# Palmprint Identification: Status and Strategies Analysis

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**Abstract: Palm print identification is a crucial component of handprint identification and serves as a technical method for confirming personal identity in investigative case-solving and judicial litigation. Currently, in practical applications, issues such as the lack of scientific identification methods, absence of clear identification standards, poor stability of certain minutia, and insufficient attention from identification personnel have led to a situation where there is a scarcity of relevant theoretical guidance and practical achievements, slow research progress, questionable scientific validity, and low efficiency in practical applications. To address these issues, improvements should be made by focusing on identification features, scientific methods, and the personnel involved in identification, aiming to fill the gaps, rectify inadequacies, and enhance the application efficiency of palm print identification.**

**Keywords: Palm Print Identification; Strategies**

## 1. Introduction

Handprint identification is a technical means used to confirm personal identity in investigative case-solving and judicial litigation. Since the recognition of handprints as a basis for personal identification, it has been widely adopted by countries around the world. It has become a powerful tool for investigative agencies to lock onto or exclude criminal suspects and serves as key evidence for judges in making convictions. Handprint identification encompasses both fingerprint and palmprint identifications. However, current research in handprint identification focuses more on fingerprints and less on palmprints. There are two main reasons for this: firstly, fingerprints are more likely to be retrieved than palmprints in crime scene investigations; secondly, compared to fingerprints, palmprints have a larger area, more feature points, and more complex spatial relationships, making them more challenging to study. Due to these reasons, palmprint identification currently shows limited research outcomes and a low application rate in practice. With the rapid development of artificial intelligence, breakthroughs in automatic fingerprint recognition technology have significantly improved its application in both public security and criminal justice domains. To apply this technology to palmprint recognition and address the difficulty of manual palmprint comparison, many scholars are actively researching automatic palmprint recognition using AI technologies [1, 2]. The research and development in automatic palmprint recognition technology have greatly enhanced the efficiency of palmprint comparison, offering considerable convenience to the field of palmprint identification. Consequently, technical departments worldwide are actively implementing palmprint identification applications. Given the current scarcity of theoretical and practical research in palmprint identification, it is primarily being conducted in a manner similar to fingerprint identification. However, the author believes that palmprints and fingerprints have certain differences and that palmprint identification should not merely replicate fingerprint identification methods. To improve the reliability and usage of palmprint identification, further research is needed for its standardized application.

## 2. Current Situation and Problem Analysis

## 2.1 Lack of Scientific Palmprint Identification Methods

In 2019, the Ministry of Public Security of the People's Republic of China issued standards related to handprint identification, including the "Forensic sciences — Code of practice for fingerprint identification " and the "Specifications for Handprint Identification Reports." The former sets out the steps and requirements for fingerprint identification, including how to compare and evaluate fingerprints, while the latter specifies the classification, format, content, archiving, and effective content of handprint identification documentation in the field of forensic science. Overall, these standards provide a framework for the identification process and documentation, but they do not address specific identification methods. Therefore, in handprint identification activities, most identification actions are influenced by the subjective cognitive abilities of the identifier. For example, in preliminary examinations, it is required to observe the overview of the handprint, determine the formation method, type, location of the residue, and examination conditions of the handprint. However, when examining and identifying handprints, especially palmprints, it is challenging to obtain specific information such as the actual location of the palmprint residue, the suspect's residual actions at the scene, and the environmental conditions. These factors require subjective judgment based on personal experience, and these judgments can influence the conclusion of the identification. Of course, the subjective cognitive ability of the identifier not only involves making preliminary judgments about the formation method, type, and residue location of the handprint but also includes considering factors such as incompleteness, blurriness, deformation, and overlap [3]. These subjective considerations can lead to different conclusions for the same handprint identification task, depending on the identifier's cognitive ability to understand the handprint. Consequently, the scientific nature of handprint identification has always been controversial. Palmprint identification is relatively more complex in practical applications. It relies more on subjective cognitive abilities compared to fingerprint identification and is more complicated. Therefore, the reliability and scientific nature of palmprint identification conclusions are even more prominent issues.

## 2.2 Lack of Clear Standards for Palmprint Identification

Currently, in judicial practice where handprint identification opinions serve as litigation evidence, there is no unified regulation on how many minutia need to match for handprints in evidence to be considered identical to sample handprints, assuming that their types and characteristics are the same. Different countries have varied standards for fingerprint identification, such as 8-12 in Germany, 12 in France, and no minimum standard in major countries like China, the USA, Canada, and Australia [4]. In practice, however, it is generally accepted in China and many other countries that fingerprint identification only requires about 8 matching minutia. Moreover, many experts believe that specific cases should be analyzed individually, and under certain circumstances, even three matching minutia may suffice for identification [5]. In actual palmprint identification processes, practitioners, based on standards for fingerprint identification, subjectively assume that since the area of a palmprint is larger than a fingerprint, a match of 12 or more minutia in palmprints is sufficient for identical identification. This method of deducing palmprint identification standards from fingerprint standards is a highly mechanical, one-sided, and imprecise approach.

## 2.3 Poor Stability of Some Minutia in Palmprints

The types, shapes, sizes, directions, angles, numbers, compositions, and distribution relationships of minutia in handprints are the fundamental reasons for individual uniqueness in fingerprints and serve as the main basis for personal identification. The most common minutia include nine types: ridge endings, bifurcations, dots, short ridges, lakes, islands, spurs, bridges, and crosses [6]. These nine types of minutia are widely used in fingerprint identification practice due to their good stability. In palmprint identification practice, the author has found certain differences in the stability of minutia between palmprints and fingerprints, particularly with unstable features like dots and islands in palmprints. For instance, some palmprints have fine dot lines that could be mistaken for dots during examination, and not all samples and evidence

might reflect these fine dot line traces, as shown in Figure 1. This discrepancy could result from factors like the force applied by the palm, the object's surface impressionability, and the grasping action of the hand. Therefore, in palmprint identification practice, a single dot or island difference should not be considered a fundamental discrepancy to serve as a basis for rejection; a comprehensive judgment should be made based on the specific situation.
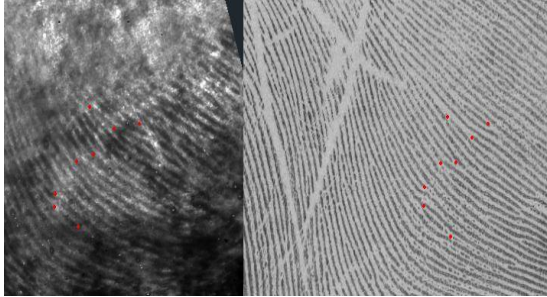


**Figure 1 Comparative Diagram of Fine Dot Line Differences in Palmprints of the Same Individual from a Scene and a Sample**

In addition to fine dot line traces, palmprints are also prone to interrupted ridge lines, creating the illusion of an extra ridge ending and bifurcation, as shown in the blue dots in Figure 2. In such cases, where a ridge line appears interrupted in the palmprint from the scene but continuous in the sample, care must be taken when comparing the start and end points of these interrupted lines, and one should not hastily use these differences as a basis for rejection.
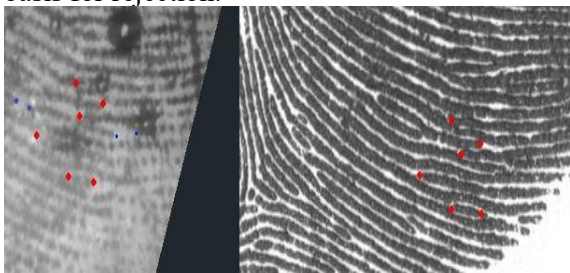


**Figure 2 Comparative Diagram of Interrupted Line Differences in Palmprints of the Same Individual from a Scene and a Sample**

## 2.4 Insufficient Attention to Palmprint Identification by Examiners

During the collection of materials related to palmprint identification and the survey of handprint experts, it was found that in judicial practice, examiners generally do not place high importance on palmprint identification.

This is evident in two main aspects. Firstly, there are few scientific research papers on palmprint identification, with only a handful of special cases available for reference. These cases are mostly based on practical experience, with little related theoretical research. Secondly, in the practice of palmprint identification, examiners tend to be arbitrary in their approach, especially regarding the use of features and the determination of the number of feature points. This approach is highly subjective, and there is often a forced or even dismissive interpretation of blank and blurred areas in palmprints. The reasons for the aforementioned situation are primarily due to the ongoing unresolved scientific issues in fingerprint identification, which has led many scholars to feel intimidated, believing that the scientific problems in palmprint identification are even more challenging to resolve. Therefore, palmprint identification is only applied based on experience, without further in-depth theoretical research to verify its scientific validity. Furthermore, most of the experts with extensive experience in palmprint identification are practical experts, and the majority have limited ability to transform practical experience into theoretical knowledge. This limitation results in issues in palmprint identification being confined to individual understanding, without forming a body of theoretical knowledge for broader dissemination. Consequently, these issues fail to gain sufficient attention and recognition from a wider audience.

## 3. Strategic Analysis

### 3.1 Reassessing the Value of Palmprint Features

The concept of three levels of features has been introduced in handprint identification: Level one includes fingerprint type features, such as pattern type, the inclination of the central pattern, the number of lines between the center and left/right deltas, and the flow, curvature, and density of ridges; Level two consists of minutia like type, location, distance, direction, shape, and number; Level three involves features like ridge line edge morphology, width, direction, fine dot lines, and pores [7]. In fingerprint identification practice, identification is primarily based on level two features. This method has been

directly applied to palmprint identification, but as previously discussed, it has some issues. The author suggests that we could learn from the experience and methods of fingerprint identification and, in combination with the characteristics of palmprints such as more crease lines and fine dot lines, reclassify palmprint features into three levels. First, we should organize all available palmprint features, such as considering adding crease line and fine dot line features. Second, we should reassess the stability and specificity of available features, starting from the value and quality of the features to divide them into three or more levels. Analyzing the usable features of palmprint identification is fundamental, and we should start with the reliability of the features to improve the reliability of identification conclusions, thereby enhancing the scientific nature and evidentiary strength of palmprint identification.

## 3.2 Strengthening the Scientific Research on Palmprint Identification

### 3.2.1 Standardizing Palmprint Identification Procedures

In 2016, Hu Jiadong [8] pointed out that in China's judicial identification theory and practice, most doctrines and methodologies adopted the Soviet model, which has been stagnant in the field of identity confirmation for a long time. This has led to increasingly prominent issues in the scientific, standardized, and institutionalized development of China's judicial identification. By comparing the handprint identification procedures of China and the USA, it was suggested that China could strengthen the scientific nature of handprint identification by formulating and amending specific rules and standards, and increasing substantive review of handprints to avoid subjective and intuitive judgments of the examiners. Since palmprint identification is more complex than fingerprint identification, the author believes that a corresponding review mechanism should be introduced in palmprint identification to further enhance its scientific nature and rigor. Meanwhile, further technical standards should be established, specifying aspects such as palmprint analysis, feature comparison, and comprehensive evaluation, including how to review whether palmprints meet the conditions for identification, standardizing the method of feature comparison, and clarifying the determination and negation methods of difference points in comprehensive evaluation. This approach aims to minimize the impact of subjective judgments of examiners on the identification conclusion, thereby ensuring the objectivity and reliability of the conclusions.

### 3.2.2 Researching Effective Standards for Palmprint Identification

Fingerprint identification standards refer to the criteria and scales used to analyze and evaluate matching and differing features in fingerprint identification, leading to the conclusion. The theoretical and practical community has tirelessly explored fingerprint identification standards, resulting in various approaches such as the minimum feature number standard, quality-quantity standard, area-quality quantification standard, topological methods and standards, and morphological methods and standards [9]. In domestic fingerprint identification practice, the quality-quantity standard has been widely applied [10], and this standard has been mechanically transposed into palmprint identification. However, with the increasing data in fingerprint databases, the issue of similar but non-identical fingerprints has become more prominent. Clearly, a single quality-quantity standard cannot meet the current needs of fingerprint identification. Additionally, palmprints differ significantly from fingerprints in terms of area and the probability of feature variation. Therefore, directly applying fingerprint identification methods and standards to palmprint identification presents significant issues. To ensure the reliability of palmprint identification conclusions, it's crucial to develop a set of scientific standards suitable for palmprint identification.

In practice, conclusions in domestic fingerprint identification mainly fall into three categories: "identification," "negation," and "inconclusive." Many scholars suggest introducing a probabilistic expression to make the identification results more quantifiable and objective, thus enhancing the evidential value of fingerprint evidence. The author believes that palmprint identification can learn from the probabilistic expression achievements of fingerprint identification, actively incorporating this scientific expression method into palmprint identification. By resolving the scientific issues of palmprint identification

standards quantitatively, the reliability and evidential strength of palmprint identification can be enhanced.

### 3.3 Enhancing Understanding of Palmprint Identification among Examiners and Relevant Personnel

Through related research, it has been found that professionals currently engaged in handprint identification mainly have extensive experience in fingerprint identification, but lack deep understanding and practical experience in palmprint identification. To increase the utilization rate of palmprints, on one hand, operational departments have already started to demand the entry of palmprints, so professionals in handprint identification should also timely enrich their theoretical knowledge and practical skills in palmprint identification. On the other hand, practical research in palmprint identification should be strengthened to enrich the theoretical knowledge related to it. This includes analyzing which features in palmprints are stable and of high feature value, and identifying common false features in palmprints. Finally, the popularization of palmprint identification knowledge at the grassroots level should be enhanced. Theoretical and practical training for grassroots personnel, especially those involved in palmprint extraction at crime scenes and professionals in palmprint identification, should be intensified to further improve the utilization rate of palmprints.

### 4. Conclusion

Handprints, with their unique characteristics of being "distinct for each individual and essentially unchanging throughout life," are widely used in China's public security and judicial practices. However, this widespread application primarily refers to fingerprints, and consequently, theoretical and practical research on handprint identification has largely focused on fingerprint identification. With the rapid development of handprint identification technology, the applicative value of palmprint identification has become increasingly prominent. However, palmprint identification faces many challenges. It not only encounters unresolved scientific issues present in fingerprint identification but also deals with the extreme instability of certain minutia

commonly used in fingerprint identification when applied to palmprints. In this context, continuing to apply fingerprint identification methods and procedures to palmprint identification is not rigorous.

To resolve the current issues in palmprint identification and enhance its reliability and evidentiary strength, we should start with the essence of its identification, reevaluating the value of its usable features and establishing a feature system unique to palmprints. Simultaneously, by drawing on the research findings in fingerprint identification, we should actively address the scientific issues in the procedures and standards of palmprint identification.

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