of Backpropagation are:
- Backpropagation is fast, simple and easy to program
- It has no parameters to tune apart from the numbers of input
- It is a flexible method as it does not require prior knowledge about the network
- It is a standard method that generally works well
- It does not need any special mention of the features of the function to be learned.

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- Wu F, Zhu J, Guo X. Fingerprint pattern identification and classification approach based on convolutional neural networks. Neural Comput Appl 2020;32: 5725–34.

Thank You