



Establishing Identity of Accused Person from Negative Image Fingerprint-A Case Study

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Abstract

The fingerprint science is the most positive means of identifying an individual. Fingerprint science provides positive identification and establishes the identity of a criminal with the crime. This study focuses on a unique challenge encountered in a high-profile impersonation case related to the Vyapam scam in Bhopal, India. The fingerprint captured on the Optical Mark Recognition (OMR) answer sheet during the examination is vital evidence related to the impersonation cases of various competitive/recruitment/admission in higher education examinations, etc. In this case the questioned fingerprint recorded on the OMR answer sheet at the time of examination was not properly recorded, and intentional manipulation, including excessive pressure and deliberate distortion, was employed to obscure the true identity of the individual who submitted the fingerprint, so as to conceal the identity of the accused person/solver/impersonator as well as to mislead the fingerprint expert also. This manipulation resulted in a colour reversal phenomenon, or negative image, where the furrows were mistakenly interpreted as ridges, effectively creating a deceptive fingerprint image. This case is related to the Vyapam scam case in Bhopal, and the thumb impression recorded on the Optical Mark Recognition (OMR) answer sheet was found as a colour reversal image of ridge details. This colour reversal image of ridges appears as dissimilarities because the disputed finger is formed by the furrows instead of ridge details so that the identity of the accused person can be hidden easily. To overcome these challenges, advanced image processing techniques were implemented to enhance the quality of the distorted fingerprint. Through the application of specialized filters and image enhancement algorithms, the true ridge patterns are successfully extracted. Subsequent comparison of the enhanced fingerprint with the suspected individual revealed a positive match, thereby aiding in the identification of the suspected person/solver/impersonator.

Keywords: Fingerprint; Identification; Solver; Impersonation; Investigation; Image Processing; Hide; Friction Skin; Ridge and OMR Answer Sheet

Abbreviations

OMR: Optical Mark Recognition.

Introduction

The palmer surface of the hands, fingers, and soles of the feet, including the toes, is covered with a special kind of skin. The skin's peculiarity consists of its being formed of minute ridges, which are the raised lines having the mechanical function of helping to prevent slipping when coming in contact with smooth external objects [1]. This skin bearing the ridges is best known as friction skin, and ridges are called friction ridges, and these ridges are formed through lateral pressure between nascent structures. These ridges are first discernible in the fourth month of fetal life and are fully formed by the sixth month of fetal life. These ridges are characterized by the numerous minute peculiarities called minutiae or ridge characteristics, and these minutiae are formed as the epidemic units have a tendency to combine in various ways, like a break is caused where the unit belongs, and two adjacent ridges fuse across the interspace. The friction skin bears some elevated and depressed lines; the elevated lines are called ridges, and the depressed lines are called furrows on the palmer surface of the hand and the plantar surface of the feet. Once the ridges formed, they never changed from birth to death till the body is decomposed after death. Only the dimension of the pattern may vary or differ from age to age, but the shape and ridge arrangement of the pattern never changed [2].

Accidental injuries or skin diseases, cut marks, burns, ulcers, etc., may change the shape temporarily, but while they will be healed up and cured, the ridges will regain their normal shape, size, and design. Only if there are any deep cuts and the mother layer of skin is affected, then ridge arrangement or ridge characteristics may change. The ridges details

of Egyptian mummies are still unchanged, and it has been scientifically proved that once the ridges are formed, they never change, and they are permanent in nature. The ridges characteristics, or minutiae, differ from finger to finger, man to man, and have their own individuality, just like the law of nature that means no two things are alike in the world, and nature never repeats [3]. This truth also applies to the papillary ridges of fingers, the palms of hands, and the soles of the feet.

According to Dr. Rabagliati, these differences exist because each person is an incarnation of a vital energy and is slightly different in incarnation from every other; the vital energy, which procreates him, translates itself into every anatomical organ and expresses itself in every physiological function, and therefore every particular form must be appropriate to the particular procreator and slightly different from each other. This reason applies to all the areas of friction skin that are covered with papillary ridges on the fingers, palms of the hands, and soles of the feet. The order of arrangement of the ridges and ridge characteristics in their relative position on the finger, palm, and sole of a person is forever different and distinct from the rest of the world, and on the basis of many experiments, it has been proved scientifically that the science of fingerprints can be relied upon as an absolute means of personal identification. Fingerprint science is an absolute science based on fingerprints, by which accurate and positive identification can be made without a shadow of a doubt [4]. This science is so perfect that no innocent person will be harassed or punished, but the actual person will be identified and punished. No branch of science has yet come near fingerprinting as far as identification purposes. That's why fingerprints are often considered one of the most valuable types of physical evidence in the field of forensic science and accepted universally [5].

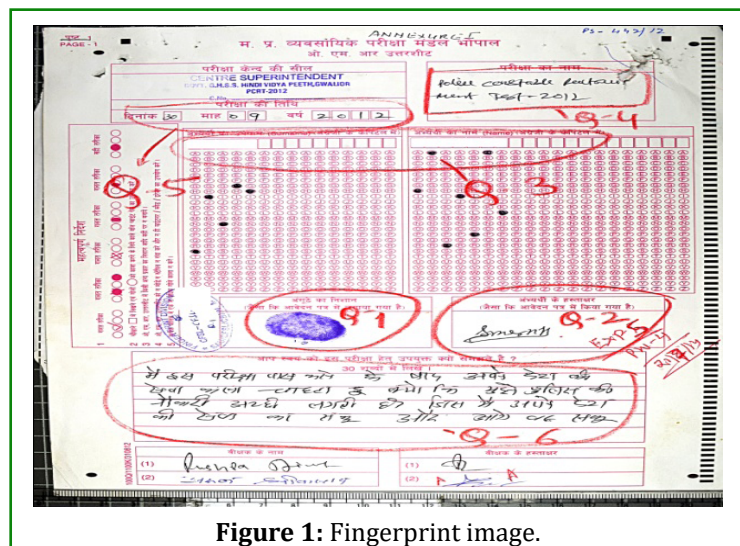


Figure 1: Fingerprint image.

The word 'fingerprint' means prints left on the surface by touching the finger/palm of a person unknowingly or by chance. The fingerprints may be visible or invisible/latent. However, in today's forensic science industry, usage of the term latent prints, means hidden/invisible or any chance of an accidental impression left by friction skin on a surface [6]. It may or may not be visible at the time of deposition. Whenever the fingerprint is recorded on any material/surface due to excess pressure, it becomes a negative or reverse image print. If pore details are present in the fingerprint, colour reversal is apparent by the presence of the pores in what may at first appear to be furrows of the print. In some instances, ridge characteristics may be off by one ridge, and a negative image fingerprint can easily mislead a fingerprint expert for establishing the positive identity [7]. A fingerprint is a reproduction of ridges on the surface by touching the finger/palm of a person, and in the case of a reverse fingerprint, it means the formation of a

fingerprint image on any surface by the furrow, not by the ridges of friction skin, and the fingerprint becomes visible as a colour-reversed fingerprint image (Figure 1) [8].

Materials and Methods

The quality of the questioned thumb impression has been enhanced by using advanced image processing techniques and different types of filters and a completely negative/reverse image of the questioned fingerprints has been prepared [9]. After that, the three times enlarged photographic prints of questioned fingerprint impressions and specimen fingerprint impressions have been prepared and compared with the specimen left thumb impression of the suspected person. Both types of images of questioned fingerprints are shown in Figure 2.

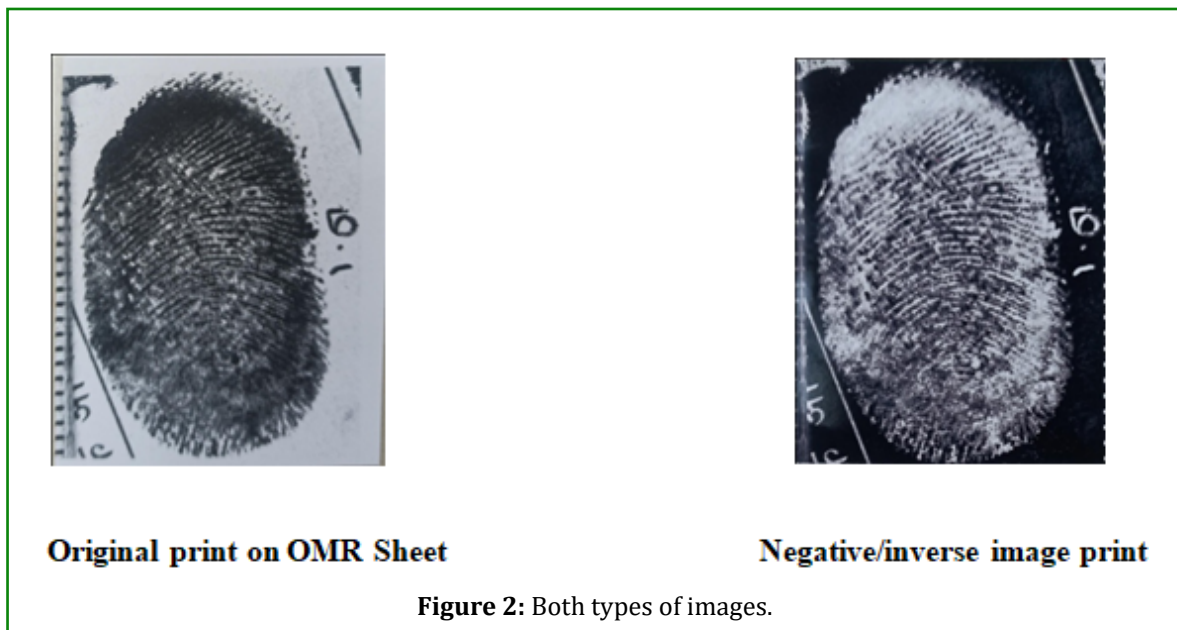


Image Processing Technique

Image processing techniques play an important role in the case of negative or reverse fingerprint impressions recorded on any documents or surfaces [10]. Image processing techniques available in Adobe Photoshop have many features for enhancing the clarity and details of fingerprint ridge characteristics by using various aspects of the images, such as contrast, brightness, and sharpness [11]. Image processing techniques can significantly improve the image quality of any fingerprint image recorded on any surfaces or any material. We can enhance the visibility of ridge details and valley structures with the help of contrast adjustment, like auto contrast, and increase the level of contrast between ridge details and valleys to make them more clearly readable for the purpose of a fingerprint identification system [12]. After

that, I have applied consistent image processing techniques to ensure that the quality of the disputed fingerprint image and specimen fingerprint image must be at a similar level to make them more reliable for fingerprint comparison purposes. Image quality of the disputed fingerprint was also enhanced with the help of clearer features. These techniques allow for more accurate detection of minutiae points in disputed fingerprint impressions as well as specimen fingerprint impressions. Histogram equalization and morphological operation techniques were also used to redistribute the intensity level of an image to improve contrast levels for making ridges and valleys more clearly visible, and with the help of morphological functions, thin ridge details can be visible after filling the gap between the ridge structures [13]. After effectively utilizing these image processing techniques

and capturing the fingerprint image and processing it through a series of image processing algorithms to obtain a clear, unambiguous skeletal image of the original grey tone impression, clarifying smudged areas, removing extraneous

artifacts, and healing most scars, cuts, and breaks, we were able to extract the more accurate and reliable ridge details from the disputed fingerprint impression recorded on the OMR sheet Figure 3.

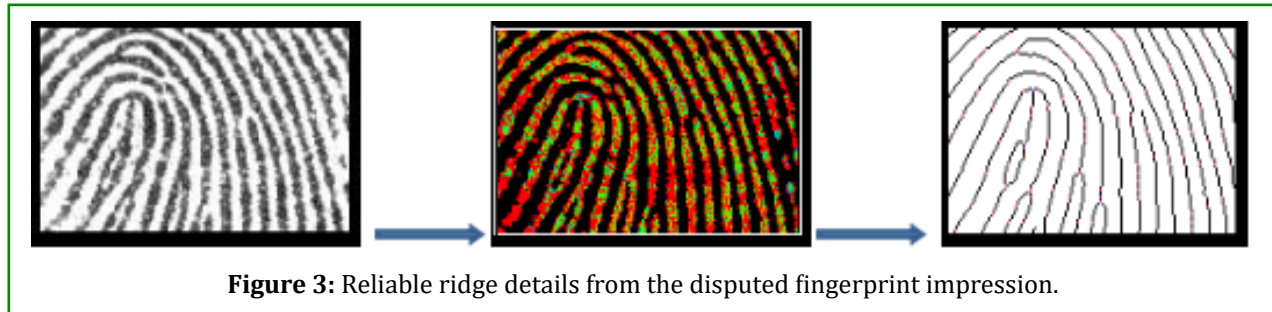


Figure 3: Reliable ridge details from the disputed fingerprint impression.

Results and Discussion

The colour reversal, or negative image, of the fingerprint impression became due to excess pressure applied at the time of recording of the fingerprint, either knowingly or unknowingly. The position and nomenclature of some ridge characteristics also changed in the colour reversal fingerprint image, and this changed ridge characteristics position easily misled the fingerprint expert for identifying the individual because the ridge characteristics present in the disputed fingerprint impression were not in their relative position with the ridge characteristics present in the

specimen fingerprint impression, but they looked as similar in their nature. A negative image or colour-reversed image of the questioned fingerprint recorded on the OMR answer sheet has been prepared by using a series of advanced image processing techniques, and after that, the questioned fingerprint impression marked as Q.1 was compared with specimen fingerprints of the suspected person with scientific aids. And questioned fingerprint marked as Q.1 found identical with specimen left thumb impression of suspected person/solver/impersonator. Image of identical prints shown in Figure 4.

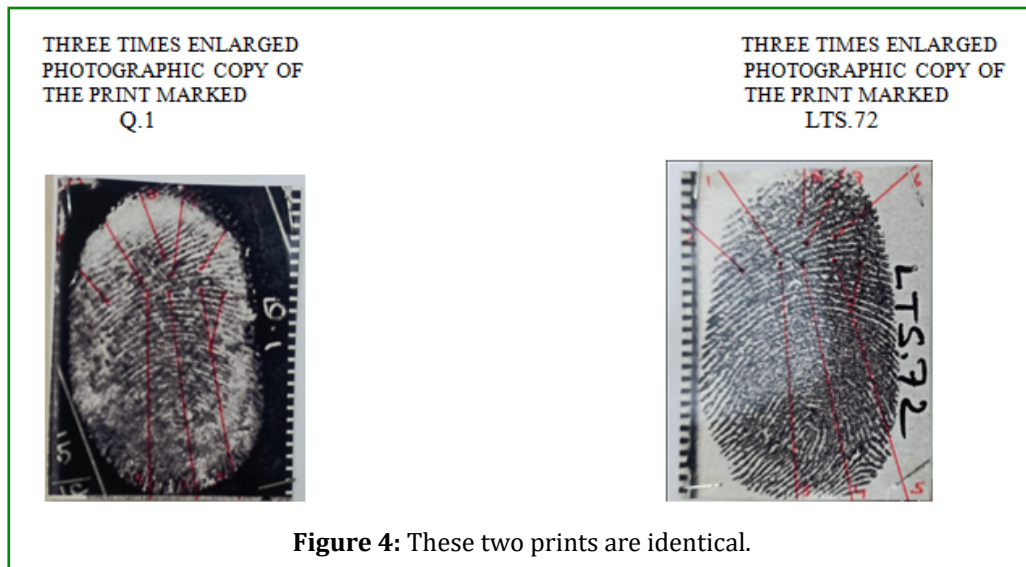


Figure 4: These two prints are identical.

Conclusion

Fingerprint identification is a science, and as such, it has well-defined principles and procedures for its application, i.e., permanency and individuality. Permanency means fingerprints formed even before birth and remain the same throughout life until and unless destroyed by decomposition after death. And individuality means two fingerprints are

identical if both are produced by the same finger of the same person. The main aim of this experiment is to compare the disputed fingerprint very carefully, as the image quality of fingerprints plays an important role in establishing the identity of a person from questioned fingerprints. To the best of my knowledge, the identity of the accused person had been established from the questioned fingerprint print recorded on the OMR answer sheet at the time of examination.

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Ethical Consideration Disclosure

The present study is part of my case-work and does not disclose the identity of the accused person/solver. The author(s) have adhered to all ethical guidelines and standards to ensure the objectivity and integrity of the research.

Conflict of Interest

The author(s) hereby declare(s) that there are no conflicts of interest associated with the research, authorship, and publication of this paper. Specifically, the author(s) have no financial, personal, or professional relationships or affiliations that could be perceived to influence the work presented in this research.

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