# Biometric access control system using ESP32-CAM module

For my thesis, I chose to implement a biometric access control system that utilizes facial recognition to identify individuals. My goal was to create an easily manageable, fast, efficient, and, above all, secure system in a cost-effective manner, thereby simplifying the daily lives of people and streamlining the identification process for individuals seeking entry into buildings

To ensure a high level of security, I chose facial recognition as the biometric identification method.

The system consists of various hardware and software components, the operation and placement of which are illustrated in the following diagram:
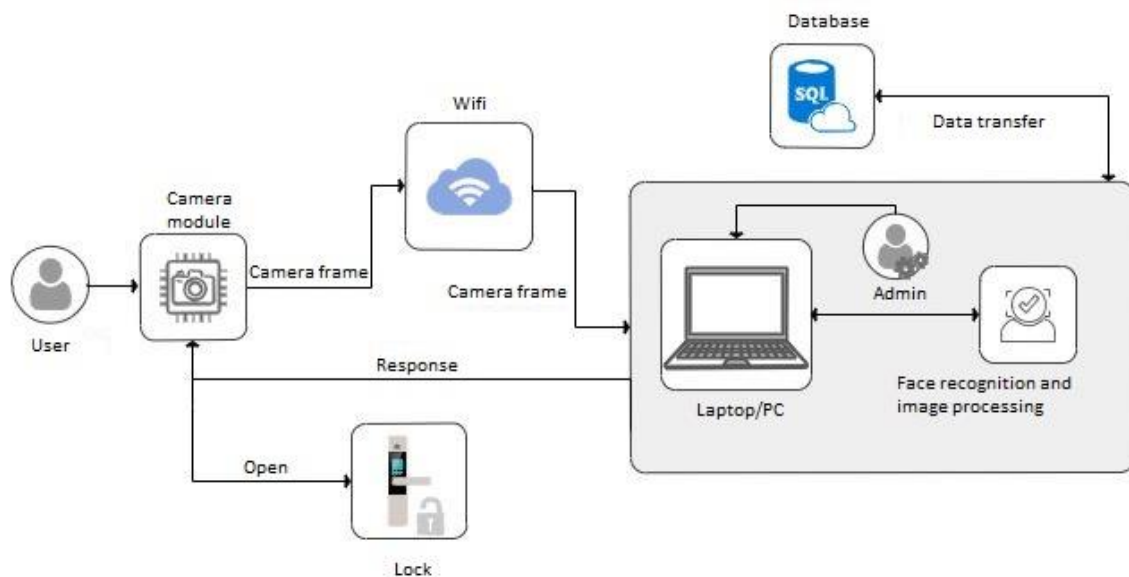

In the initial phase, the camera module captures the camera image, and then, with the assistance of a WiFi connection, transmits it to a computer or laptop where the image processing module is running. The captured frames are compared with the images in the database. If a match is found with any of the images, a notification is sent back to the camera module, which triggers the lock to open. On the other hand, if an unknown person is detected, the lock remains closed.

The hardware components of the system are shown in the following diagram:
- ESP32-CAM module
- RGB TFT LCD display
- 5 volt relay
- IR distance sensor

For the system to initiate, a person needs to stand in front of it. This presence is detected by the infrared reflective distance sensor. As a consequence, the ESP32-CAM module wakes up, and the continuous transmission of image frames begins towards the face recognition module and the display. If the facial recognition is successful, the relay is set to a HIGH state with the help of the camera module, enabling entry.

The main component of the system, as mentioned earlier, is the ESP32-CAM module, which is a microcontroller containing the ESP32-S chip. The ESP32 is a dual-core chip developed by Espressif, providing wireless communication capabilities through WiFi and Bluetooth.

We can see the ESP32-CAM module on the following diagram:

To facilitate ease of use, I created a user interface that allows for easy addition of individuals, and for traceability, the system maintains a list of individuals who have entered the building, along with the exact entry time.

To gain entry, it is a requirement for the administrator to add the individuals' data and images. Once this condition is met, the person is granted access to the building. The user simply stands in front of the camera at an appropriate distance, and if they are found in the system, the door opens, allowing them to enter. I implemented this using Bootstrap framework and PHP.

In the following sections, I will present a few of the more important pages.

The login page can be seen in the following image:
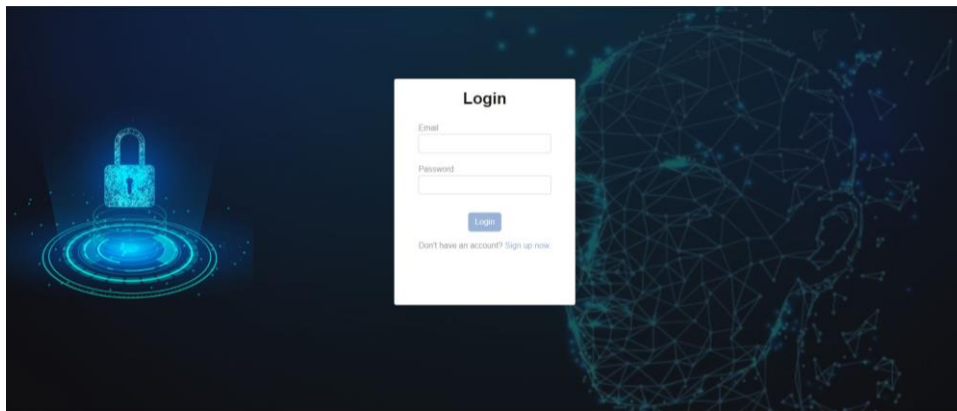
On the main page, the admin fills out the fields in the login form. They will need their email address and password. Afterward, they press the "Login" button to log in. If they are not registered yet, they will be redirected to the registration page where they can complete the registration process using their email address and a password. After successful login, they will have the option to access the content of the page.

The next image displays the home page.
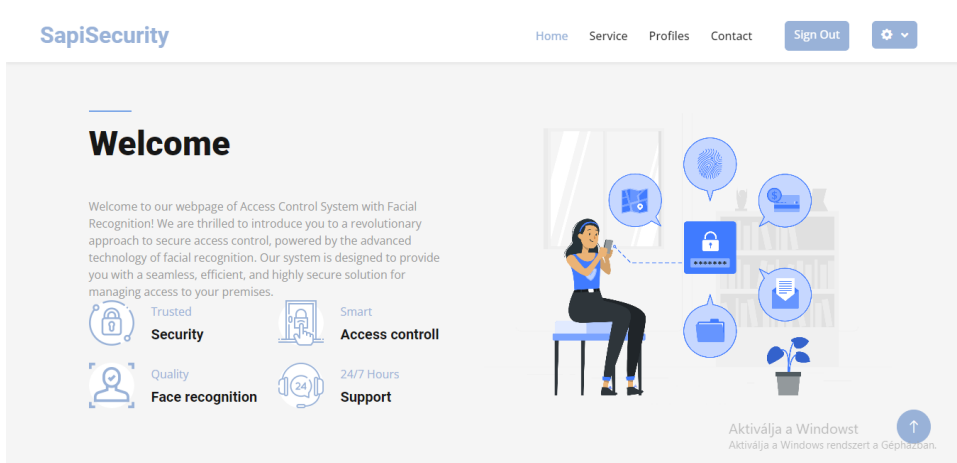
This page contains general descriptions and information about the system.

The pages of the system's members are visible below:
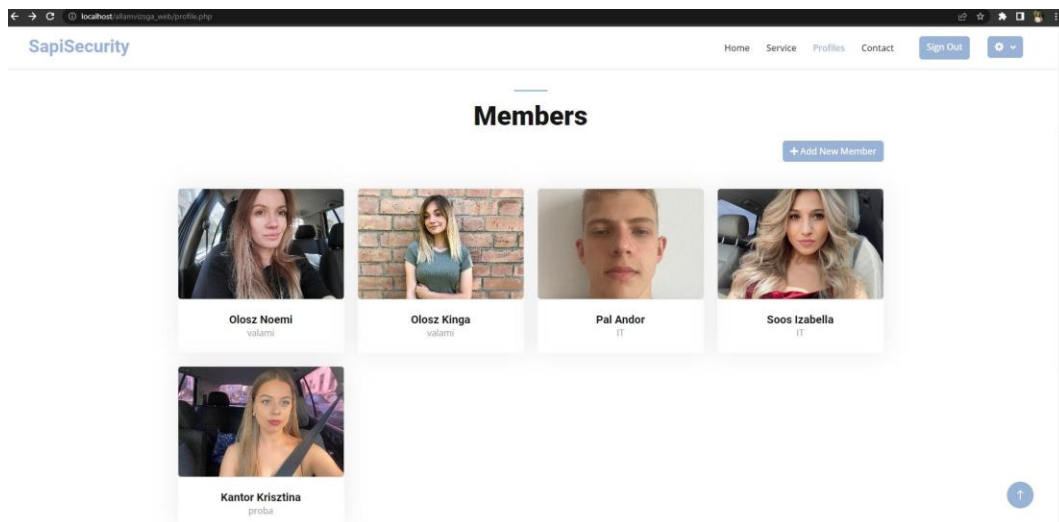
We can view the list of profiles that have been added so far. Different profiles display an associated image, name, and job position. If you wish to create a new user profile, you can do so by clicking the "Add New Member" button. You also have the option to delete individual profiles by clicking the trash icon in the top right corner of their respective images. Furthermore, you can explore detailed profiles of specific individuals by clicking on their images.

Next, we can see the page for creating a new profile:

To add a new user, click on the aforementioned "Add New Member" button, which will take you to the createProfile page. Here, you fill out the form with the required information and then click the "Submit" button to send it.

The image below shows the profile detail page:
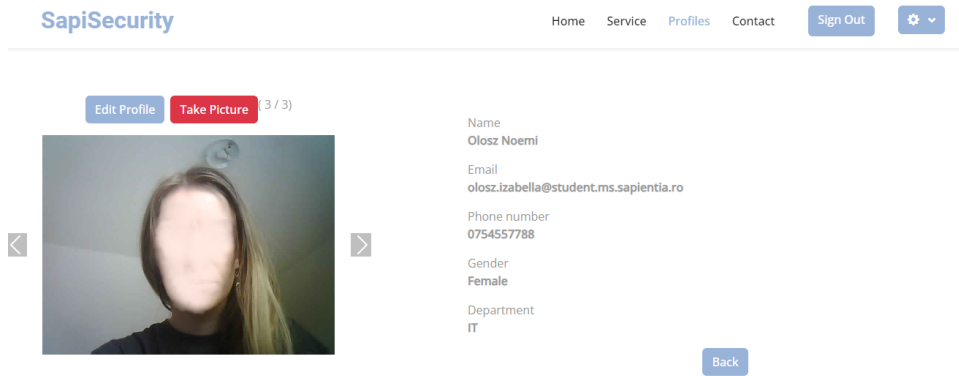
On the "profileDetail" page, you can add photos to the person by pressing the "Take Picture" button. This action prompts the camera to capture three frames of the person in front of it and adds them to the person's profile. The newly added photo will be displayed immediately.

In summary, I can say that I have successfully implemented an access control system based on real-time facial recognition that meets the technological expectations of the 21st century.

The system is visible in the following image:
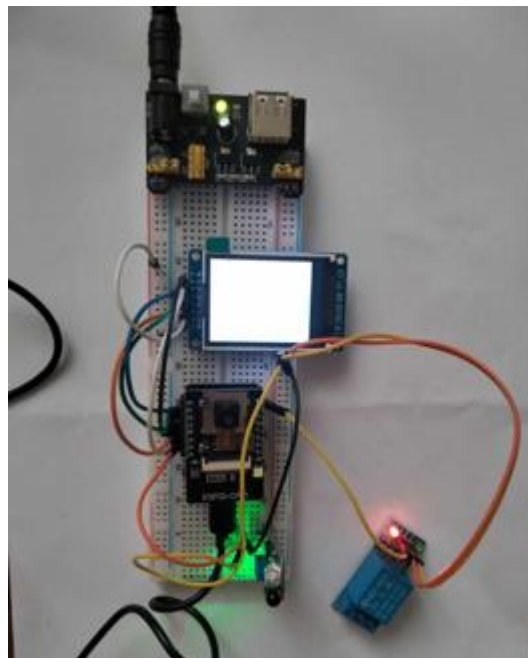
In the future, I would like to further enhance the system by integrating additional authentication methods alongside facial recognition.