# Chapter 48
# Fingerprint Matching Using Rotational Invariant Orientation Local Binary Pattern Descriptor and Machine Learning Techniques

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## ABSTRACT

*The objective of this article is to propose rotation invariant fingerprint descriptor, and a faster and better generalized performance classifier. The author proposes a new multi-resolution analysis based fingerprint descriptor, computed from fingerprint orientation pattern called as orientation local binary pattern (OLBP). The feature vector is constructed by concatenating the OLBP histograms obtained from tessellated ROI of distorted fingerprint images. Secondly, the author proposes a hybrid classifier, which combines a powerful extreme learning machine (ELM) and a well generalized resilient propagation (RPROP). Finally, they propose two hybrid training algorithms using ELM and RPROP. The matching accuracy of 99.9% validates the performance of the proposed OLBP features and the proposed hybrid classification algorithms perform better as compared to the original ELM.*

## 1. INTRODUCTION

Fingerprint based biometrics is perhaps the most deeply investigated research problem in the literature and still a very active research area for personal identification. The fingerprint properties like, collectivity, acceptability, uniqueness, universality etc. make it practical and popular to be implemented in our networked society. Fingerprint images are represented by the pattern of ridges and furrows on human

DOI: 10.4018/978-1-7998-2460-2.ch048

fingertips, which are considered as oldest and highest reliable biometrics (Maio and Jain, 2009; Berry and Stoney, 2009). If one looks at the finer details of these ridge and furrows, local and global characteristics point are observed on these ridges. These local characteristics points are ridge bifurcation and ridge termination and are also known as minutiae points. Minutiae features like coordinates, direction with respect to x-axis, and type (bifurcation or termination) are represented by a tupple shown as {x, y; θ; t}. The global features normally provide the information about singularities or Singular Points (SP) such as core and delta points. Most important point is the core point, which is the point of highest curvature lies on innermost ridge and is used as a reference for fingerprint registration. Global features are used for fingerprint classification, fingerprint matching, and alignment (Hong and Jain, 1999; Kawagoe and Tojo, 1984; Jain et al., 2000).

Automatic Fingerprint Matching System (AFMS) is a computer based techniques for human recognition and operates in two modes, Verification mode (1: 1 matching) or Identification Mode (1: N matching). The fingerprint matching algorithms are mainly classified into three categories: (i) minutiae-based, (ii) Pattern or image-based matching, and (iii) correlation based matching. Most of the algorithms proposed in the literature belong to the first category (i.e. minutiae-based). Minutiae based algorithms search the best alignment of minutiae points between input and query image to find the match or non-match (Jiang and Yau, 2000; Liu et al., 2000). A well–known algorithm, proposed by Tico and Kuosmanen (2003) utilizes minutiae points and directional information around the minutiae for matching. An image-based algorithm extracts the features vector from gray scale fingerprint images and performs matching by means of distance based matcher or statistical classifier (Jain et al., 2000; Yang et al., 2006). In correlation based matching algorithms input and query images are compared to maximize the correlation at different alignments to find the match (Maio and Jain, 2009; Bazen et al., 2000; Karna et al., 2008).

Due to the poor image quality and diverse input conditions, minutiae based algorithms results in low matching accuracy. In additions to this, a minutia based algorithms also does not fully utilizes the rich discriminatory information of fingerprints.

Ojala et al. (2002) proposed a powerful method for texture description at the circular neighborhood of an image or a part of an image, known as Local Binary Pattern (LBP). LBP is the most widely used descriptor because of low computational complexity, resistive to intensity variation and has ability to extract the finer details. In recent years LBP operator and its variants have been used in almost all image processing applications such as facial expression detection (Fasel & Luettin, 2003; Shan et al., 2009), Face detection (Ahonen et al., 2004; Liao et al., 2007, Zhang et al., 2010), remote-sensing image analysis (Lucieer et al., 2005;), classification problems such as biomedical images (Sorensen et al., 2010)) and biometrics (Wang et. Al., 2006; Nanni & Lumini, 2008). Numerous variants such as Local Ternary Pattern (LTP) (Nanni et al., 2011), 1 dimensional Local Binary Pattern (1DLBP) (Benzaoui & Boukrouche, 2013) Centralized Binary Pattern (CBP) (Fu & Wei 2009), Completed Binary Pattern (CLBP) (Zhao et. al., 2012), and Fuzzy LBP (FLBP of the original LBP have been proposed in the recent years. Nanni et al., (2012) proposed the use of LBP and its variants for fingerprint matching. A hybrid approach proposed by Nanni and Lumini (2008) utilizes the Invariant LBP features, extracted from fingerprint sub images after convolution with Gabor filters for fingerprint matching.

Machine learning based algorithms have been widely used in the literature for fingerprint image preprocessing (Jia et al., 2007), feature extraction (Yang et al., 2005), recognition (Jia et al., 2007; Yang et al., 2013), and classification (Wilson et al., 1993). Neural Network (NN) has been successfully applied since many years to the regression and classification problems. NN has a very wide range of applications ranging from business applications to medical, Defense, telecomm and many more. Yang and