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# Implementation and Comparative Analysis of Rotation Invariance Techniques in Fingerprint Recognition

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**ABSTRACT**
In the image processing systems, the input image is first preprocessed, which may involve restoration, enhancement or just proper representation of the data. The most significant problem in image analysis is the detection of presence of an object within a given scene or an image. Such a problem occurs in trademarks classification and other areas like remote sensing for monitoring growth patterns within urban areas, weather prediction from satellite, target detection from radar or from the fighter plane etc. For this purpose template detection or template matching is the most commonly used technique. Using Rotation Invariant Template matching the object of interest can be easily searched even if it is rotated at any angle within the query image. In this paper, Rotation Invariant Template Matching is used for fingerprint identification, biomedical imaging, remote sensing and feature tracking.

***Keywords:*** Biometrices, Fingerprint Recognition, Rotation

## I. INTRODUCTION

Biometric system is an imperative area of research in recent years. Biometrics refers to the use of distinct physiological and behavioral characteristics to identify individuals automatically and has the ability to distinguish between an authorized person and imposter. Physiological characteristics include fingerprint, face, retina iris etc. and these characteristics are unique to every person [1]. Among all biometrics (e.g., face, fingerprint, hand geometry, iris, retina, signature, voice print, facial thermo gram, hand vein, gait, ear, odor, keystroke dynamics, etc.), fingerprint-based identification is one of the most mature and proven technique.

Nowadays, fingerprint recognition is one of the most important biometric technologies based on fingerprint distinctiveness, persistence and ease of acquisition. Although there are many real applications using this technology, its problems are still not fully solved, especially in poor quality fingerprint images and when low-cost acquisition devices with a small area are adopted. In fingerprint recognition process, the important step which affects on system accuracy is matching between template and query fingerprint.

## II. FINGERPRINT RECOGNITION

A fingerprint is comprised of ridges and valleys. The ridges are the dark area of the fingerprint and the valleys are the white area that exists between the ridges. Fingerprint recognition (sometimes referred to as dactylos copy) is the process of comparing questioned and known fingerprint against another fingerprint to determine if the impressions are from the same finger or palm. It includes two sub domains: one is fingerprint verification and the other is fingerprint identification. In addition, different from the manual approach for fingerprint recognition by experts, the fingerprint recognition here is referred as AFRS (Automatic Fingerprint Recognition System), which is program based.

However, in all fingerprint recognition problems, either verification (one to one matching) or identification (one to many matching), the underlining principles of well defined representation of a fingerprint and matching remains the same[2].

## III. TRANSFORMS USEDIN PROPOSED MODEL

Rotation invariant moments and transforms are such processes, which successfully deal with these situations. There are two types of rotation invariant moments and transforms: orthogonal and non orthogonal. The orthogonal rotation invariant moments (ORIMs) and orthogonal rotation invariant transforms (ORITs) are more effective in performance because they have minimum information redundancy and hence better information compactness. A few low order moments and transforms are sufficient to capture the essential features of an image.

The ORITs that were introduced in [3] include the polar complex exponential transforms (PCET), polar cosine transforms (PCT) and polar sine transforms (PST). These transforms are collectively known as PHTs. The difference between ORIMs and ORITs is that the radial parts of the kernel functions in ORIMs are polynomials and in ORITs these are sinusoidal functions.

The PHTs are preferred to ORIMs because PHTs are computationally very fast [4] and the high order transforms are numerically stable, where as the ORIMs are less efficient and high order moments are numerically unstable. Because of their attractive features, PHTs have recently been used in many image processing applications. In [5], authors observed that PHTs-based features yield results comparable to state-of- art methods for fingerprint classification.

An extensive evaluation of invariance property of PHTs for image representation in terms of rotation, scale and noise has been conducted [6]. The authors observed that the ORITs are more suitable than ORIMs for applications, which require many features. The results are compared with ZMs and PZMs, and it is observed that the performance of PHTs is better than that of ZMs and PZMs.

The PHTs on Radon images for object recognition is applied [7] and the authors also compared their results with that obtained by ZMs, OFFMs and Radial Fourier Mellin moments. Through the theoretical analysis and experimental results, it is observed that the performance of PHTs for image description is much better than the three moments especially under noisy conditions.

In this paper, we propose a method for the fast computation of the PHTs by developing recursive relations for the radial and angular parts of the kernel functions of the transform. An 8-way symmetry/anti-symmetry property is used to enhance the speed of the algorithm.

We have also studied the comparative analysis on these Rotational Invariant Techniques on basis of False Matching Ratio (FMR), False Rejection Ratio (FRR) or False Non-Matching Ratio (FNMR) and Accuracy.

## IV. PERFORMANCE ANALYSIS

Fig 1 shows the steps implemented in the proposed model. Table 1 shows the False Acceptance Rate (FAR) and False Rejection Rate (FRR) at different Threshold values. The values in this table are obtained using first rotation Invarint technique known as Polar Sine Transform (PST) which varies at different angles (eg: 120 145 160). Table 2 shows the FAR and FRR at different Threshold values obtained using first rotation Invarint technique known as Polar Cosine Transform (PCT) which varies at different angles (eg: 120, 145, 160). Table 3 shows the FAR and FRR at different Threshold values obtained using first rotation Invarint technique known as Polar Cosine exponential Transform (PCET) which varies at different angles (eg:120,145, 160). Fig 2, Fig 3 and Fig 4 shows the FAR & FRR with different values of Threshold on basis of PST, PCT, PCET respectively.

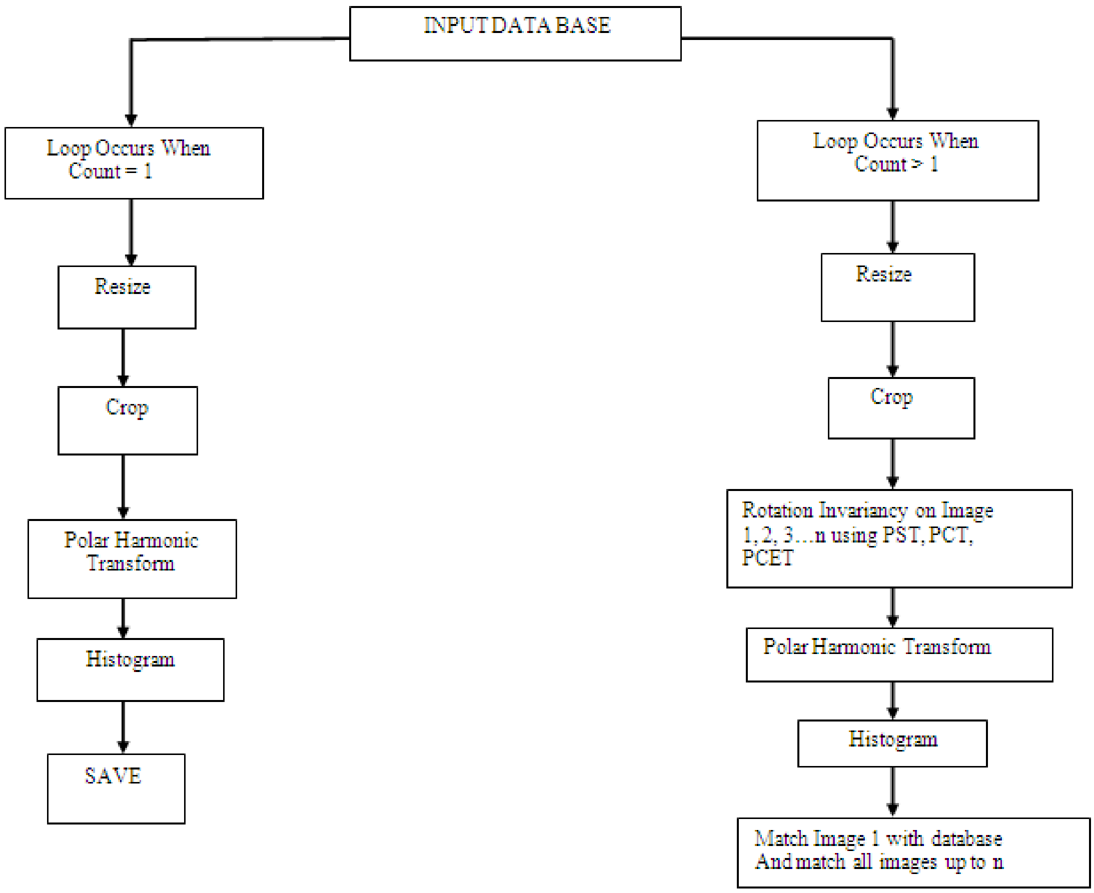



Figure 1: Framework of the Proposed Model

Table 1: PST Performance

| | Threshold 1 | Threshold 2 | Threshold 3 |
|---|---|---|---|
| Threshold | 4 | 6 | 8 |
| False Accept | 0 | 3 | 6 |
| False Accept % | 50% | 33.3% | 25% |
| False Reject | 0 | 3 | 6 |
| False Reject % | 50% | 66.6% | 75% |
| Accuracy | 100% | 50% | 33% |

Table 2: PCT Performance

| | Threshold 1 | Threshold 2 | Threshold 3 |
|---|---|---|---|
| Threshold | 4 | 6 | 8 |
| False Accept | 3 | 3 | 0 |
| False Accept % | 0% | 66.6% | 75% |
| False Reject | 3 | 3 | 0 |
| False Reject % | 100% | 33.3% | 25% |
| Accuracy | 0% | 100% | 100% |

Table 3: PCET Performance

| | Threshold 1 | Threshold 2 | Threshold 3 |
|---|---|---|---|
| Threshold | 3 | 4 | 6 |
| False Accept | 0 | 2 | 0 |
| False Accept % | 33.3% | 83.3% | 66.6% |
| False Reject | 0 | 2 | 0 |
| False Reject % | 66.6% | 16.6% | 33.3% |
| Accuracy | 100% | 125% | 100% |

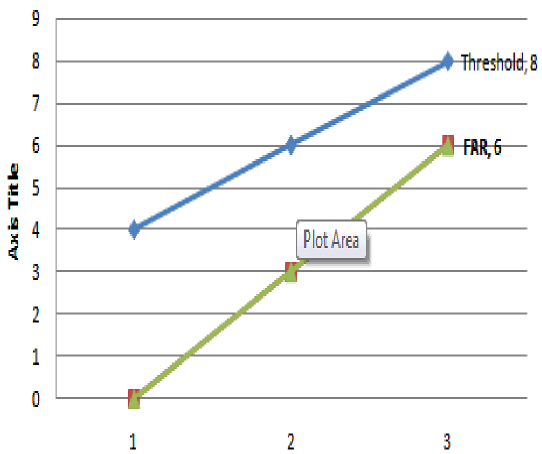



Figure 2: FAR & FRR vs. Threshold on basis of PST

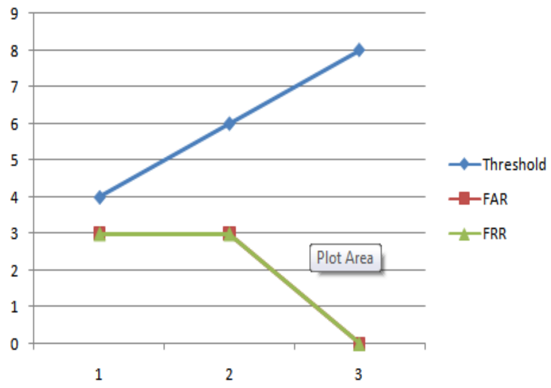
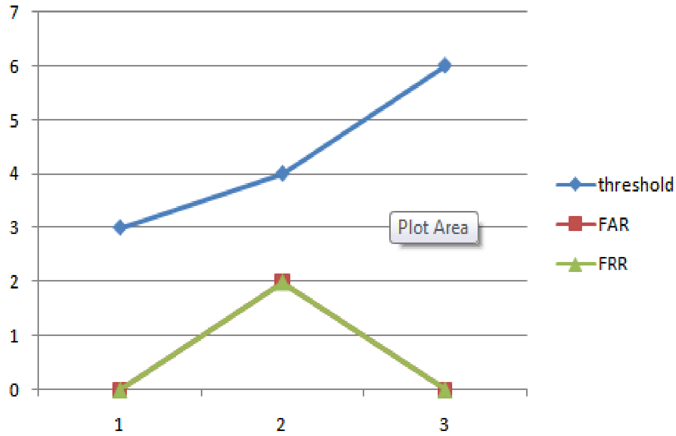



Figure 3: FAR & FRR vs. Threshold on basis of PCT




(c)

Figure 4: FAR & FRR vs. Threshold on basis of PCET

## V. CONCLUSION AND FUTURE WORK

In this paper, we have presented rotation invariancy in fingerprints by applying different techniques i.e. PHT, PCT, PCET. A fast method is developed in this paper for the calculation of PHTs. The comparison is made among all these three techniques with different threshold values and FAR, FRR are obtained by rotating images at different angles. This shows that the proposed method is suitable for applications where PHT coefficients are used as features in real-time environment involving large databases or on devices with low computation power. In future, these techniques can be used with Support Vector Machines (SVM) to provide better results.

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