SCANNERRF: Person identification system with facial recognition

SCANNERRF: Sistema de identificação de pessoas com reconhecimento facial

SCANNERRF: Sistema de identificación de personas con reconocimiento facial

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Abstract:
Lack of safety in schools has been a worrying problem affecting society at large, this is noticeable given the waves of violence that eventually occur afflicting the entire education system. This project is based on the proposal to develop a desktop application that aims to identify and monitor students' access to school through facial recognition technology, the software is produced in the Python programming language, with the help of PYQT5 libraries to create graphical interfaces and OpenCV for manipulation and processing of digital images. Using the application, it is possible to supervise the entrance of students, assist school management, and make it difficult for undue people to access the environment. The methodological approach of the project consists of six steps that address quantitative and qualitative combinations responsible for gathering the information that can be useful in the development of the work, aiming to obtain the success of the developed software and the complete effectiveness of the application.

Resumo:
A falta de segurança nas escolas tem sido um problema preocupante que afeta a sociedade em geral, isto é perceptível tendo em vista as ondas de violência que eventualmente ocorrem e afligem todo o sistema educacional. Este projeto baseia-se na proposta de desenvolver uma aplicação *desktop* que tem o intuito de identificar e monitorar o acesso dos estudantes à escola por meio da tecnologia de reconhecimento facial. O *software* é produzido na linguagem de programação *Python*, com o auxílio das bibliotecas PYQT5 para criar interfaces gráficas e *OpenCV* para manipulação e processo de imagens digitais. Utilizando a aplicação é possível fiscalizar a entrada dos alunos, auxiliar a gestão escolar e dificultar o acesso de pessoas indevidas ao ambiente. A abordagem metodológica do projeto consiste em seis etapas que abordam combinações quantitativas e qualitativas responsáveis por reunir as informações que podem ser úteis no desenvolvimento do trabalho, almejando a obtenção do sucesso do software desenvolvido e da eficácia completa da aplicação.

Resumen:
La falta de seguridad en las escuelas ha sido un problema preocupante que afecta a la sociedad en general, esto se nota en vista de las olas de violencia que eventualmente se presentan y afectan a todo el sistema educativo. Este proyecto se basa en la propuesta de desarrollar una aplicación de escritorio que tiene como objetivo identificar y monitorear el acceso de los estudiantes a la escuela a través de la tecnología de reconocimiento facial. El software se produce en el lenguaje de programación Python, con la ayuda de las bibliotecas PYQT5 para crear interfaces gráficas y OpenCV para la manipulación y el procesamiento de imágenes digitales. A través de la aplicación, es posible supervisar la entrada de los estudiantes, ayudar a la gestión escolar y dificultar el acceso de personas indebidas. El enfoque metodológico del proyecto consta de seis etapas que abordan combinaciones cuantitativas y cualitativas encargadas de recopilar las informaciones que puedan ser útiles en el desarrollo del trabajo, con el objetivo de obtener el éxito del software desarrollado y la completa efectividad de la aplicación.

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1. INTRODUCTION

This work addresses the lack of supervision and security in schools. According to Abramovay (2002), violence in schools has become an everyday topic, which is frequently covered by the press and generates alerts from authorities. The deaths caused as a result affect the entire society, which is very concerned about the problems of violence in the school environment. This scenario becomes even more worrying when one takes into account that schools have a large concentration of children and adolescents, who may be more susceptible to incidents of violence and harassment.

It is possible to highlight that levels of violence have been increasing in recent years. Based on Folha de São Paulo (2023), since February 2022, 21 cases of attacks on schools have been recorded in Brazil. In the last 22 years, almost 60% of the cases of attacks that occurred were concentrated post-pandemic. And this highlights the lack of safety in the school environment that can generate negative consequences for everyone involved in the community.

The lack of adequate supervision at the entrance to schools is one of the main reasons for the vulnerability of these environments, allowing the entry of people who do not belong to the school environment and can be potentially harmful to everyone involved. As Alonso says:

> É importante destacar as questões à acessibilidade de estranhos ao interior da escola. Durante o período de funcionamento regular da escola não devem circular estranhos ou pessoas não autorizadas. Há que se ter atenção com qualquer um que não esteja ali com o propósito de atuar ou colaborar para o processo educativo (ALONSO, 2023).

The current means of identifying enrollment in the academic environment are mainly limited to the use of uniforms and, in some schools, the use of ID cards. However, according to José (2021), these methods are insufficient when used as an exclusive security measure, as there is a possibility of these items being counterfeited or stolen. Due to this, the need to improve the means of validating identity in schools stands out, which is the objective of the project.

ScannerRF is a desktop identification and monitoring system with facial recognition. It was developed with the aim of offering an assistance mechanism to school agents regarding security in academic environments. Its difference between competitors is cost-benefit, the only prerequisite for its use is having a laptop with a webcam and internet access. The development of this software consists of several steps, such as carrying out research on the main internal security problems in schools, selecting the most appropriate technologies for developing the application, designing user interfaces, developing the application and realizing usability and security testing. Regarding the methodology adopted, field research, bibliography and qualitative-quantitative approaches were used, which aimed to demonstrate how the project could be implemented in schools, providing information that proves the effectiveness of facial recognition as a security method.

Therefore, the project is expected to contribute significantly as a mechanism to assist agents in supervising the security of school units..

2. THEORICAL FOUNDATION

This chapter consists of the theoretical foundation, where work topics and technologies used in the development of the application will be presented.

2.1. The lack of security in schools

The educational system is crucial in the formation of human beings, responsible for transmitting knowledge, values and skills to students, who develop both academically and personally. During this

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process, the system educates students from their pre-school childhood to adulthood, following the entire process of evolution throughout their journey. According to article 205 of the 1988 Federal Constitution: "Art. 205. A educação, direito de todos e dever do Estado e da família, será promovida e incentivada com a colaboração da sociedade, visando ao pleno desenvolvimento da pessoa, seu preparo para o exercício da cidadania e sua qualificação para o trabalho." (BRASIL, 1988, Art. 205). It is important to ensure the well-being of students who are required to participate in the educational process. For the school community to thrive, it is essential that the school prioritizes safety standards in its facilities. As Santana (2023) highlights, '[...] A escola precisa ser um espaço de paz, de valorização de professores e de acolhimento e proteção para nossas crianças e jovens.'

According to Araújo (2023), security in schools still presents significant problems, and there are many actions to be taken in search of a peaceful school environment. It is possible to note the need to address student safety issues in the educational environment, as its lack represents a significant danger to everyone involved. Considering this need, the potential of technology can be explored in more depth to address this issue.

2.1.1. How technology can help safety in schools

According to CNN Brasil (2023), technology has undergone a notable increase in recent years and process automation is gaining prominence, becoming increasingly present in the global market, the sector's prospects for appreciation are around of US$350 billion by 2024. With recent technological advances, repetitive and predictable tasks that previously required labor can now be automated.

In the context, where monitoring student access is usually carried out by security guards, the application of appropriate tools can simplify the student entry process, resulting in more efficient access control in the academic environment. This can be seen in the excerpt below:

> O investimento em ferramentas modernas de segurança reflete nas matrículas para escolas particulares. E os gestores públicos estão se convencendo de que é preciso optar por soluções perenes, empregar os recursos públicos em soluções realmente eficazes, entendendo que adotar exclusivamente a vigilância humana é uma estratégia ultrapassada e suscetível a muitas falhas. (ULRICH, 2019). .

2.1.2. Facial recognition in the school environment

The effectiveness of registration authentication can be maximized through the use of the most appropriate technology. Current identification methods at school entrances may be less effective when compared to facial recognition, which presents several factors favorable to its use. This is evidenced in Ristow's speech, which compares facial recognition with other existing identity validation methods and highlights its importance.

> O foco das escolas eram as catracas eletrônicas, hoje, isso já mudou. Agora os gestores educacionais precisam se preocupar em formar barreiras de segurança que identifiquem, registrem e permitam ou não o acesso de pessoas e veículos. No momento, o reconhecimento facial é o recurso que apresenta melhores resultados para essa finalidade. (RISTOW, 2019).

ScannerRF brings facial recognition technology to the school environment with the aim of improving security when accessing schools. In this context, in addition to the best results, the application also provides the best cost-benefit among competitors, as to use it you only need to have a laptop with a webcam and internet access.:

2.2. Technologies used

For the development of the ScannerRF application, the following technologies were applied:

2.2.1. SQLITE3

As Banin (2018) reminds us, SQLite is shared on several devices, being a lightweight, indisputable and very favorable technology as a data repository for various applications. This database management system is relational and open source, does not require a separate server to function and has the ability to store database files within its own structure, making it suitable for websites and mobile systems. It was used in this system due to its ease in storing digital images.

2.2.2. PYTHON

Python is a programming language developed with simple learning, it has a wide range of development, being able to develop applications, websites, games, data analysis, desktop systems, artificial intelligence, among others. According to Manzano (2018), Python offers the possibility of allowing your practices to be quickly carried out at your operational location, being able to instantly visualize the action of an orientation carried out.

The main characteristics of this language are:

- Multiplatform, that is, there are several versions of operating systems;
- Multiparadigm, it is possible to program with different bases such as object-oriented, functional or procedural.

2.2.3. PYQT5

According to Linhares (2023), PyQt5 is the connection between the Qt library and the Python language that allows the usability of a simple interface to facilitate programming. This library provides a tool called Qt Designer, an application development framework that helps you create graphical user interfaces (GUIs) quickly and efficiently.

2.2.4. OPENCV

According to Barelli (2018), OpenCV (Open Source Computer Vision Library) has simple functions with the task of manipulating and processing digital images. The programming library is aimed at different types of verification, including facial recognition and photo and video editing. The tool is open source, currently having more than 500 functions that can be used in multiple languages such as C++, Python, Ruby, Java, among others.

3. MATERIALS AND METHODS

This chapter covers the application development processes. It details the data diagramming and modeling steps.

3.1. Modelo de entidade e relacionamento (MER)

It follows the Entity and Relationship Model that represents the logical structure of the application's database system.
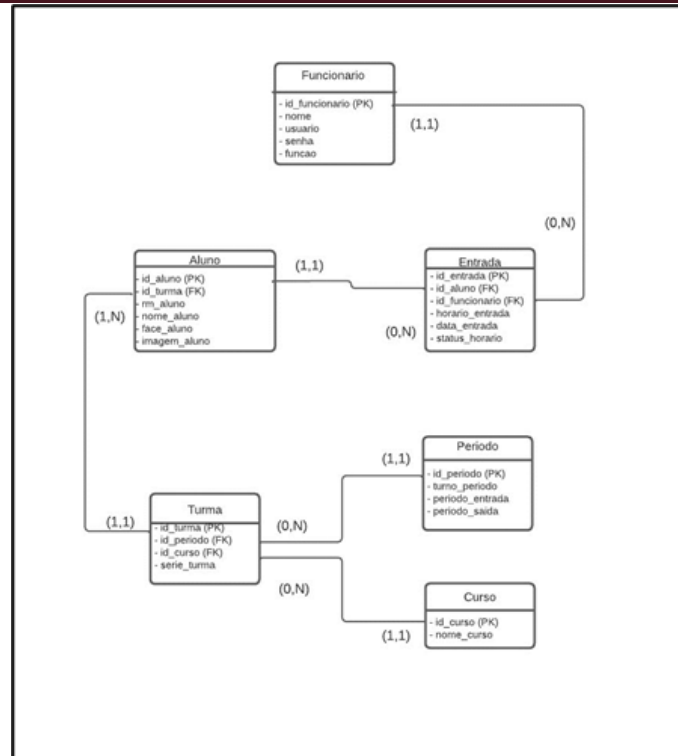
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Figure 1 - Entity and Relationship Model (MER)
Source: From the author (2023).

It shows the ScannerRF database tables, with their respective relationships and cardinalities.

3.2. Use Case Diagram

This diagram was used to verify and represent the system's functionalities or actions. Below is the application's use case, presenting the interactions that actors can perform.
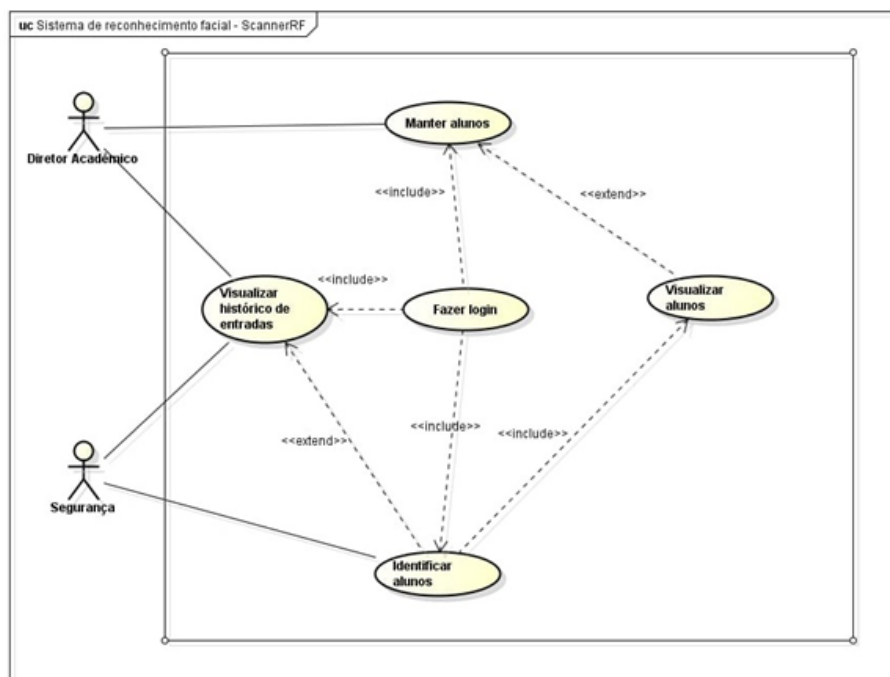

Figure 2 - Use Case Diagram
Source: From the author (2023).

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3.2.1. Documentation of use cases

As guided by the UML modules, follow the functional and non-functional requirements that are part of the ScannerRF use case diagram documentation. They enable a better understanding of how the system works.

Functional requirements of the Academic Director:
- RF01 – The system must allow the academic director to log in.
- RF02 – The academic director may register students in the system.
- RF03 – The academic director will be able to view the students registered in the system.
- RF04 – The academic director will be able to update the student's information in the system.
- RF05 – The academic director may delete student information from the system.
- RF06 – The system should allow the academic director to view the history of entries made by students, displaying the security guard who checked the respective entry.

Security functional requirements:
- RF01 – The system must allow the security guard to log in.
- RF02 – The system will provide the security guard with an interface to perform automated validation of student entry through facial recognition, together with analysis of the status of students' arrival time.
- RF03 – The security guard will be able to view the history of entries that he himself checked.

Application non-functional requirements:
- RNF01 - The system interface must be intuitive and easy to use, ensuring an efficient experience for users.
- RNF02 - Facial recognition must be carried out in real time, with a quick response time, allowing quick verification of student entries.
- RNF03 - The system must support a large number of registered students and carry out queries and updates efficiently, ensuring adequate performance even in high demand scenarios.
- RNF04 - The system must guarantee the privacy of student data and adopt protective measures against unauthorized access.
- RNF05 - The system must be reliable and capable of dealing with temporary failures without loss of data or functionality.
- RNF06 - The system must be modular, well documented and easy to maintain.

4. RESULTS AND DISCUSSION

The main subject covered in this chapter is the graphical results of the application, which are experienced directly by the user.

4.1. Finished interfaces

Here is the final result of ScannerRF, with the back and front-end complete, with all interfaces designed and defined.

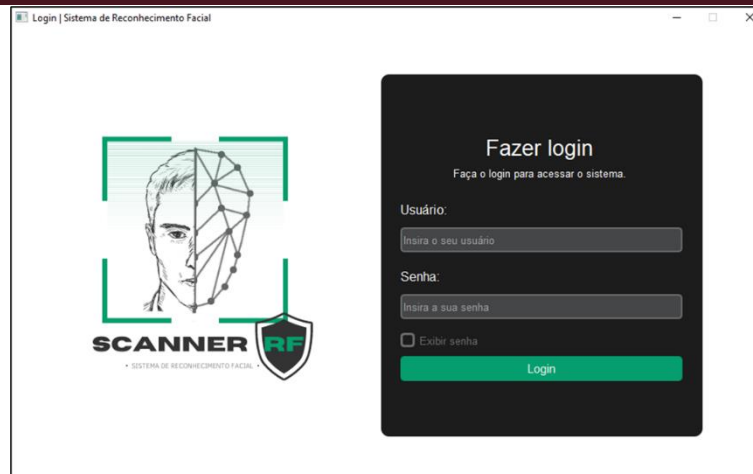**Figure 3 – Execution: Login**
Source: From the author (2023).

This is the system's initial interface, where the director and security guard can log in with their unique credentials, granting access to the corresponding screens and their specific functions.
Below are the academic director's screens and functionalities in the system:
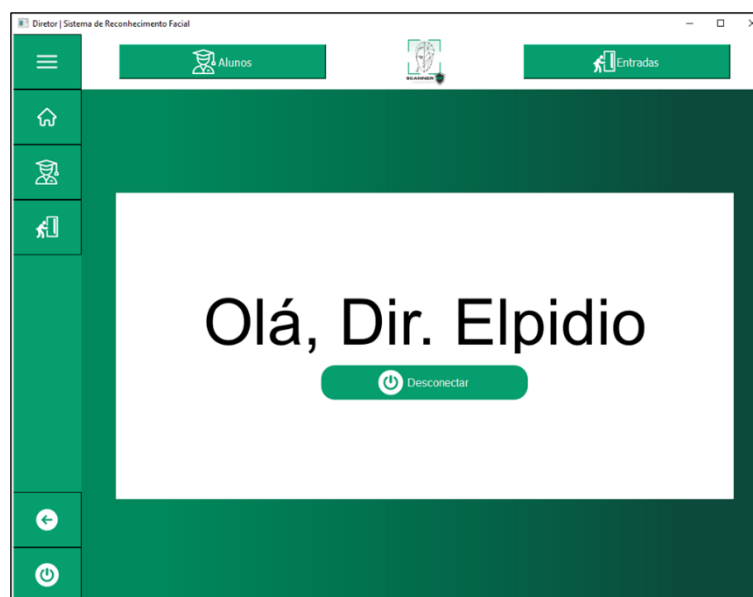

Figure 4 – Execution: Home Page (Academic Director)
Source: From the author (2023).

After logging in with the director's credentials, this interface will be revealed as the system's home screen. It gives the user the option to navigate to other screens through menu options including "Home", "Students" and "Inputs". Furthermore, it provides the possibility of disconnecting from the system. The menu will remain visible on all pages, making it easier for the user to navigate through the system.
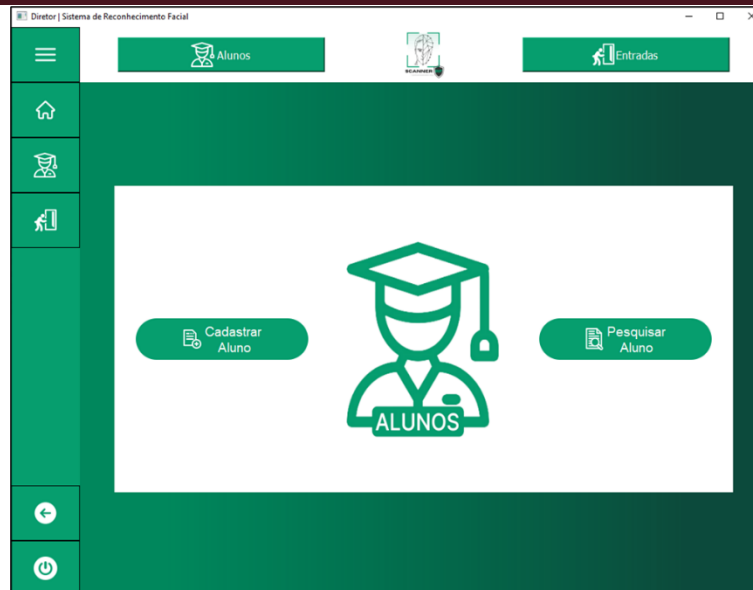
Figure 5 – Execution: Students (Academic Director)
Source: From the author (2023).

The director can choose between two options on this page. They can choose to access the "Register Student" page or the "Search Student" page.
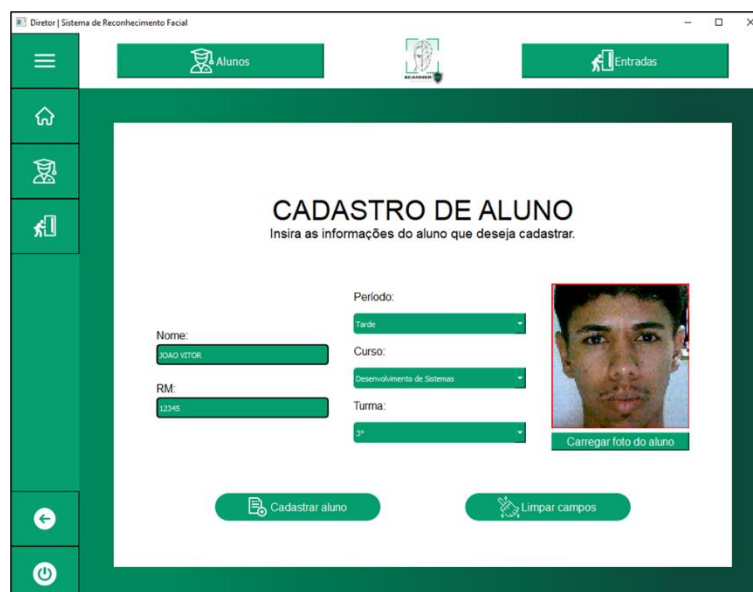

Figure 6– Execution: Register Student (Academic Director)
Source: From the author himself (2023).

This screen is the place for registering enrolled students. Making it possible to fill in the fields with the respective data and add the student's photo.

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Figure 7– Execution: Search Student (Academic Director)
Source: From the author himself (2023).

The director has two options for carrying out the research. He can choose to perform a broader search, using the period, course and class criteria or search directly by the student's RM (enrollment record).

Figure 8 – Execution: View Class (Academic director)
Source: From the author himself (2023).

After searching for the class using the criteria mentioned above, this screen will be displayed. It will contain some relevant information about the class and the table that lists the students present in it.

Figure 9 – Execution: View Student (Academic Director)
Source: From the author himself (2023).

When searching for the student, this screen will be displayed. In this context, it is possible to view data relating to the researched student, in addition to enabling the director to update the student's information or delete their record.
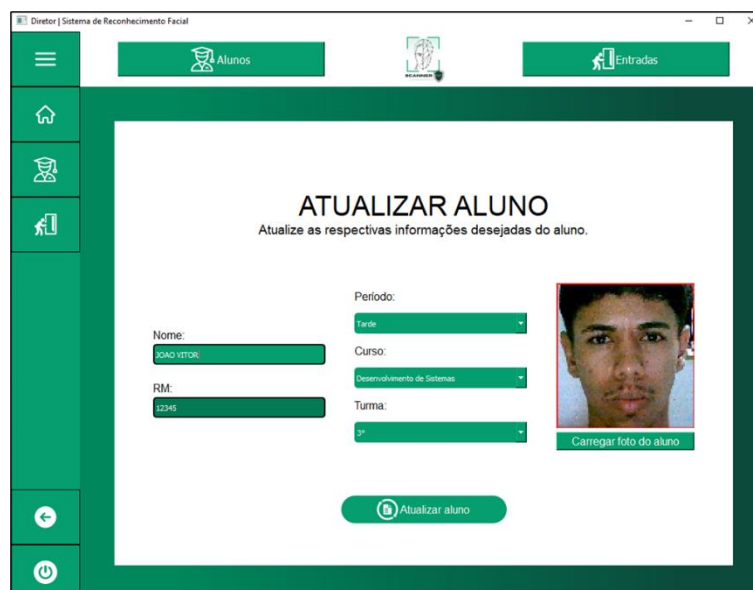

Figure 10 – Execution: Update Student (Academic Director)
Source: From the author himself (2023).

When selecting the "Update Student" option on the student information screen, the user will be redirected to this interface. Where the student's data will be presented, offering the possibility of making updates if necessary.

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Figure 11 – Execution: Entry History (Academic Director)
Source: From the author himself (2023).

The director has the option of consulting students' admission history in general. It can filter searches by any parameter in the table, being able to search by name, RM, period, date, time, status and the respective security that made the entry.

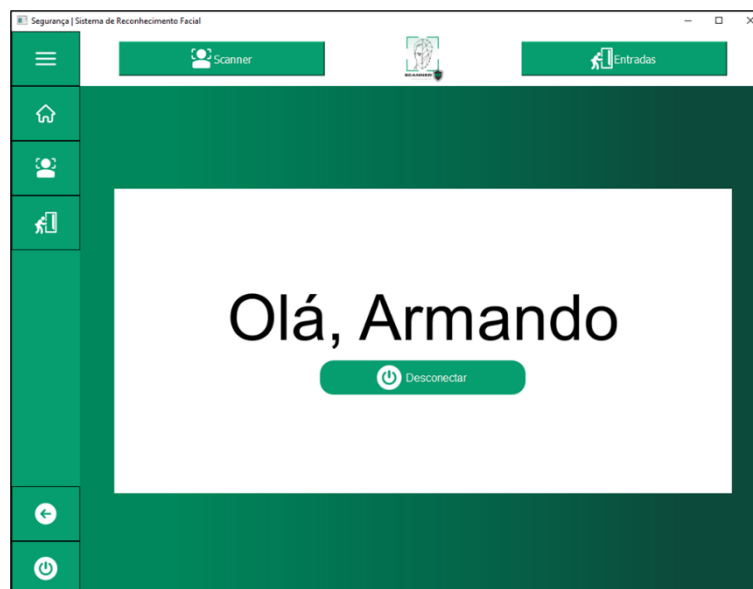Now, the security screens and functionalities in the system will be shown:

Figure 12 – Execution: Home Page (Security)
Source: From the author himself (2023).

This interface will be revealed when logging in with the security guard's credentials. Due to the distinctiveness of the user profile, it presents different options in the menu, including "Home", "Scanner" and "Inputs". The menu will also remain visible on all screens.
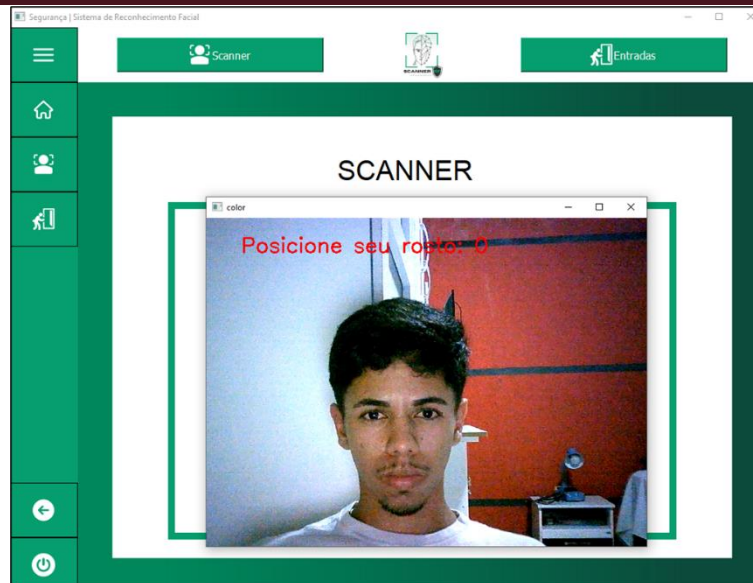
Figure 13 – Execution: Scanner (Security)
Source: From the author himself (2023).

This is an exclusive security feature. When this screen is displayed, it automatically activates the camera to identify students.
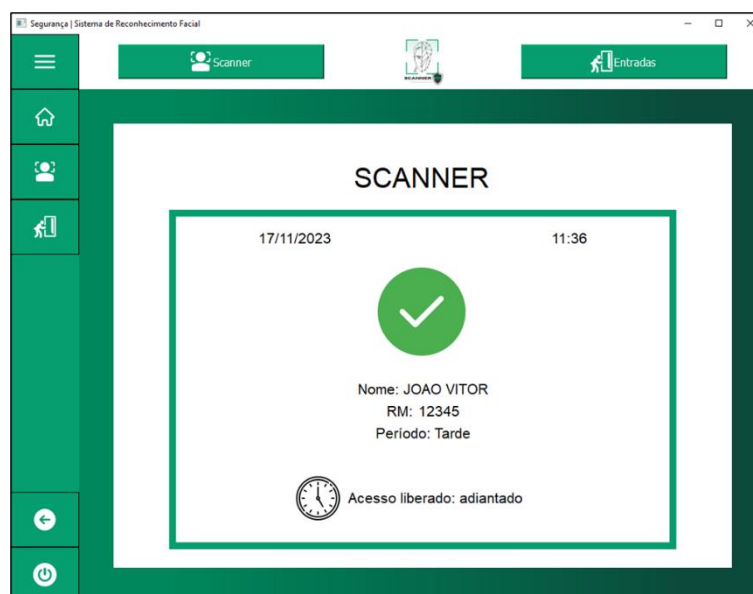

Figure 14 – Execution: Result (Safety)
Source: From the author himself (2023).

This interface presents the result of the student's identification, showing whether he or she is enrolled or not. It displays some important information about the student and shows their time status, classifying them as "Early", "On Time", "Late" or "Limit Exceeded".

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Figure 15 – Execution: Entry History (Security)
Source: From the author himself (2023).

On this screen, the security guard has the ability to check detailed information about the student entries he has made. It can also filter searches by any parameter in the table, being able to search by name, RM, period, date, time and status.

5. CONCLUSION

During the process, the study of facial recognition identification technology, a solution widely used in different sectors, was explored in greater depth. ScannerRF provides a solution that facilitates the work of professionals responsible for school protection and administration, improving the management of student access, ensuring that the director manages student data and supervises entry histories, thus preventing unauthorized people from entering. in the school environment. Although facial recognition technology requires high investments in other contexts, this system allows it to be implemented in an accessible way, using little equipment to run the system.

Considering this, it is possible that this work will contribute to the advancement of school security and open possibilities for future improvements in the field of enrollment validation in educational environments.

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