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Digital Forensics: Application Innovation for Fingerprint Pattern Research

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Abstract

Fingerprint patterns are unique phenotypes in each individual that are formed genetically and do not change throughout life unless influenced by environmental damage (Mundijo & Chairani, 2018; Purbasari, 2017). The inheritance of fingerprint patterns from parents to children has been proven in various studies, where 46.4% of children obtain fingerprint patterns similar to their parents. Based on this phenomenon, this study aims to investigate the inheritance of fingerprint patterns in families, especially in the Javanese population, and to analyze the similarities of these patterns using specially developed software. This study uses a Fingerspot Flexcode 4500 fingerprint scanner combined with software to record, store, and analyze fingerprint patterns digitally. The development of the software aims to facilitate the process of analyzing the inheritance of fingerprint patterns and studying the similarities and differences in one family. The method used is the creation of a tool in the form of software that is able to record individual personal data, scan fingerprints, and analyze pattern similarities between individuals. The constraints faced in this study were the length of time required for the design and development of the software, so that the fingerprint pattern analysis stage could not be completed during this research period. Initial results indicate that the software developed has great potential to facilitate fingerprint pattern analysis and identify genetic inheritance in families. This study is expected to contribute to further understanding of the genetic aspects in the formation of fingerprint patterns as well as practical applications in the fields of forensics and family identification. The targeted output is publication in a Q1-Q4 indexed journal or non-Q proceedings.

Keywords: Fingerprint patterns, genetic, software, analysis

1. Introduction

Based on a 2017 study, it was stated that 46.4% of children have the same fingerprint pattern as their parents. This means that a trait including fingerprint patterns is passed down to offspring. Fingerprints have basic Arch, Whorl and Loop patterns, and are influenced by genetic, environmental and ontogenetic factors that interact heterogeneously, thus affecting morphological differences. The formation of tendrils, the number of tendrils formed is directly influenced by genes so that more genes are involved than when forming fingerprint patterns. Although fingerprint patterns and the number of tendrils can be inherited genetically, the number of tendrils is more heritable than fingerprint patterns. Each individual has their own uniqueness and uniqueness of the fingerprint patterns formed. In studying

the fingerprint pattern, there are three main characteristics that need to be considered, namely the fingerprint type pattern, the number of all triradii and the total number of tendrils, while to compare between populations can be done by comparing the pattern type index and the pattern intensity index. Fingerprint type patterns can be grouped into whorl, ulna loop, radial loop and arch types. Based on the explanation above, genetics are related to the formation of fingerprint patterns. In fact, fingerprint patterns have a relationship in the identification process. The study stated that fingerprints are more determined by genetics than influenced by the environment. This is because the print pattern is inherited from parents. By understanding the extent to which fingerprints can be inherited in families, this study can provide new insights into the usefulness of forensics or security in the context of families. Thus, this study aims to analyze fingerprint inheritance and fingerprint pattern similarities in families in the Java region. However, the data collection process is still done manually and inefficiently. A tool is needed that can facilitate data collection in the form of fingerprint patterns, the research team also designed and created a tool that can facilitate the data collection process.

This study aims to identify certain patterns in the fingerprints of family members and examine the factors that influence the similarities and differences in fingerprint patterns. The novelty of this study lies in the analytical approach that uses modern technology, namely the Fingerspot Flexcode 4500 fingerprint scanner combined with software developed specifically to record and store data. This method provides a more efficient way to collect large amounts of fingerprint data, as well as allowing for more accurate and in-depth analysis of genetic inheritance patterns. By conducting research in Javanese populations, this study also contributes to a broader understanding of genetics in specific ethnic and cultural contexts.

2. THEORETICAL FRAMEWORK AND HYPOTHESIS

a. Fingerprint Patterns

Fingerprint patterns are a phenotype found in every human being with unique characteristics for each individual (Mundijo & Chairani, 2018). Fingerprint patterns are determined by many genes (polygenes) so that genetically they never change throughout life, unless influenced by environmental damage (Purbasari, 2017). The science that studies fingerprint patterns in humans is known as dermatoglyphics. In fingerprint patterns, there are parallel dermal tendrils on the fingers and toes, as well as the palms of the hands and soles of the feet. This fingerprint pattern is a genetic expression controlled by several genes (polygenic) whose basic pattern will not change throughout life (Dayana et al., 2019). The unique and individual nature of these patterns is formed during the embryonic stage. Therefore, fingerprint patterns are very important and are used in various sciences, including forensics, anthropology, and medical diagnostics (Wallo et al., 2004). Dermatoglyphic patterns are not only aesthetic, but they also store a lot of information about a person's genetic makeup, developmental history, and potential predisposition to certain medical conditions. According to the Galton system, dermatoglyphic studies include patterns such as arches, loops, and whorls that form unique patterns in each individual. The distribution of fingerprint patterns in previous studies showed around 5% arch patterns, 25-30% whorl patterns, and 65-70% loop patterns (Suryo, 2016). Dermatoglyphic studies have provided valuable insights into various aspects of human life, from personal identification to more in-depth scientific studies. The use of modern technology has also enabled the use of dermatoglyphic patterns in various technological applications, such as data security and biometric identification.

b. Genetic Aspects in Fingerprint Patterns

Some people do not realize that they are carriers of disease factors, making it difficult to detect early and provide early treatment for sufferers of diseases caused by genetic factors. One application in the field of genetics that is quite widely used is fingerprint patterns. Fingerprint patterns have long been used to identify criminals at a crime scene. The unique and different fingerprint patterns between one person and another make fingerprint patterns accurate data in identifying a problem. Because of its special features, fingerprint patterns are used to identify diseases that are genetically inherited. One of the applications that we want to apply is to know the application of fingerprint science and its relationship to diseases caused by genetic factors, which is expected to support knowledge about fingerprint patterns in humans who have genetic diseases that can be detected early and can be treated and handled earlier. Its many benefits certainly make fingerprint patterns in the future can be used for research in other fields that are currently still rarely used to identify a problem or event.

People with classic chromosome abnormalities have a different phenotype from normal people. So that it is likely to get various health problems, lower intelligence than normal people, social problems with their environment and even with their families. Early treatment for sufferers may be since in the womb, early birth, sufficient family support, physical exercise, vocational will be able to improve the quality of life of sufferers of the syndrome. One way used to detect the investigation of a disease and a person's behavior is to use fingerprints. Various studies have been conducted on fingerprint patterns in groups of individuals with genetic disorders such as diabetes mellitus, Down syndrome, mental retardation, and obesity (Purbasari, 2017).

c. Fingerprint Pattern Application

Currently, many tools or applications related to fingerprints have been found and are starting to be developed. This tool certainly makes it easier for humans both in collecting data in the form of fingerprint patterns and helping in the data storage process. Currently, tools that involve the role of biometric data with fingerprint patterns are widely found in everyday life. This fingerprint pattern is used in individual identification, attendance processes, interest and talent consultations to analysis of potential diseases.

According to Nazhifah's research (2022), Computerization with fingerprint scanning has been widely applied in the market, for example in attendance machines, Fingerprint Analysis Application Systems or PIN/password authorization machines. The biometric method is more directed at how the fingerprint scanning process is followed by storage until the extraction and structuring process of fingerprint patterns. The fingerprint analysis application is able to recognize human fingerprint patterns which are intended for characteristic analysis that can make it easier for parents to determine how or methods to educate and provide direction to children appropriately according to the characteristics of the child. The characteristics in question include the direction of intelligence, personality, learning style, potential, and so on. However, in the implementation of research involving data collection in the form of fingerprint patterns, manual methods are still used, namely with the help of paper, ink and a magnifying glass. Of course, this is inefficient and time-consuming because the method seems conventional. For this reason, one of the main objectives of this research is to create tools and applications that can facilitate researchers in collecting data and analyzing the results.

3. METHOD

This research method is designed to achieve the main objective that focuses on the development of tools

in the form of software for capturing and analyzing fingerprint patterns. This research is descriptive and consists of several clearly structured stages.

A. Research Stages

1. Current Condition Analysis: currently fingerprint pattern identification is still taken manually using ink and paper and then analyzed manually using a magnifying glass.
2. Tool Design: the research team held discussions with IT development regarding the design of the tool to be used. This tool uses Fingerspot Flexcode 4500 to scan fingerprint patterns and then separate software is created to record.
3. Making Tools and Software: Developing and making tools and software for capturing fingerprint pattern data. The tool is installed and tested to find out the features in the software. This software is able to record fingerprint patterns and store data with a unique code for each pattern.
4. Testing and Repair: Identifying and fixing problems that arise during testing of tools and software.

B. Research Flowchart

The following is a flowchart that describes the stages of research that have been carried out and will be carried out:

Fig 1. Research Flowchart

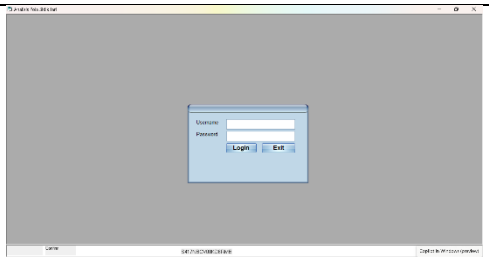
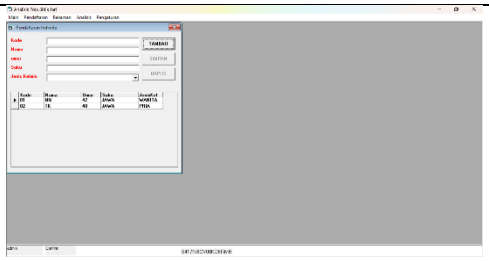
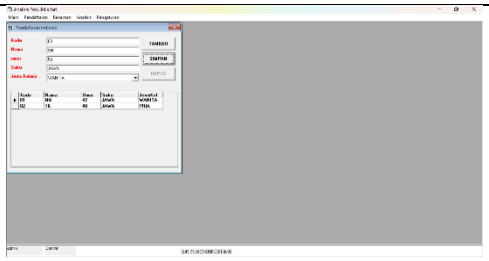
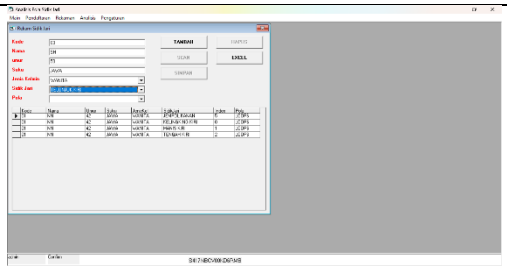
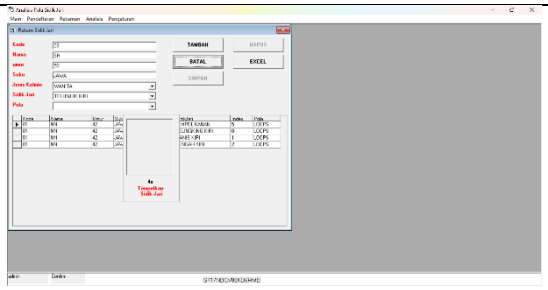
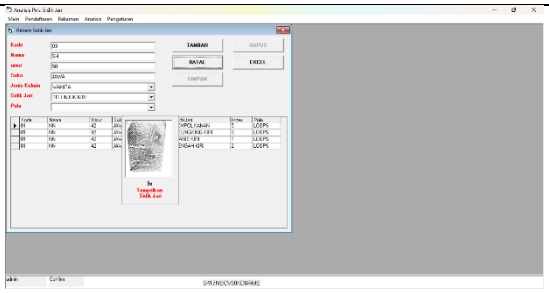
This methodology involves a systematic approach to designing, developing, and testing tools and software to be used in fingerprint pattern data collection. Each stage is designed to ensure that the research can achieve its objectives effectively and efficiently. This research is expected to provide significant contributions in the development of more effective fingerprint pattern data collection tools and methods, as well as assist in further understanding of fingerprint pattern inheritance in the context of the Javanese population.

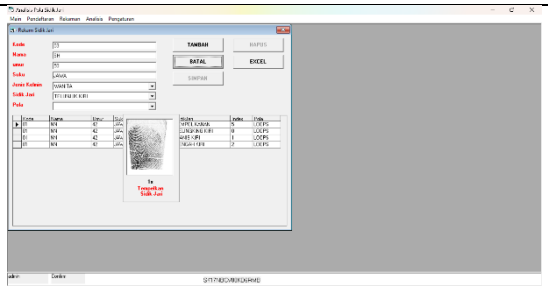
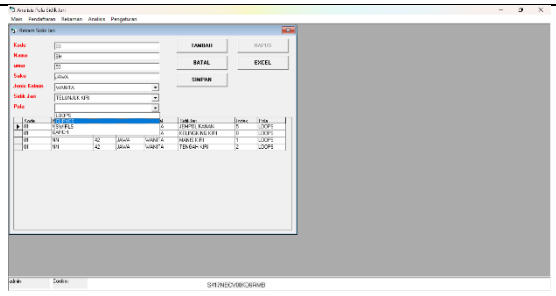
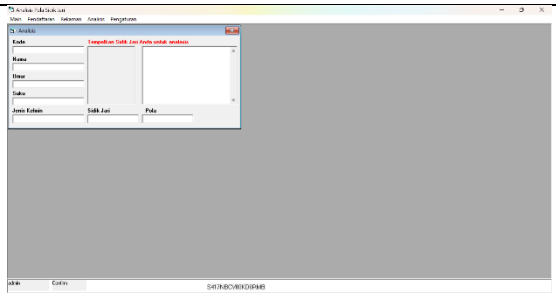
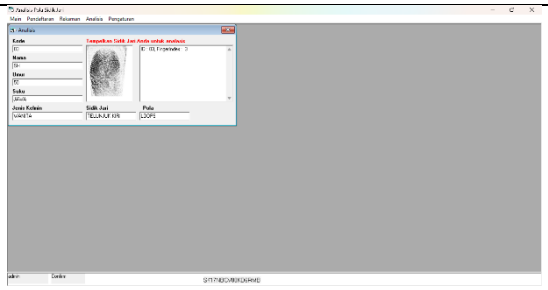
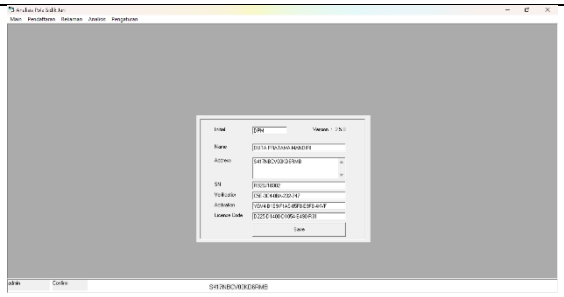
4. RESEARCH RESULTS

In this study, the team focused on making a tool in the form of software which of course took quite a long time. The tool used was a fingerspot flexcode 4500 combined with the following software and the appearance of the tool created.

Table 1. Display of fingerprint pattern recording software

No.	Display Application	Information
1.		Initial view The software is installed using a laptop and connected to a fingerspot as a fingerprint pattern scanner

2.		When login, you can use the username and password that have been created to enter the application.
3.		On this page, you can enter data in the form of code, name, age, ethnicity and gender as a marker for the fingerprint pattern to be saved.
4.		After entering, you can click "save" and the data will appear in a table as shown in the picture.
5.		After that, you can select the part of the finger whose fingerprint pattern will be recorded.
6.		The fingerprint pattern to be recorded can be attached to the connected fingerspot tool.
7.		The results of the fingerprint pattern recorded using the fingerspot can be seen as shown in the following picture.

8.		Then click "cancel" if you want to repeat
9.		In this section, you can select the shape of the pattern that appears
10.		This is the initial display to start scanning new respondents
11.		Place your finger on the scanner to perform fingerprint identification analysis, then fingerprint data will appear along with the pattern based on previously stored data.
12.		This is the final display of the application.

5. CONCLUSION

The research method proposed above includes a thorough analysis of the current conditions, design and manufacture of the tool, and testing and improvements required to produce a ready-to-use device. With a systematic approach, this study aims to achieve reliable and valid results in the context of fingerprint pattern research.

In this study, several significant obstacles have been faced, especially in the design, manufacture, and testing aspects of the tool used for fingerprint pattern capture and analysis. The obstacles faced are: The process of designing the tool using Fingerspot Flexcode 4500 took longer than expected. The research

team must ensure that the designed tool not only functions properly but also meets the technical standards required for fingerprint scanning accuracy. The creation of software integrated with the tool has also been delayed. This development requires intensive collaboration between the IT team and programmers to create an application that meets the specified specifications. During the software development process, several improvements were made to adjust the features and functionality of the application to the specific needs of the study. These improvements include testing various algorithms and user interfaces to ensure ease of use and effectiveness in data collection. The changes and improvements made affected the research timeline, thus slowing down the trial process that should have been carried out after the software was completed. These obstacles show that the development of tools and technologies in research is a complex process and does not always go according to plan. However, despite the challenges, the research team remains committed to completing each stage and adapting to the needs that arise during the research process. It is hoped that by resolving these obstacles, the research can proceed to the data collection and fingerprint pattern analysis stage more efficiently.

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With the support of UPPM FK UNUSA and the collaboration of the Maspion IT team and programmers, this research can run well, and is expected to produce useful tools to facilitate the capture and analysis of fingerprint patterns. The role of partners is vital in the success of this project, both in terms of funding, technology development, and technical support.

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