JAVA GUI APLICATION FOR COMPARING THE LEVELS OF BIOMETRIC SECURITY - FINGERPRINT VS. IRIS

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Abstract:

Introduction/purpose: The main purpose of this paper is to present a novel Java GUI – based software application for a comparative analysis of fingerprint and iris biometrics.

Methods: The first part of this work is realized in Java Programming language. in the GUI framework named swing while the rest of the paper shows in detail the advantages and disadvantages of both systems and gives scientific data on when fingerorint and iris recognition can be used to enable top level security. The main method here is a well known comparative analysis.

Results: The results were obtained for both fingerprint and iris biometrics, showing the difference between the two.

Conclusion: Different types of biometrics, based on body parts formed at different age, are given as well as the comparison of their security levels.

Keywords: programming, Java, GUI, biometrics, fingerprint, iris, patent.

Introduction

Java is one of the oldest object-oriented programming languages based on all OOP concepts. Its framework, or, better to say, the swing set of libraries is one of the oldest and most stable ones for creating GUI (GUI – Graphical User Interface) applications. Biometrics is a scientific discipline and technology that measures and analyzes biological

characteristics of people. It is a part of advanced security systems widely used in today's modern society and protection systems.

The highest persistence in biometrics and the lowest possibility of interrupting data are found in fingerprints and their minutiae; therefore, this work and this patent device focus on this kind of biometrics.

The main difference between fingerprints and the iris in humans is their forming period: fingerprints are formed in the prenatal period, before a baby is born, and the iris with its pigmentation is formed from year two to year four in children. This is crucial for understanding security systems that can be created and used based on these two biometrics types.

Technology overview

A well-known OOP programming language which runs on over 3.5 billion devices worldwide is Java. It is a very strong and stable programming language providing all OOP aspects of software development. In developing this application, the authors used the swing framework in Java.

All known tech devices based on fingerprint scanners use different algorithms and SDK in their scan process to determine a person's identity. Search through the national patent base of the Republic of Serbia has shown that devices with this purpose, similar to the one presented in this paper, have not been found, namely, not one of these patents deals with this idea and a solution presented here, with this dual fingerprint biometric scanner with its own lighting and battery supply. (Dahlen & Caplice, 2014), (Lalović et al, 2017), (Lalović et al, 2016b)

Today, all devices scan only one or more fingers of only **one** person; there are no fingerprint scanners that can scan fingers of two different people at the same time using only one device, which is unique to our idea. What is more, there are no devices which generate a unique reference ID while scanning is performed, and that unique ID can be connected with the record of fingerprint scanned and stored data. (Lalović et al, 2015)

If we look at the issued patent confirmation no. П-2009/0253, of International classification such as G-07-D7/12 (2008.04), a device called "Hand mobile device for checking travel and personal documents, reading biometric data and face recognition of persons which carry those documents" has been described as one function of the device that scan the finger of one person at just that moment, unlike ours. (Lalović et al, 2016b), (Moore et al, 2015), (Wing, 2014).

Discusion

One issued patent with no. confirmation 13848069.4 of April 2/2013, with remark W-O-2014059761 and classification no. G–06 F21/00 is a classic scanner named “Fingerprint Identification Device”, described as a device which has a scanning function and provides all data about the fingerprint of a person (extractor for fingerprint *minutiae*[1]). (Lalović et al, 2019), (Jain et al, 2008)

Our device has two separate fields for simultaneous scanning of fingers from two different persons, which, at the same time, generates a unique constant ID reference with an additional guarantee of a person's identity and provides a guarantee of the motherhood for every newborn baby in maternity wards. (Lalović et al, 2016a), (Maček et al, 2015)

Java GUI application

It is well known that Java is one of the oldest and most stable object-oriented programming languages established around 1995, with strong OOP principles when creating all kinds of applications. A good knowledge of this language prompted us to create a GUI application in Java swing framework (set of libraries) in order to provide a quality overview in real time. As far as the design is concerned, the GUI app builder in *NetBeans* IDE 8.2 was used while for the source code we overrode methods OnClick in JButton object, showing the result set in two panels at a same time. For the main frame, we used JFrame Java class and its methods on the object created with the next source code and the constructor class method:

JFrame mainWindow = new JFrame(“Main Window”);

A Java swing GUI is an older and stable Java framework for designing and developing good graphical applications based on classes and top level containers such as JFrame and its methods.

Figure 1 shows a GUI builder in NetBeans 8.2 version for the development of a Java GUI application. (Lalović, 2020)

[1] Minutiae – fingerprint specific points visible on a finger image

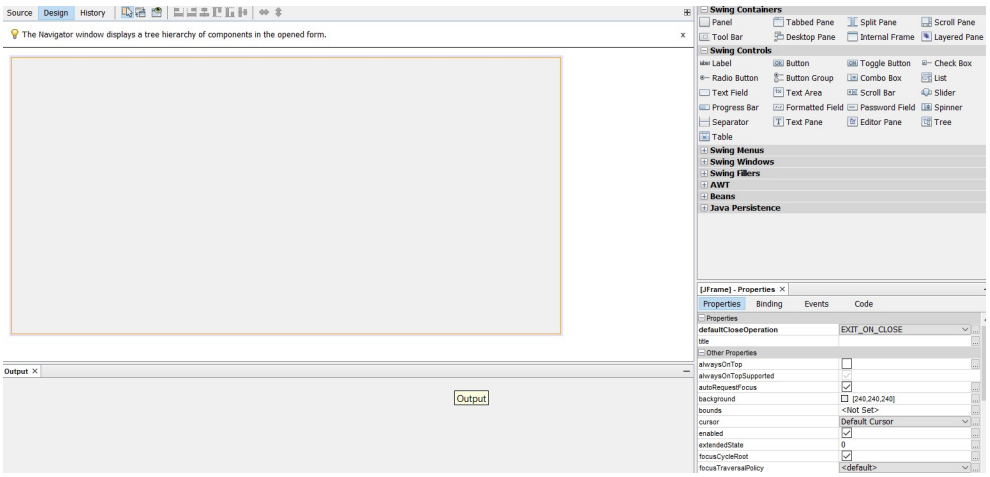

Figure 1 – GUI Builder NetBeans 8.2 IDE
Рис. 1 – Графическое окружение для развития приложения NetBeans 8.2 IDE
Слика 1 – Графичко окружење за развој апликација NetBeans 8.2 IDE

Essence of two biometrics

A scientific fact in biometrics, used as a part of advanced security systems such as informatics and computers, is that fingerprints are formed during the prenatal period of every newborn baby, i.e. during the fetal period, and they remain constant in the same shape of minutiae during the whole life of a person. (Lalović et al, 2019), (Jain et al, 2008), (Lalović et al, 2016a)

Many research studies discuss fingerprints of the fetus and ultra-wave and biometrics scans show that the minutiae on every finger are formed until the end of 7th month of pregnancy, prenatally. This important fact is needed to be mention here, since babies born before their regular time of birth, during 8th, and especially by the end of 7th month of pregnancy, already have fingerprints formed on every finger and toe. (Lalović et al, 2019)

This information is essential because the fingerprint minutiae (ridges and valleys) are the only biometrics formed prenatally and can be used for the purpose of guaranteeing identity. The idea of this patent and innovation is based on this very scientific fact confirmed by both biometrics and gynecology, i.e. midwifery as a branch of healthcare protection system. (Lalović et al, 2016a), (Maček et al, 2015), (Lalović, 2018)

Other types of biometry such as iris recognition are not reliable in this, period at the moment of birth, because until the age of four the pigmentation in the child's eye is changeable and can become very different. Thus, since both the shape and the color change, this makes it impossible to be used for this purpose and for this idea.

Also, the head, the hand, and the body shape and size rapidly change since they normally grow, so it is obvious why they cannot be used here. The scientific fact is that the fetus fingerprint is formed prenatally, by the end of 7^{th} month in the uterus of a pregnant woman and stays constant with the same construction and shape of minutiae. (Lalović et al, 2019)

There are a large number of various fears during the birth process, both of mothers and also of people in medical health care systems in maternity wards. A study done in Australia and New Zealand from 2009 to 2011 based on 17 workshops with the participation of over 700 midwives shows that this device can now dispel one of the biggest fears - dealing with unknown. (Dahlen & Caplice, 2014)

Data is gathered during the process of fingerprint scans of a mother and her baby, with an ID unique reference that is also encrypted and stored at the device, its memory or at the server in an encrypted form. The device is not to be left opened or available to unauthorized personnel, but only to authorized nurses, doctors, and midwives who have contact with the device in maternity wards.

After the process of scanning, motherhood is confirmed for each mother – baby pair by the authorized person - representative of a maternity ward and the mother who enter PIN2 code that only they have for the data. (Jain et al, 2008), (Lalović et al, 2017)

A change of the stored data is disabled and the identity of each newborn baby is guaranteed 100% in practical terms and there is no possibility of making a human mistake during the process thanks to the device.

It is possible to check any mother-baby pair in maternity wards worldwide, at any time.

The Information stored on the device or the server with a backup copy is always in a completely encrypted form and there is no possibility of corrupting the data. A possibility of archiving data is enabled only after the confirmation of the mother that everything has been done right and after this mother – baby pair has left the hospital. That is the moment

[2] PIN – Personal Identification Number - code

when proving the guarantee of motherhood is no longer necessary in a hospital. (Dahlen & Caplice, 2014)

It is very important to prevent any possible theft of baby's identity or babies getting switched at birth, which has unfortunately probably happened at some places and parts of the whole world, including the Balkans. At the moment when it is implemented, the device will guarantee, prove, and serve as evidence of motherhood for every newborn baby.

The application itself of the device is universal, on every continent and in every country; there are no restrictions on the use of it. It requires only basic IT equipment for implementation, such as a PC, a server and this patent device which is a dual-biometric fingerprint scanner. The device will be affordable to be installed in every maternity ward in any health care system in any country in the world.

Research

Figure 2 shows a fingerprint of a human finger with all minutiae on it.

As it can be seen clearly, ridges and valleys are scanned on one of the existing fingerprint scanners. There are various scanners such as: optical, capacitive, thermal, pressure, etc. All of them possess advantages and disadvantages, depending on the purpose and the fingers scanned. (Tot et al, 2021)

Figure 2 – Fingerprint minutiae (Anthony, 2019)
Рис. 2 – Детали отпечатка пальца (Anthony, 2019)
Слика 2 – Минуције отиска прста (Anthony, 2019)

The main difference between these two kinds of biometrics is that fingerprints are formed in the prenatal period and can be acquired at the very moment of birth, while the iris is formed between the second and the fourth year in children, at the early period of childhood, because iris pigmentation is then formed, so iris biometrics can be acquired subsequently, from the age of five.

Figure 3 – Iris recognition in biometrics (Burt, 2020)
Рис. 3 – Биометрическое распознавание по радужной оболочке глаза (Burt, 2020)
Слика 3 – Ирис препознавање у биометрији (Burt, 2020)

It can be seen that both systems provide a high level of protection, depending on the purpose and the age of humans.

Further development

Both of these biometric types, iris and fingerprint recognition, have a big potential in the future. They are part on many known security systems being used today. At the moment, we can say that it will be a future of security systems and biometry development. Each of them has both advantages and disadvantages and Java programming language can be used for many possible applications.

Conclusion

It is well known in research circles that the main purpose, besides identity guarantee and nonrepudiation, each biometrics is eager to provide is minimization of FAR[3] and also of FRR[4] in order to become more accurate and secure. Our results with this device and GUI app are also within this mainstream.

The main difference here is that fingerprints are formed at a moment of birth and the iris is formed after the age of four.

Also, each biometric system has a large potential of making good security systems, which is possible and existing nowadays. We can freely say, now for sure, that fingerprint and iris recognition will be the future of security systems and biometrics development. Java as OOP programming language can be used for each application for biometric measurements either of the iris or the fingerprint, creating good user experience at the same time.

References

Anthony, A. 2019. *8+ Biometrics APIs At Your Fingertips* [online]. https://nordicapis.com/8-biometrics-apis-at-your-fingertips/ [Accessed: 20 February 2021].

Burt, C. 2020. *New terminal brings contactless iris biometrics to UnionCommunity's UBio line* [online]. Available at: https://www.biometricupdate.com/202005/new-terminal-brings-contactless-iris-biometrics-to-unioncommunitys-ubio-line [Accessed: 20 February 2021].

Dahlen, H.G. & Caplice, S. 2014. What do midwives fear? *Women and Birth,* 27(4), pp.266-270. Available at: https://doi.org/10.1016/j.wombi.2014.06.008.

Jain, A.K., Flynn, P. & Ross, A.A. 2008. *Handbook of Biometrics.* Boston, MA: Springer. Available at: https://doi.org/10.1007/978-0-387-71041-9. ISBN: 978-0-387-71041-9.

Lalović, K. 2018. Patent overview: Device for fingerprint identity guarantee. *Vojnotehnički* glasnik/Military Technical Courier, 66(2), pp.366-379. Available at: https://doi.org/10.5937/vojtehg66-15868.

Lalović, K. 2020. *Osnove Java programiranja*. Belgrade: Golden Mind (in Serbian). ISBN: 978-86-902148-0-8.

[3] FAR – False Accept Rate
[4] FRR – False Reject Rate

Lalović, K., Anđelić, S. & Tot, I. 2017. How to guarantee baby identity based on fingerprint biometry. In: *The Ninth International Conference on Business Information Security (BISEC-2017)*, Belgrade, pp.1-4, October 18 [online]. Available at: http://bisec.rs/files/2017/16-k-lalovic-s-andjelic-i-tot-bisec-2017.pdf [Accessed: 20 February 2021].

Lalović, K., Maček, N., Milosavljević, M., Veinović, M., Franc, I., Lalović, J. & Tot, I. 2016a. Biometric Verification of Maternity and Identity Switch Prevention in Maternity Wards. *Acta Polytechnica Hungarica*, 13(5), pp.65-81. Available at: https://doi.org/10.12700/APH.13.5.2016.5.4.

Lalović, K., Milosavljević, M., Tot, I. & Maček, N. 2015. Device for biometric verification of maternity. *Serbian Journal of Electrical Engineering*, 12(3), pp. 293-302. Available at: https://doi.org/10.2298/SJEE1503293L.

Lalović, K., Nikolić, J., Tot, I. & Lalović, Ž. 2016b. Software algorithm of device for biometric identification of parenthood. In: *The Eighth International Conference on Business Information Security (BISEC-2016)*, Belgrade, pp.66-71, October 15 [online]. Available at: https://www.metropolitan.ac.rs/files/2016/10/BISEC2016_Conference-Proceedings.pdf#page=67 [Accessed: 20 February 2021].

Lalović, K., Tot, I., Arsić, A. & Škarić, M. 2019. Security Information System, Based on Fingerprint Biometrics. *Acta Polytechnica Hungarica*, 16(5), pp.87-100. Available at: https://doi.org/10.12700/APH.16.5.2019.5.6.

Maček, N., Đorđević, B., Gavrilović, J. & Lalović, K. 2015. An Approach to Robust Biometric Key Generation System Design. *Acta Polytechnica Hungarica*, 12(8), pp.43-60. Available at: https://doi.org/10.12700/APH.12.8.2015.8.3.

Moore, K., Persaud, T.V.N. & Torchia, M. 2015. *Before We Are Born, 9th Editio*n. Philadelphia, PA: Saunders. ISBN: 9780323313445.

Tot, I., Trikoš, M., Bajčetić, J., Lalović, K. & Bogićević, D. 2021. Software Platform for Learning about Brain Wave Acquisition and Analysis. *Acta Polytechnica Hungarica*, 18(3), pp.147-162. Available at: https://doi.org/10.12700/APH.18.3.2021.3.8.

Wing, B. 2014. NIST publishes compression guidance for fingerprint. *IT Professional*, 16(2), pp.38-44. Available at: https://doi.org/10.1109/MITP.2013.89.

ПРИЛОЖЕНИЕ JAVA GUI ДЛЯ СРАВНЕНИЯ УРОВНЕЙ БИОМЕТРИЧЕСКОЙ БЕЗОПАСНОСТИ – РАДУЖНАЯ ОБОЛОЧКА ГЛАЗА ПО СРАВНЕНИЮ С ОТПЕЧАТКАМИ ПАЛЬЦЕВ

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РУБРИКА ГРНТИ: 50.00.00 АВТОМАТИКА. ВЫЧИСЛИТЕЛЬНАЯ ТЕХНИКА:
50.41.00 Программное обеспечение вычислительных машин, комплексов и сетей
ВИД СТАТЬИ: обзорная статья

Резюме:

Введение/цель: Основная цель данной статьи заключается в представлении нового программного приложения, основанного на графическом приложении Java для сравнительного анализа биометрических данных отпечатков пальцев и радужной оболочки глаза.

Методы: Первая часть работы реализована на языке программирования Java, в графическом окружении swing, в то время как в продолжении статьи подробно описаны преимущества и недостатки обеих систем и приведен ряд значимых научных данных о том, в каких случаях распознавание отпечатков пальцев и радужной оболочки глаза может использоваться для обеспечения безопасности на высшем уровне. В исследовании применялся сравнительный анализ.

Результаты: В статье приведены результаты исследования обеих систем как отпечатков пальцев, так и радужной оболочки глаза, а также описаны выявленные разницы между ними.

Выводы: Различные виды биометрического распознования формируются в зависимости от возраста людей без учета сравнения уровня безопасности.

Ключевые слова: программирование, Java, графическое окружение, биометрия, отпечаток пальца, радужная оболочка глаза, патент.

ГРАФИЧКА АПЛИКАЦИЈА ЈАВА ЗА ПОРЕЂЕЊЕ НИВОА БИОМЕТРИЈСКЕ СИГУРНОСТИ ИРИСА ПРЕМА ОТИСКУ ПРСТА

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ОБЛАСТ: информационе технологије
ВРСТА ЧЛАНКА: прегледни чланак

Сажетак:

Увод/циљ: Главни циљ рада јесте да прикаже нову софтверску апликацију за компаративну анализу између отиска прста и ириса у биометрији, формирану код људи кроз графичку апликацију јава.

Методе: Први део рада реализован је у програмском језику јава, графичком окружењу званом свинг, а остатак детаљно приказује предности и недостатке оба ова система и научно обезбеђује све релевантне податке када могу бити коришћени и узети да би обезбедили врхунску сигурност. Главни метод представља компаративна анализа.

Резултати: Резултати садрже оба система – и отисак прста и ирис, а приказана је и разлика.

Закључак: Врсте биометрије различито се формирају, а зависе од година старости, без поређења нивоа сигурности.

Кључне речи: програмирање, Јава, графичко окружење, биометрија, отисак прста, ирис, патент.

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