Design a Potential Analysis using Fingerprint PC Base

Davy Ronald Hermanus$^{1,4}$, Sasmoko$^{2,4*}$, Yasinta Indrianti$^{3,4}$

$^1$Computer Science Department, Bina Nusantara University Bandung, Bandung, Indonesia 40181
$^2$Primary Teacher Education Department, Faculty of Humanities, Bina Nusantara University, Jakarta, Indonesia 11480
$^3$Entrepreneurship Department, Podomoro University, Jakarta, Indonesia 11470
$^4$Research Interest Group in Education Technology, Bina Nusantara University, Jakarta, Indonesia 11480

* sasmoko@binus.edu

Abstract. Fingerprint analysis is a concept that continues to develop to be implemented in various fields. Starting from the forensic needs, nowadays fingerprint analysis can be applied in various fields including education in terms of exploring one's potential. This study is a series of preliminary research that aims to develop fingerprint analysis in relation to the concept of multiple intelligence. The research method used is the Neuro Research method with the main stage of exploratory research. The result of the research is the successful use of a fingerprint detection tool via PC so that it can produce patterns that can be analysed further. This pattern will be developed in the next stage to identify various important aspects and components in multiple intelligence.

1. Introduction

In the last few decades, fingerprint has become an interesting topic to discuss. Since the late 19th century, fingerprints have been used in various forensic investigations to identify a person [1]. Until now, the development of fingerprint has been so rapid that it can be used for various purposes, namely for security keys, attendance and various other analyses. One of the findings of fingerprint analysis devices relates to the detection of patterns is defined in certain areas and associated with a system. This is based on a large number of crimes that occur in the United States with a large amount of data to safeguard. A study published in 1972 stated that the Federal Bureau Investigation has an archive of 182,000,000 fingerprint cards with ten prints each. This publication discovers a system that automatically indicates the position and angle of the minutia in a fingerprint. The device used in this system was capable of reading and showing fingerprint patterns which were then converted into digital form [2].

The Fingerprint Analysis Process for forensic investigation should be conducted with the principle of ACE-V (analysis, comparison, evaluation and verification) method to reach a determination on each point [3]. Besides the application for forensic investigation, the finding patterns of fingerprint have been used for other purposes such as the recognition of Dermatoglyphics pattern recording and interpretation. Etymologically “Dermatoglyphic” is a harmonious blend of two words Derma which means skin and Glyph meaning carve. It gives the impression that something has been carved out of the skin. Every individual has unique patterns on the palms and sole which are used for personal identification. This is valuable not only for crime investigation but also for medical practitioners, psychologists, writers, printers and palmists and also for educators. The development of the primary fingerprints occurs at the embryonic age, between the 13th and the 19th weeks of gestation.[4].
Fingerprint is a physiological trait where the pattern and texture are formed by ridge skin impressions so that the surface can be detected. This pattern is then studied and developed to determine its suitability [5].

![Figure 1. Illustration of taxonomy of fingerprint feature levels](image)

With the existence of illustrations and the diversity of patterns that can be grouped, fingerprint analysis can be developed to detect a person's personality. This potential should be developed by referring to a concept where every aspect of human life always involves complex cognitive processes, and this has been studied when fingerprints are developed for forensic purposes. Fingerprints, hair, handwriting and other forensic domains all involve comparative examination through visual recognition [6]. Although various pro and contra opinions have coloured the journey of fingerprint development, understanding the role of cognitive aspects is one of the efforts to increase the reliability of fingerprints related to one's personality.

In 2017, fingerprint development was carried out to see a person's personality based on the Big Five Personality. This study was able to design 14 personality constructs and implement fingerprints by utilizing technology for the classification process. The results showed that there was a correlation between personality traits and fingerprint types. They also found additional fingerprint types in this study, namely S-type, Eddy and Balon. This study provides an insight that technological developments can offer high practical value in the implementation of valid personality assessments by utilizing fingerprints as a unique human biological characteristic [7].

There are various aspects of human life that involve complex cognitive processes that have the potential to be further analysed using human biological characteristics, the fingerprints. Among them is the potential for multiple intelligence. The basic concept of multiple intelligence is a description of understanding intelligence itself which shows the potential of a person's mental processes. Gardner further developed the concept of intelligence into multiple intelligences consisting of 7 concepts, namely linguistic intelligence, logical mathematical intelligence, musical intelligence, spatial intelligence bodily kinaesthetic intelligence, interpersonal intelligence and intrapersonal intelligence [8].

Dermatoglyphics and Intelligence have been studied with several focuses. First, focus for creating self-awareness on potentials, strengths and personality [9]. Second, for getting a recognition of Bipolar disorder [10], or third for developing interpersonal communications skills, appreciation skills bases on personalities of individuals [4]. According to Dholy, people who employ dermatoglyphics analyses are more likely to advance in their careers faster than their peers who do not use this medical analyses tool. With success comes happiness and a sense of value for life. This means that dermatoglyphics improves value for life [11].

A previous study by Seila Yohaness that used sampling of 100 sex matched students from each of the major colleges at the university gave us some patterns related to Multiple Intelligences based on Howard Gardner's model. Their results: especially with patterns on the right middle fingers, left thumbs, left middle, and left ring fin particular, linguistic intelligence was associated with loop patterns, musical intelligence with whorls, spatial/visual intelligence with arches, interpersonal intelligence with whorls, and total multiple intelligence with whorl patterns [12]. This study aims to develop a concept to utilize fingerprint analysis using Personal Computer (PC) with USB optical Scanner instead of using fingerprint ink method in exploring one's potential in relation to the intelligence capacity that is owned by referring to the potential for multiple intelligence.
2.1. Multiple Intelligence

The theory of multiple intelligence developed by Howard Gardner has inspired many researchers in the world to continue to develop this concept. This theory illustrates that humans have some intellectual capacity to solve problems or create something [13]. In the frame of mind, Howard Gardner treats a person's intellect as a part that is connected together as a unity in a person. Even though multiple intelligence can appear together, each operates independently. Multiple intelligence can be used at the same time and complement each other when a person develops skills and when solving problems [14].

The first intellectual capacity, linguistic intelligence, is shown by the presence of a person's sensitivity to spoken and written language. Individuals who have linguistic intellectual capacity have a high ability to learn language and use the language to accomplish a specific goal. This intelligence capacity is also closely related to a person's ability to express himself through writing and poetry so that this individual is usually very informative. In a study, linguistic intelligence can even be evaluated from a person's ability to do story telling [13],[15].

The second intelligence capacity is logical-mathematical intelligence which is shown by the ability to analyse problems logically, carry out various mathematical solutions and investigate scientific problems. Another capacity included in this intelligence is how to detect various patterns, deductive reasoning and logical thinking [13],[15]. The third intelligence capacity is music intelligence which includes various skills related to performance, composition and elaborating on various musical rhythms, pitches, tones and rhythms. Usually musical intelligence parallels language intelligence [16]. The fourth intellectual capacity is bodily kinaesthetic intelligence which is shown through one's potential in body work to solve problems. This capacity is usually related to the mental capacity to coordinate various movements [16].

The fifth capacity of intelligence is Spatial intelligence, which is intelligence shown through one's potential in understanding and using various patterns of space and various limited areas. This intelligence is also related to visual arts, navigation, mapmaking, architecture, and various activities that require the ability to visualize objects from different perspectives and angles [13],[16]. The sixth intelligence capacity is interpersonal intelligence which is shown through a person's ability to collaborate with others and the ability to communicate both verbally and non-verbally. Another capacity included in interpersonal intelligence is how a person can understand the motivations and desires of others so that it can help them work together more effectively [13],[16]. The seventh intellectual capacity is intrapersonal intelligence which is shown through a person's capacity to understand himself, his feelings, his fears and his motivation. The mastery of a person over his internal conditions is very strong. They really understand the thought process, are very capable of self-reflection and rely on the power of their intuition [13],[16],[17]. The seventh intellectual capacity is naturalistic intelligence which is shown through one's ability to recognize natural patterns and conditions so as to be able to classify objects, develop sensitivity to various natural objects, both living and inanimate objects [16].

2.2. Relationship Between Multiple Intelligence and Fingerprint Pattern

Dermatoglyphic is the study of the fingerprint and can be traced back to 1892 by Sir Francis Galton, a cousin of Charles Darwin, published his non classical work in fingerprints. This epidermal ridge configuration is study of dermal ridges on palms, fingerprints and soles. This epidermal ridge configuration starts in the third month of intrauterine life and completes its development by the fifth month of intrauterine life and remains unaltered throughout the life except for an increase in size in parallel with general growth of the individual [9].

2.3. Brain Structure, fingerprint and Personality Relationship

A recent study revealed that structural neural network architecture patterns in the human brain could be related to individual differences in phenotype, behaviour, genetic determinants, and clinical outcomes from neuropsychiatric disorders. In that study their finding result suggest the fingerprint found by their dynamic modelling approach is sufficient for classifying between individuals, and is also capable of predicting general intellectual ability across human development.[18].
2.4. Biometric
The term biometric comes from the Greek words Bios (life) and Metrikos (measure). Biometric system is the science to recognize a person mainly based on physiological or behavioral characteristics. A biometric system can work on verification or identification mode. Verification involves comparisons, only with the templates corresponding to the claimed identity and identification involves comparison of the acquired biometric information against templates corresponding to all users in the database.

Fingerprints are the most widely accepted biometrics trait. In fingerprint sensing, the fingerprint of individuals are captured by fingerprint scanners to represent in digital form the numerous applications available for collection and their applications in law enforcement, security system and government agencies both in the form of off-line image and live-image. Acquisition of fingerprint data should be reliable and precise during comparison and verification. Fingerprint identification process is of two types namely manual and automatic methods.

2.5. AFIS (Automatic Fingerprint Identification System)
The Automated Fingerprint Identification System (AFIS) programs provide a database of fingerprints to solve crimes. Automatic Fingerprint Identification System (AFIS) are mainly classified as exemplar and latent fingerprints. Exemplar fingerprint samples are deliberately taken from the subject for enrolment into the system database. Exemplar fingerprints are taken through live scanners and ink on paper cards. Latent fingerprints are the impressions left out on the surfaces of the objects. These impressions are recorded by chemical, physical and electronic processing techniques [19]. Commonly AFIS Algorithm are Image Enhancement, Future Extraction, Indexing and Matching [20] and enhanced study using Fingerprints Segmentation [21] and FIVDL: Fingerprint Image Verification using Dictionary Learning [19].

2.6. Type of Dermatoglyphic Pattern
Different types of fingerprint patterns were identified by the standard method set by Cummins and Midlo in 1943. Four main type of fingerprint patterns were classified as whorl, ulnar loop, radial loop and arch. Each finger is connected with one brain lobe plus a specific type of intelligence and each type of fingerprint is connected with the following type of learning: Whorl Loop – Cognitive Learning- Ulnar Loop- Affective Learning, Radial Loop – Critical Thinking, Tented Arch – Enthusiastic Learning, Arch – Reflective Learning [9]. To find the qualitative Dermatoglyphic Analysis ,the frequency of true patterns of loops, whorls and arches were counted on the fingerprint of all the 10 digits of people who will be examined [4]. Other study revealed that ulna loop pattern on the second digit of both right and left hands could indicate high logic intelligence while high frequency of arch pattern especially on index finger is indicative of high musical intelligence. The hierarchy of kinaesthetic intelligence also correlated with the average total ridge count on the left fingers of males. It has therefore shown that dermatoglyphics has a significant relationship with multiple Intelligence. More studies on the relationship between dermatoglyphics and multiple intelligences with larger sample size should still be embarked on, to unravel different association that could exist between these parameters, if any.[23].

2.7. Sample Data Collection
Database of fingerprint used by previous studies consist of three type such as fingerprint ink, palm print, and scanner by sensor. Fingerprints: Black duplicating ink was used to record fingerprints (both right and left hand) of all the subjects which were applied on the fingers with a sponge head rolling paint brush. The benefit of using black duplicating ink was that the prints achieved were clear and did not get smudged and the prints could be preserved for an indistinct period of time. The digits were guided and pressed tightly against the white bond paper clipped on to a hard board [4]. The ten fingertips of each subject were directed on the touchpad of the fingerprint sensor, starting from the right fingers of thumb,
index, middle, ring, and the little finger. Followed by left hand; thumb, index, middle, ring and little fingers. These fingertips’ pattern images were stored on the hard-disk of a laptop and backed up on an external memory device.[23].

2.8. Fingerprint Data Analysis
Fingerprint analysis as a technology-based method is a very interesting technique to see the relationship among various aspects of humans, one of which is the aspect of their intelligence capacity. Correlation between the created patterns can be studied through fingerprint analysis as part of the physiological properties, which could detect patterns and textures formed by the ridge prints on the surface of a finger [1], [5], [25]. At the first level, the given pattern usually represents the overall ridge flow of the fingerprint itself. This pattern is still divided into five categories, namely left loop, right loop, whorl, arch and tented arch [26]. Whereas level 2 usually uses the ridge ending which refers to several types of divisions; termination, bifurcation, short ridge, dot, enclosure, break, crossbar, overlap, bridge, opposite bifurcations, trifurcation, dock, return and spike as shown Figure 2.

![Figure 2. Type level 2 [27]](image1)

Level 3 is more profound; the fingerprint pattern is usually used for various forensic purposes.

3. Research Method
The research method used in this study is the neuroresearch method with the main stages of exploratory research [28] [29]. At this stage, the researchers conducted various explorations of various previous studies on how to implement fingerprint analysis. The researcher also conducted exploratory research
to find various components and factors for the construct that would be developed using the fingerprint analysis method, which is about multiple intelligence.

This research is a preliminary research that will continue to be carried out until product testing on how fingerprint analysis can detect a person's multiple intelligence capacity. The stages of the fingerprint analysis implementation process that will be carried out as Figure 4.

![Figure 4. The stages of the fingerprint analysis process](image)

4. **Results and Discussion**
The results of this study are several experiments that have been carried out with several possible equipment. This research was conducted using a PC.

The hardware and software specifications used are as follows:
- Dell Xeon PowerEdge 220 Windows Server 2016, 32Gb RAM
- Eclipse 2020 For Java Application Program
- USB Scanner Digital Persona 4500U with OneTouch SDK

![Figure 5. Image of USB Digital Persona U4500 Scanner and its specifications used in research](image)
There are three examples of programs used. These programs are pilot programs that study how the AFIS Fingerprint process applies. With the steps that are in principle similar to this stage, namely fingerprint enrolment with the number of recording times, saving the fingerprint template and verification when we match our fingers with existing records from the fingerprint template. The process of enrolment, identification and verification is carried out with an overview of the process as Figure 7.

The following describes the differences between the three sample program modes in the Java language.

4.1. Console Mode.
Console mode is Enrollment and Verification without graphics. Ten fingers each can be scanned per four times in a single scan. The advantage in this mode compared to other modes is that there is a prior naming of the person who will record the fingerprint. The disadvantage is that there is no graphic appearance.

4.2. Enrollment Mode.
Enrollment mode is to show a larger image in a new contact which will be verified. The advantage of this mode is in the saving of the fingerprint templates, which can be given a name before trying to verify it.
4.3. GUI Mode.
GUI Mode is a 10-finger graphic displayed on a layer that can be clicked with a mouse for finger verification. By obtaining ten valid fingerprint enrollments from a user, ten image files are also obtained which can be stored in the database to obtain the minutiae.

5. Conclusion
Through the results of PC-based trials that have been found, the tool used has been able to produce fingerprint recordings with various identifiable patterns [30]. Therefore, the various aspects that will be observed in the future can be tested by compiling specific criteria from the resulting pattern so that it can provide a picture that matches the aspect in question, which is multiple intelligence. Illustrations and the diversity of patterns produced in the next research will be grouped according to the capacity of intelligence, referring to the Gardner theory [13],[16],[31]. This research is very possible to be developed by referring to the various forensic studies that have developed regarding fingerprints. Comparative examination and visual recognition will be sharper so that it can produce a more accurate and accountable analysis. Fingerprint research associated with the Big Five Personality is also one of the main inspirations in the development of this research. It is hoped that in the future research on fingerprints will provide broad benefits in identifying various aspects of personality and human potential.

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