ElectroCap Mid-Program Pitch Deck (Automated Alarm System)

Monitoring Smart Home Security (Team 12)

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TÉCNICO LISBOA

Team

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Advisors and Mentors

- **Scientific Advisor**: Prof. Luís M. Correia
- **Coordinator**: Prof. Luís M. Correia
- **Mentor**: Prof. João Felício

Problem definition

Nowadays most alarm systems implemented in people's homes aren't totally automated, needing someone to manually enable or disable them. Our focus is to implement an alarm system whose purpose is to control the access to the apartment while making it as automatic, robust and reliable as possible.

A restriction/disadvantage of an automated alarm system might be the cost of its components.

Solution beneficiaries

The segment of society who benefits from the alarm are mainly the owners of the buildings where it is installed, as well as their neighborhood.

Anyone who owns a home and is concerned about its safety can benefit from this solution, increasing the reliability of its security. Neighbors of homes that have this solution implemented can also benefit from it, since better security in one home allows better alerts to be given to the neighboring homes.

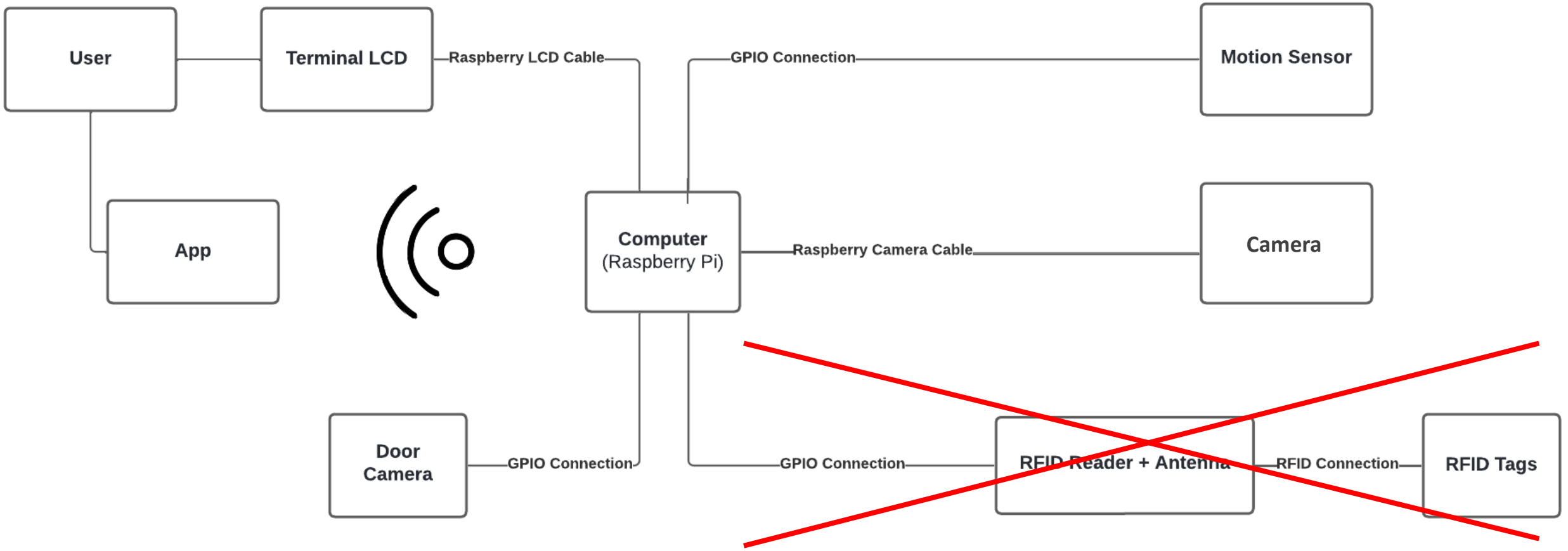
Technological solution

The technical solution for the given problem is the development of an automated alarm system through a central computation unit that supports incoming sensory inputs from a myriad of sensor types, such as cameras and motion sensors. As such, the only fully-mandatory requirement in terms of hardware would be a central computer. Said central computer would run software that implements a solution incorporating input from several types of sensors, accounting for implementations where there are more/less sensors installed, and correspondingly adapting said solution. The amount and type of sensors implemented in each scenario can therefore be variable.

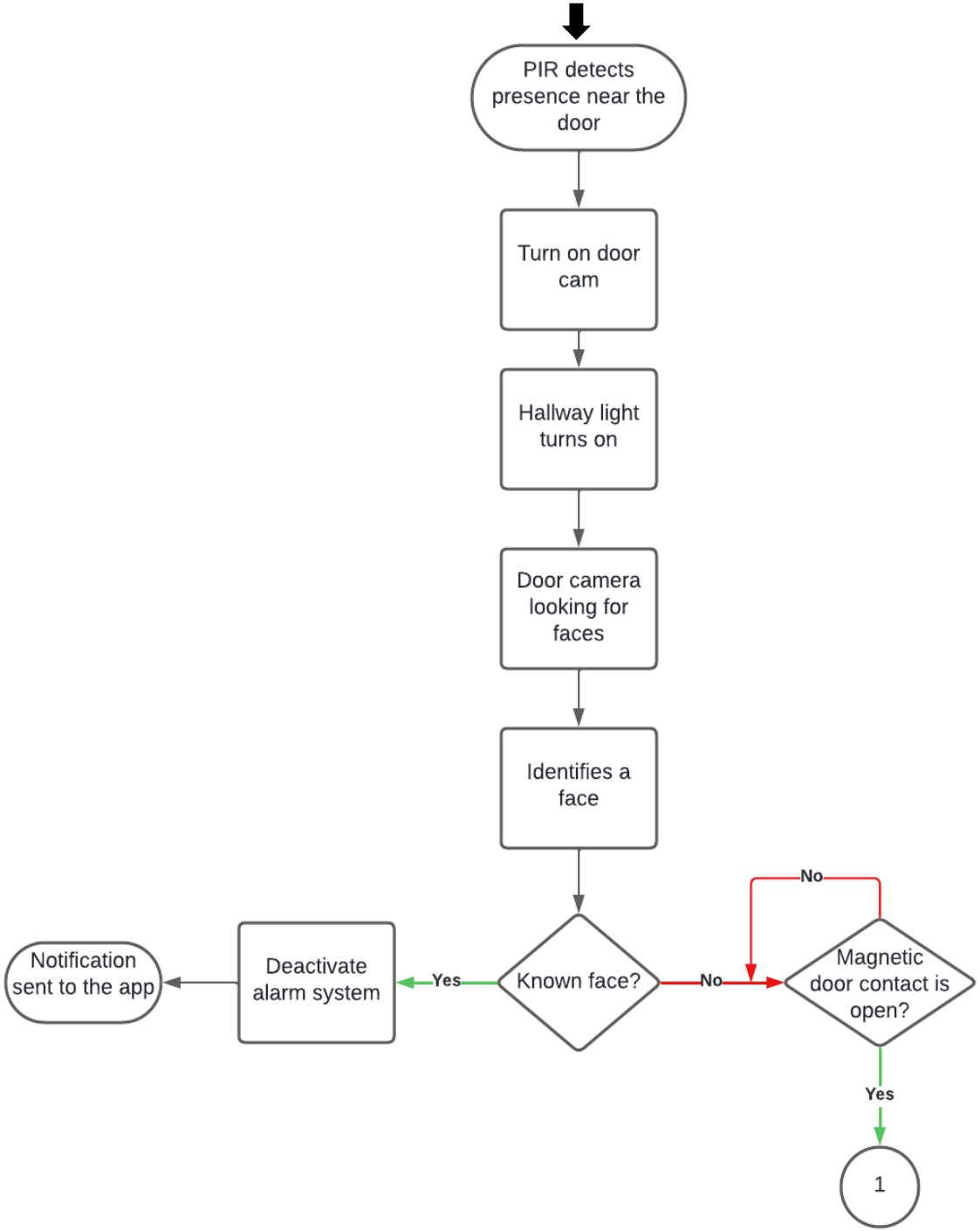
Our solution involves installing a door camera to capture video, which will undergo facial recognition algorithms. Additionally, an overhead door camera will monitor movement in the area, complemented by a motion sensor to track individuals entering or exiting the apartment.

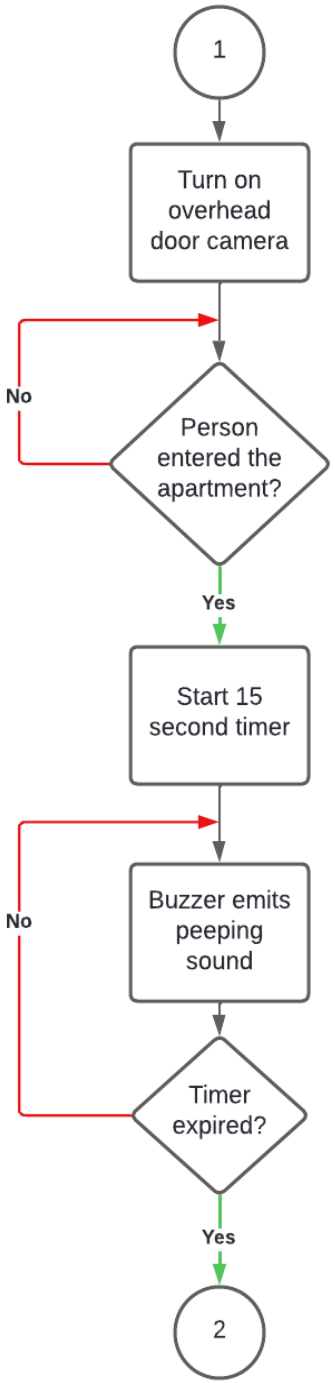
The system will also use an app that provides an easy way for users to manage their alarm system, providing information about suspicious activities as well as giving the user control over the system functionalities, such as disabling the alarm after they have been made aware of the possible threat at hand.

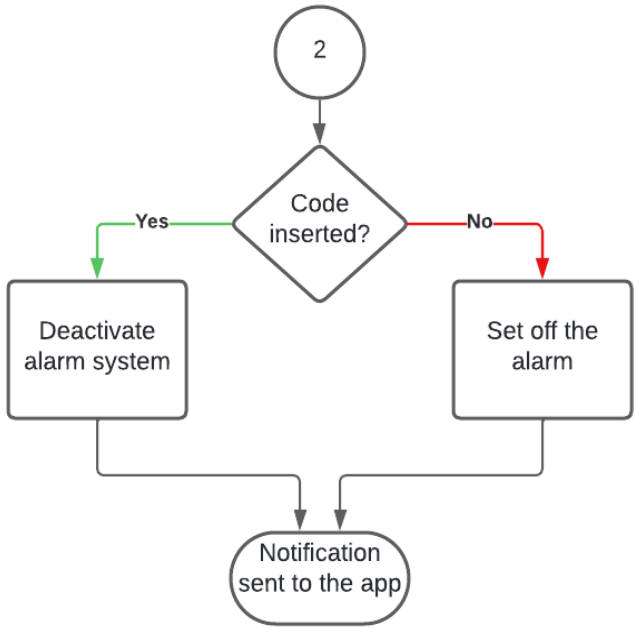
Technological solution



Technological Solution Logical Sequence


PIR detects presence near the door
Turn on door cam
Hallway light turns on
Door camera looking for faces
Identifies a face
Known face?
Yes
No
Deactivate alarm system
Notification sent to the app
Magnetic door contact is open?
No
Yes
1


1
Turn on overhead door camera
Person entered the apartment?
No
Yes
Start 15 second timer
Buzzer emits peeping sound
No
Timer expired?
Yes
2


2
Code inserted?
Yes
No
Deactivate alarm system
Set off the alarm
Notification sent to the app

Competitors and previous work

Existing alarms end up not being completely automated resulting in the need to manually operate them. Some companies that sell these products are Securitas, Ring, Prosegur, etc.

Site Securitas : https://www.securitasdirect.pt

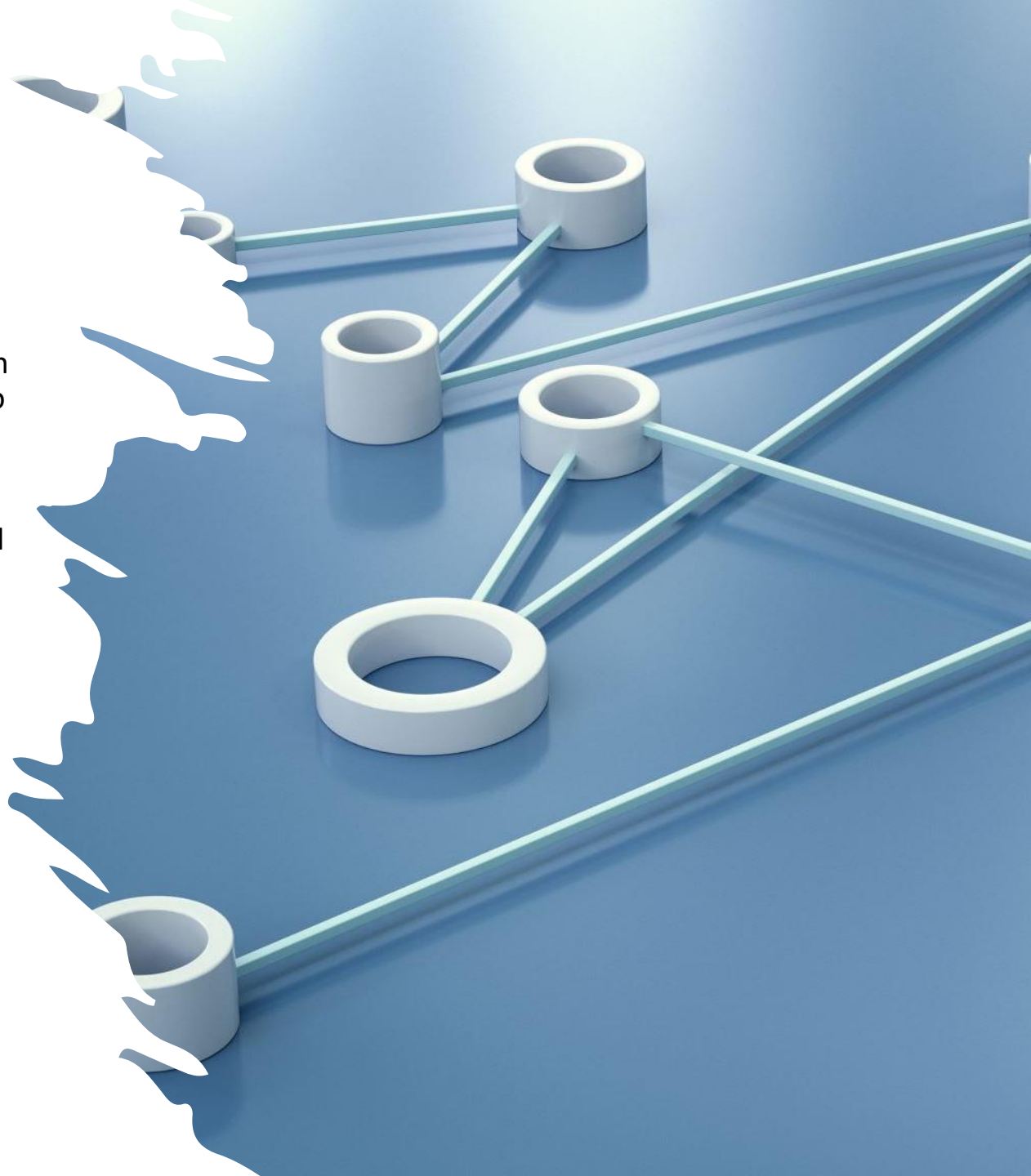
Site Prosegur : https://alarmes.prosegur.pt

Site Ring : https://eu.ring.com/

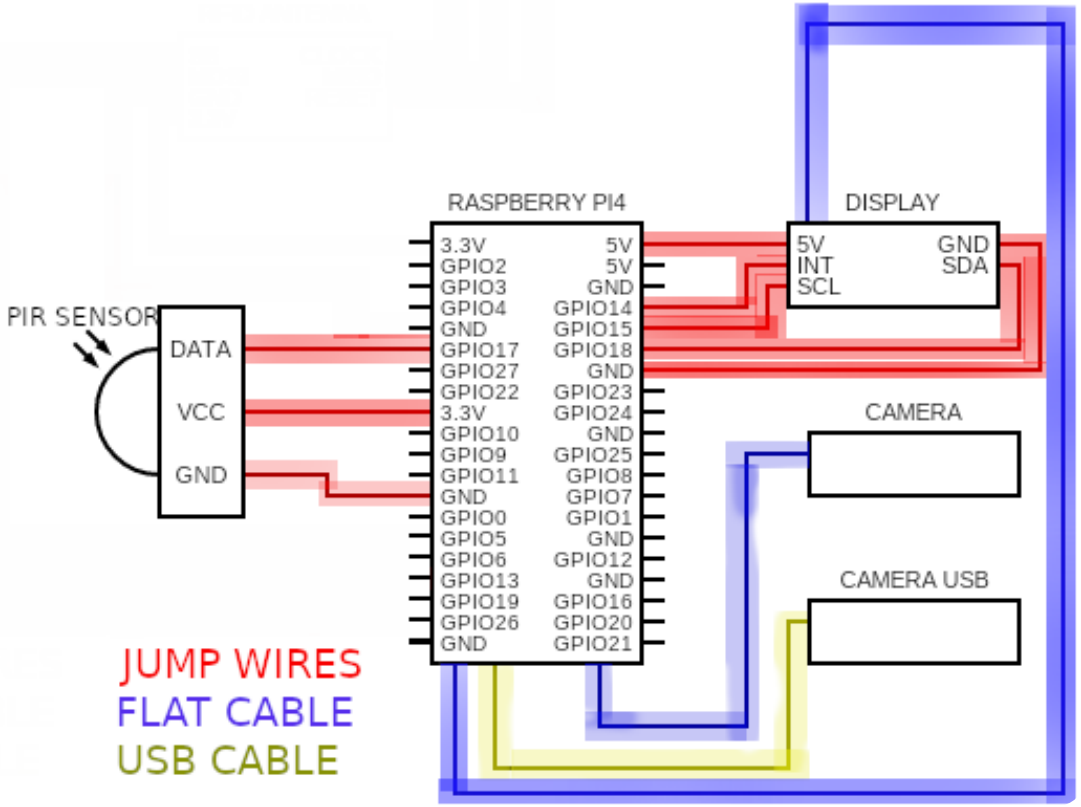
Solution requirements

Our solution must be robust enough to accurately function in both the most common scenarios and in scenarios where more creative ways to have unauthorized access to the home are attempted. As such, the following parameters must be met:

- **Performance** - The solution must reliably monitor entrances and exits with high accuracy. The video-processing algorithms used should therefore also work with high accuracy. The system response time should be fast enough to ensure timely alerts, ideally instantaneous.
- **Usability** - The system interface should be user-friendly for easy setup and management.
- **Reliability** - The video-processing algorithms used in the system should operate reliably under various lighting conditions and camera angles.
- **Security** - All data pertaining to users must be securely stored and encrypted, as to preserve privacy. The system must have mechanisms to prevent tampering or hacking.
- **Compatibility** - Ideally, the system should be compatible with most common home security infrastructures and be able to integrate with existing home automation systems, when such an interface is possible.
- **Scalability** - The solution must scale well, in the sense that it must work accurately in both small and large homes. It must also provide a reliable solution, even if with variable levels of accuracy, when implemented with less/more sensory components.



Solution requirements



The cameras that are going to be used for the facial recognition should have a minimum resolution of 1080p, a frame rate of at least 30fps and a sensor adaptable to various lighting conditions.

The terminal camera has a 5-megapixel chip, 2952 x 1944 pixel resolution and 90 FPS. The USB camera also has 2592 x1944 pixel resolution.

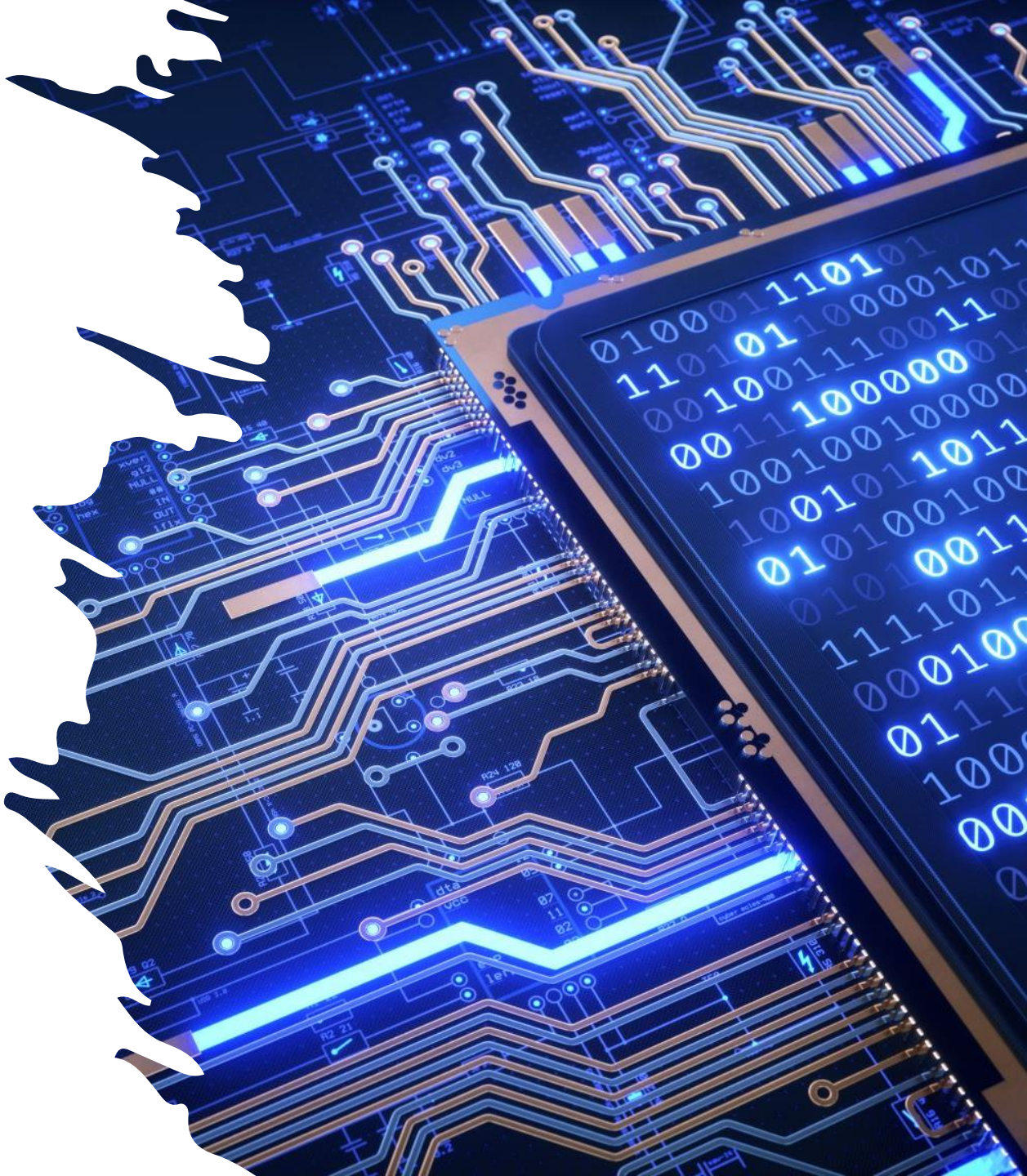
The most suitable central computation unit for the system is a raspberry pi that coordinates the synchronization between tasks that it has to perform. It should also be able to support inputs from various sources.

Technical challenges

The main challenges of our solution revolve around guaranteeing that the detection mechanism that keeps track of entrances in the home is reliable. Capable intruders might be knowledgeable enough to avoid detection by the motion sensor. Windows or entrances left open might also tamper with said tracking.

The cameras using the facial recognition technology might not work properly due to ethnicity issues, misidentifying people of color as well as some marginalized groups.

Other technical challenges might emerge along the way of our development.



Partners

So far, we have not partnered up with any companies.

We tried to contact **Prossegur** via email but haven't received a response yet.

Some companies in the home security area or others that operate with the mentioned technologies could provide us with equipment and/or important feedback.

PROSEGUR

Testing and validation metrics

Testing our system will include the regulation of the sensors and the testing of the facial recognition algorithm to ensure its' consistency. The sensor should also be prepared/tested in case there is no Wi-Fi/energy.

Validation metrics:

- **Facial Recognition** : accuracy and speed of the system, measuring the percentage of correctly identified individuals and how long that recognition takes. The camera’s resolution and overall performance can also be considered as a metric;
- **Motion Sensor**: the sensitivity of the sensor to detect unauthorized movement without generating false alarms.

Testing and validation metrics (facial recognition)

Camera Resolution = 5MP (2952 x 1944 pixels);
Average Face Size = 200x200 pixels;
PPI (Pixels per Inch) = horizontal resolution/image width= 2952/200 = 14.76 PPI
Focal Distance = 1,67 mm
Field of View = 2 x arctan(200/(2x1.67)) = 69.67°
Minimum Distance = 50/(2 x tan(69.67/2)) = 35.92 inches => 91.25 cm

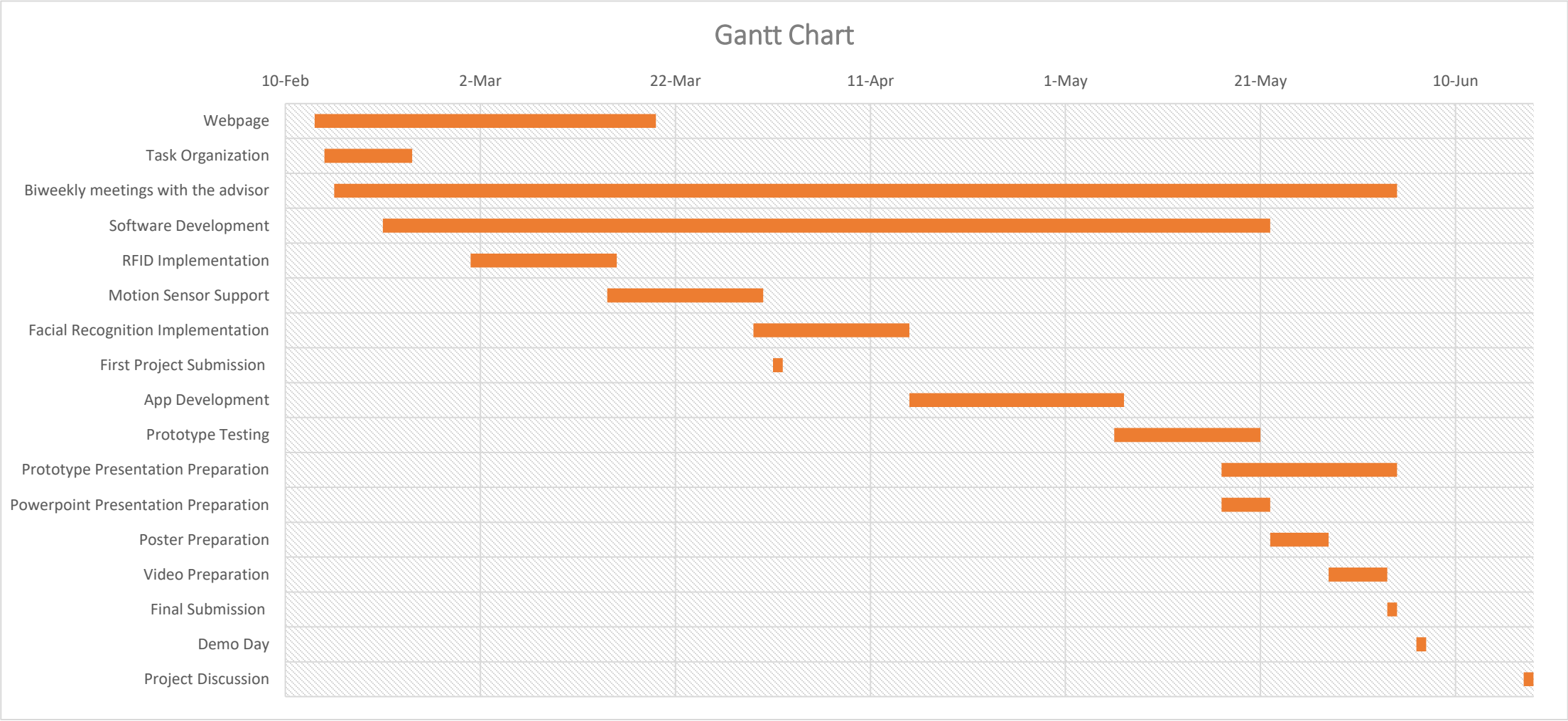
Division of labor (1)

Miguel Neves	João Saraiva	Gonçalo Amaral
Team Communication, Organization and Leadership	**Hardware Developer**	**Software Developer**
Hardware Development	Software Development	App Development
Data Organizer	System Tests	Proof of concept
Prototype Presentation (PPT)	Prototype Presentation (Video)	Alarm System Sensors
Proof of concept		Prototype Presentation (Poster)

Division of labor (2)

Pedro Paiva	Francisco Carmo	Francisco Henriques
Webpage Manager	**Hardware Developer - Cameras**	**Hardware Developer - Sensor**
Hardware Development	Facial Recognition Software	Facial Recognition Software
Webpage Creation	System Tests	System Tests
Prototype Presentation (Poster)	Prototype Presentation (Video)	App Development
		Prototype Presentation (PPT)

Original Schedule



Mid-program status

The central objective of the project is now directed towards crafting an **automated alarm system** that incorporates **an access control mechanism**.

So far, we have already begun developing **software** in **Python** related to **facial recognition**, using the PC camera, and a testing software to verify if the **users are entering or leaving**. The next step is to test the software on the project's components, namely on the Raspberry Pi.

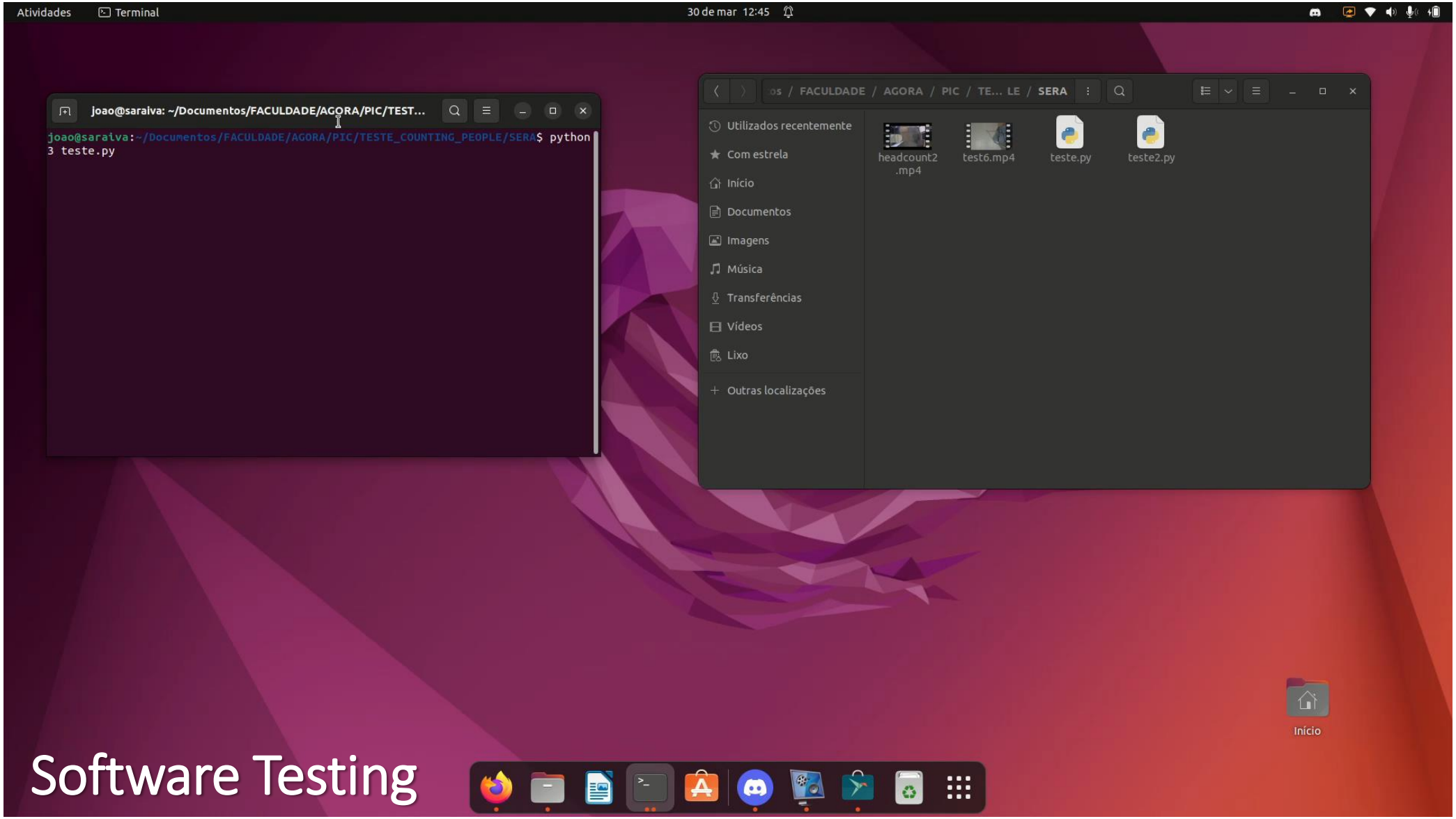
During the process of gathering and analyzing requirements, we concluded that the facial recognition camera should be able detect individuals from at least 90 centimeters away.

Achieved results

- Public Webpage and blog;
- Software testing - verify the entrance or exit of people;
- Software testing - facial recognition;
- Project architecture and components.

Webpage

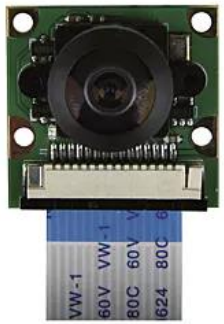
https://web.tecnico.ulisboa.pt/ist196900/



Software Testing

Software Testing (Facial Recognition)

Project Components (Proof of Concept)



For the **final project**:

- **Infrared sensor** - enhances facial recognition accuracy;
- **Buzzer**/Speaker;

Challenges faced by the team

The main challenge we encountered in the project so far is related to the **RFID technology** and its limitations, such as:

- **Reading interferences** with certain materials like metals;
- RFID tag data **can be read by anyone** with a compatible reader;
- **High component costs** for the final project.

We decided to abandon this technology for now, leading our project to become an access control system that monitors and validates who enters and exits the apartment. One drawback of this is that it makes the project more “ordinary.”

We encountered difficulties with the webpage's functionality on mobile phones, as it was not performing as expected.

Another challenge we came across is how to process personal data for the facial recognition system without privacy issues.

Deviations from original schedule

The project has experienced a notable deviation from its initial concept, as RFID technology has been excluded from the solution. The primary focus has shifted towards developing an automated alarm system seamlessly integrated with an access control mechanism using facial recognition technology.

Additional factors might be linked to the substantial reliance on hardware (cameras) for a significant portion of the project, alongside the workload of other courses, etc.

Contribution of each team member

Miguel Neves	João Saraiva	Gonçalo Amaral
Team Communication	Motion Detection Software	Motion Detection Software
Reunion Planner	Hardware Research	System Tests
Hardware Research	System Architecture	Logical Sequence
Mid-Program Pitch Deck	Testing and Validation Metrics (facial recognition)	Hardware Research

Contribution of each team member

Pedro Paiva	Francisco Carmo	Francisco Henriques
Webpage Creation	Facial Recognition Software	Facial Recognition Software
Webpage Management & Blog	System Tests	System Tests
System Tests		Camera Research
Hardware Research		

Corrected Schedule