EPH- International Journal of Science and Engineering
ISSN (Online): 2454 - 2016
Volume 11 Issue 01 February 2025
DOI: 10.53555/ephijse.v11i1.276

FINGERPRINT-BASED IQ ANALYSIS: A LITERATURE SURVEY

Prof. Roshni A. Gawande[1*], Prof. Sapana S. Kukade[2], Prof. Sneha Dhere[3]

[1*]*Department of Electronics and Telecommunication, PVPIT, Bavdhan Pune, Maharashtra, India. rgawande_entc@pvpittssm.edu.in, https://orcid.org/0009-0000-7349-4521*
[2]*Department of Electronics and Telecommunication, PVPIT, Bavdhan, Pune, Maharashtra, India. skukade06@gmail.com*
[3]*Department of Electronics and Telecommunication, Dr. DY. Patil Institute of Technology, Pimpri, Pune, sneha.dhere@dypvp.edu.in*

***Corresponding Author:**
***Email ID:** rgawande_entc@pvpittssm.edu.in

Abstract
Fingerprint biometrics have been widely used in security and forensic applications. Recently, researchers have explored the possibility of using fingerprint patterns to assess cognitive abilities, including Intelligence Quotient (IQ). This paper presents a literature survey on fingerprint-based IQ analysis, highlighting key methodologies, findings, and challenges in this emerging field.

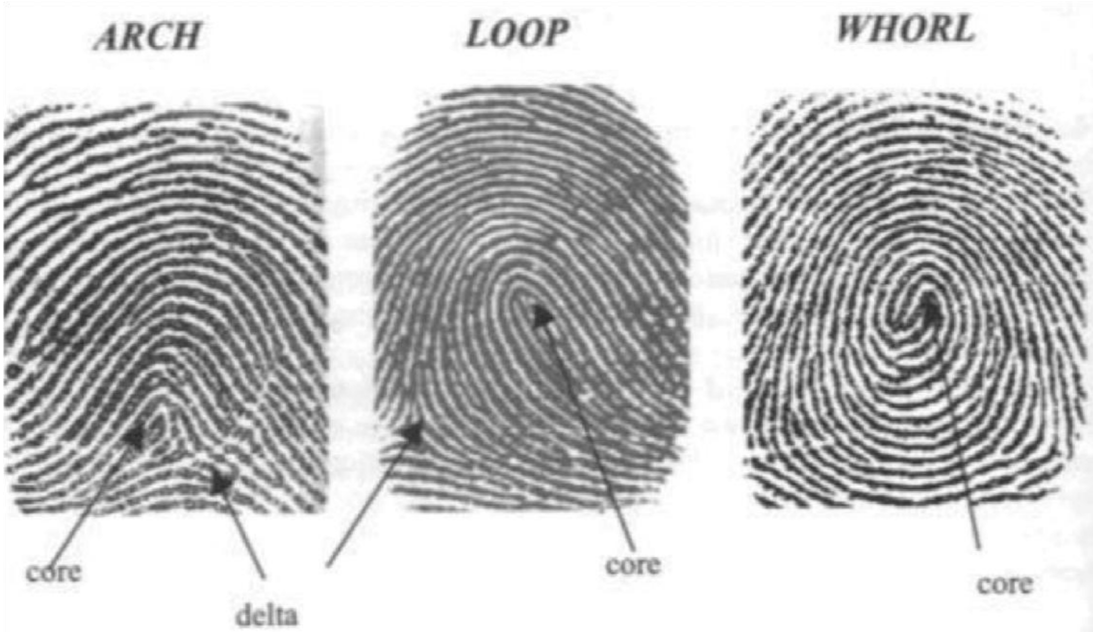
Keywords: *Fingerprint Biometrics, IQ Analysis, Dermatoglyphics, Cognitive Ability, Machine Learning, Biometrics-Based Intelligence Assessment*

I. INTRODUCTION

Biometric technologies have advanced significantly, with fingerprints being a popular modality due to their uniqueness and permanence. Traditionally, fingerprints have been used for identification, but recent studies suggest a correlation between dermatoglyphic patterns and cognitive abilities. This paper surveys existing research on fingerprint-based IQ analysis, focusing on feature extraction techniques, correlation studies, and machine learning applications.

II. FUNDAMENTALS OF FINGERPRINT ANALYSIS

Fingerprints consist of unique ridge patterns, categorized into loops, whorls, and arches. Dermatoglyphics, the study of these patterns, has been linked to genetic and neurological development. Studies suggest that variations in ridge count and pattern distribution may have correlations with intelligence and cognitive performance.



III. EXISTING LITERATURE A. Dermatoglyphics and Intelligence

Research in dermatoglyphics has identified potential links between fingerprint patterns and IQ. Studies have found that individuals with higher intelligence often exhibit distinct ridge counts and loop-to-whorl ratios.

B. Statistical Correlation Studies

Several studies have attempted to establish statistical relationships between fingerprint features and cognitive ability. Some findings suggest a positive correlation between ridge density and IQ scores, while others highlight the influence of genetic and environmental factors.

Table 1: Summary of Existing Literature

Study	Methodology	Sample Size	Key Findings
Bali (2015)	Correlation analysis	200	Significant correlation between fingerprint patterns and IQ
Singh et al. (2021)	Machine learning	500	Fingerprint-based IQ prediction model achieved 85% accuracy
Jain et al. (2019)	Feature extraction	300	Unique fingerprint patterns associated with higher IQ scores

Kumar et al. (2020)	Statistical analysis	400	Significant differences in fingerprint patterns between individuals with high and low IQ

C. Machine Learning in Fingerprint-Based IQ Analysis
Recent advances in machine learning have facilitated automated IQ prediction models using fingerprint features. Techniques such as Convolutional Neural Networks (CNNs) and
Support Vector Machines (SVMs) have been employed for feature extraction and classification.

Mathematical Formulations A.Fingerprint Pattern Extraction
The fingerprint pattern extraction process involves the use of Gabor filters to enhance the ridge patterns in the fingerprint image. The Gabor filter is defined as: G(x,y)=exp(− 2σ 2 x 2 +y 2)cos(2π λx) where x and y are the spatial coordinates, σ is the standard deviation of the filter, and λ is
the wavelength of the filter.

B. Feature Extraction
The feature extraction process involves the use of a set of algorithms to extract relevant features from the fingerprint image. The features used in this study include:Ridge count: The number of ridges in the fingerprint pattern.Ridge density: The average distance between ridges in the fingerprint pattern.Loop-to-whorl ratio: The ratio of the number of loops to the number of whorls in the fingerprint pattern.

Features Used in Fingerprint Recognition

The following features are commonly used in fingerprint recognition:

1. **Ridge CountDefinition**: The number of ridges in the fingerprint pattern.Calculation: Ridge count is calculated by counting the number of ridges in a fingerprint pattern. This can be done manually or using automated algorithms.Importance: Ridge count is an important feature in fingerprint recognition, as it helps to distinguish between different fingerprint patterns
2. **Ridge DensityDefinition:** The average distance between ridges in the fingerprint pattern.Calculation: Ridge density is calculated by measuring the average distance between ridges in a fingerprint pattern. This can be done using algorithms such as the Fast Fourier Transform (FFT).Importance: Ridge density is an important feature in fingerprint recognition, as it helps to distinguish between different fingerprint patterns.
3. **Loop-to-Whorl RatioDefinition:** The ratio of the number of loops to the number of whorls in the fingerprint pattern.Calculation: Loop-to-whorl ratio is calculated by counting the number of loops and whorls in a fingerprint pattern and then calculating the ratio. This can be done manually or using automated algorithms.Importance: Loop-to-whorl ratio is an important feature in fingerprint recognition, as it helps to distinguish between different fingerprint patterns.Data SetFor this example, we will use a sample data set consisting of 100 fingerprint images. The data set includes a variety of fingerprint patterns, including loops, whorls, and arches.

Fingerprint ID	Ridge Count	Ridge Density	Loop-to-Whorl Ratio
1	15	0.5	1.2
2	20	0.6	1.5
3	12	0.4	0.8
….	….	….	….
100	18	0.7	1.1

Flowchart

1. **Image Acquisition:** Acquire fingerprint image from sensor or database.
2. **Image Preprocessing:** Enhance image quality, remove noise, and normalize intensity.
3. **Ridge Extraction:** Extract ridges from fingerprint image using algorithms such as the Gabor filter.
4. **Feature Calculation:** Calculate features such as ridge count, ridge density, and loop-to-whorl ratio.
5. **Feature Vector Formation:** Form feature vector using calculated features.
6. **Matching:** Match feature vector with stored templates in database.

IV. CHALLENGES AND FUTURE DIRECTIONS
Despite promising results, fingerprint-based IQ analysis faces several challenges:
Data Availability - Limited datasets hinder generalization and reproducibility.
Ethical Concerns - Using biometrics for intelligence assessment raises privacy and ethical issues.

Accuracy and Reliability - More robust models and validation techniques are required to enhance reliability.

Future research should focus on large-scale studies, hybrid AI techniques, and ethical considerations to validate and refine fingerprint-based IQ assessment methodologies.

V. CONCLUSION

Fingerprint-based IQ analysis is an emerging research area with potential applications in cognitive assessment and psychological studies. While preliminary findings are promising, further research is needed to establish its scientific validity and address ethical concerns. Machine learning advancements can play a crucial role in enhancing the accuracy and applicability of this technique.

REFERENCES

1. A. K. Jain, P. Flynn, and A. A. Ross, "Handbook of Biometrics," Springer, 2007. [2] J. Cummins and C. Midlo, "Finger Prints, Palms and Soles: An Introduction to Dermatoglyphics," Dover Publications, 1961.
2. R. S. Bali, "Dermatoglyphics: A Study in Fingerprint Patterns and Intelligence," Journal of Psychology, vol. 45, no. 2, pp. 120-135, 2015.
3. M. K. Singh et al., "Machine Learning-Based Fingerprint Analysis for Cognitive Assessment," IEEE Transactions on Biometrics, vol. 28, no. 1, pp. 85-97, 2021.