ElectroCap Project Proposal

Forest Fires Detection

André Alves
Catarina Salazar
Inês Coelho
Inês Martins
José Marques
Pedro Rodrigues

TÉCNICO LISBOA

1. Advisors and Mentor

- Scientific Advisor: Luís Correia
- Scientific Co-advisor: João Felício
- Coordinator:
- Mentor:

2. Problem definition

One of the challenges in forest fire detection is the inability to detect them quickly and safely. This incapacity can lead to a rapid spread of fire in certain remote areas, resulting in a delayed immediate response and potentially causing damage of significant proportions. There are several factors that can impede the development of a viable solution to this problem, such as the need for effective detection over large forested areas, which hinders the use of traditional methods like smoke detectors, and the lack of widespread pursuit for a potential solution.

3. Solution beneficiaries

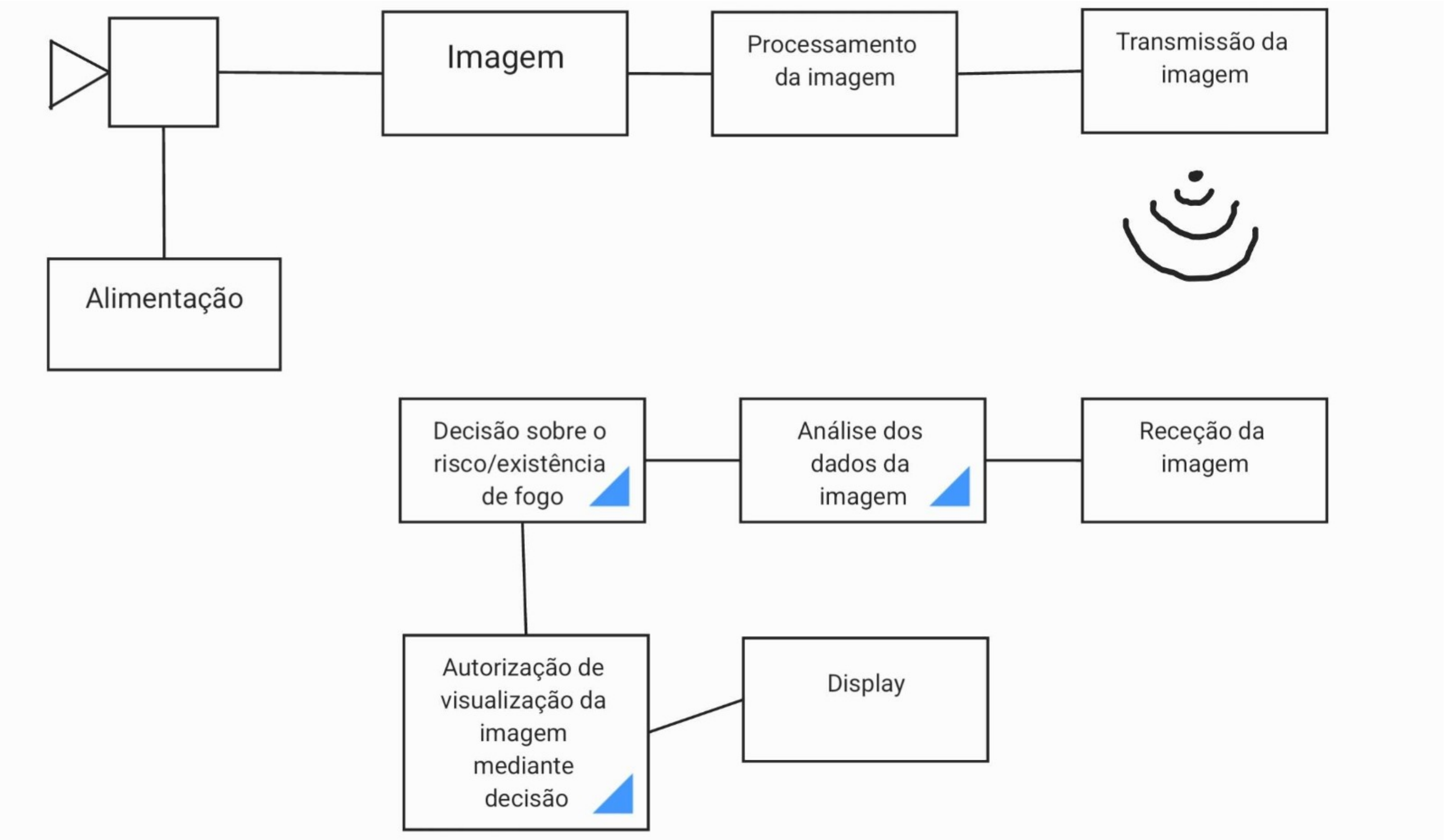
First and foremost, alerting local communities about forest fires through drones would enable rapid detection, allowing for swift responses to contain initial fires and protect properties. Additionally, firefighters and rescue teams would benefit from real-time information, enhancing the safety and efficiency of fire-fighting operations. Agricultural businesses would also gain by safeguarding their properties against fires that could spread to farming areas. Municipal councils and local authorities would experience an enhanced monitoring capability, swiftly identifying suspicious fire activities for a quicker and more effective response. In summary, this project would benefit not only local communities and emergency services, but also agricultural enterprises and municipal entities, ensuring a more efficient response to protect lives, properties, and the environment.

4. Technological solution

We propose a solution that involves the use of a drone, capable of following predefined routes, equipped with an integrated thermal camera. The data collected by the thermal camera are transmitted to the user's computer/control station. Based on the transmitted data, our software determines whether the area exhibits excessive heat, indicating a fire or a high-risk fire zone. Should this be the case, the software issues an alert to the user along with the image captured at that moment, enabling the user to ascertain whether it is a false alarm or an actual fire.

If a fire is confirmed, the user is then able to notify the relevant authorities (firefighters and civil protection) promptly, facilitating a rapid and more effective response. This solution addresses certain limitations as it does not require significant financial investment for implementation.

4. Technological solution scheme



5. Competitors and previous work

Insight Robotics - https://inteccon.com/products/wildfires-detectioncameras/

AlertWildfire uses patented geolocation technology that allows it to locate the source of a wildfire with a precision of 2 m2 and a range of 5 km. Additionally, the fire camera operates 24/7, searching for wildfires every 10 minutes, and its automatic detection system allows for real-time management of wildfire threats.

DJIZenmuseH20N-
https://grupoacre.com.pt/es/catalogoproductos/djizenmuseh20n/

This is probably the best and more adapted camera to the DJI drones. One of its functionalities consists in the possibility of simultaneously visualize thermal and stellar night image , allowing zooming also simultaneously. This functionality may enable the utilization of the drone during night in case of need.

5. Competitors and previous work

DJI FlyCart - https://www.dji.com/pt/flycart-30

Flycart model from DJI is the perfect example of combination of load capacity (30Kg) and speed (15m/s), what makes this drone a really viable option to suport a thermal camera and monitoriza extense forest areas.

Infinity Eletro-Optics - https://www.infinitioptics.com/cameras/eclipse

Eclipse is a really powerful thermal camera, with different DRI rantings according to the specs. One of the specs has a human DRI rating of 8.6km, 2.9km, 1.45km, making it a potencial thermal camera to be operated attached to a drone that would make possible a fast approach to any anomaly detected; Using this way full potencial of both equipment.

6. Solution requirements

To implement the solution we propose, we will require software capable of collecting images from the thermal camera, processing, and analyzing them. Subsequently, these images, along with other data such as temperature, will be transmitted to a receiver. At this receiver, there will be a control system responsible for forwarding both the alert message and the image captured by the thermal camera to the display, enabling the operator to distinguish between a fire and a false alarm.

Concerning the drone, it is essential to have a long battery life to support extended periods of surveillance. In terms of usability, an intuitive user interface is necessary to facilitate remote control, as well as to simplify the processes of configuration and implementation. Regarding security, encryption measures will be required for data transmission to protect the information, such as secure login procedures and authentication.

6. Solution requirements

In this case, we would use the MLX90640 thermal camera, which has a resolution of 32 x 24 pixels and detects temperatures in the range of -40 ºC to 300 ºC with an accuracy of approximately 1 ºC. It weighs 3.5g and has a viewing angle of 55° x 35° or 110° x 75°, detecting up to 9 meters away. We will also utilize the Klack Mini Drone Klack F185 Pro 4K Professional HD, which weighs 92.5g, with a flight time and charging time of 15 and 100 minutes, respectively. It has a remote control distance of 80-100 meters, and the drone's camera offers a viewing distance of 20-30 meters with a resolution of 4K 2560x1440.

7. Technical challenges

- Generally speaking, the technical challenges are subdivided into the following sectors:

Data transmission:

- Data transmission will be ensured by means of wireless protocols with low communication latency: -In the context of a proof of concept, one of two options will be used: Wi-Fi or Bluetooth. If we are talking about a more professional implementation, satellite communication would be ideal for guaranteeing high data transfer rates between two distant points.

Simulation materials:

- In order to simulate a forest fire, materials will be used whose combustion gives rise to a low-temperature flame, namely ethyl alcohol (ethanol), candles, lighters, propane or butane gas or flame lamps.

7. Technical challenges

Hardware (proof of concept):

- Since the aim of the work is fire detection, the camera in question must be able to take temperature measurements in a range from -5 ºC to 300 ºC. The MLX90640 thermal camera module meets the project's requirements. The camera's resolution is 32 x 24 pixels and it detects temperatures in the range of -40 ºC to 300 ºC with an accuracy of approximately 1 ºC.

In addition to the above, an Arduino board or, alternatively, Raspberry Pi or ESP32 will be needed to collect and analyze the information obtained. In the case of the thermal camera, the temperature value recorded by each pixel will be analyzed to create a criterion that associates the temperature of a given number of pixels with fire.

With regard to data reception, a display will be required to provide visualization of any thermal image captured by the respective camera.

7. Technical challenges

Hardware (concept):

In a more professional scenario, we would use the Eclipse All-Weather Long-Range PTZ Camera System thermal camera for fire detection. This camera has remarkable features, including several zoom lens options up to 510mm, optional infrared illumination with a range of up to 2km, optional thermal zoom up to 275mm, water resistance with military connectors. In addition, one of the specifications has a human DRI (Detection, Recognition and Identification) rating of 8.6 km, 2.9 km and 1.45 km.

Drones:

-For the final prototype, we will use the Klack Mini Dron Klack F185 Pro 4K Profesional HD drone which will have attached the thermal camera inherent in the proof of concept as well as the other elements used in it.

- In a more specialized context, there are several alternatives to consider. The DJI FLYCART 30 drone meets these requirements, offering high efficiency, the ability to support heavy loads (up to 30 kg), a strong signal, robust material, among other features. Given that the drone's maximum load is 30 kg, we can say that it will be possible to attach the equipment needed to obtain and process data to the drone with a comfortable weight margin.

8. Partners

In contact with Partner networks of Técnico (NOS, Vodafone, Thales, etc.).

A StartUp, connected to maritime control - Sea.AI

Altice - Engineer Luís Lamela

https://www.linkedin.com/in/luislamela/?originalSubdomain=pt

9. Testing and validation metrics

For testing and validating the results, we will employ a camera integrated into a drone. The distance metrics of the camera can only be determined based on its resolution and range.

Ideally, we would use a drone with the best possible autonomy, capable of remote control over kilometers, as forests are vast, and with the highest resolution possible, which is ideal for large forest areas. However, for prototype testing, we only require a drone with a 15-minute autonomy, a camera vision range of 20-30 meters, and a remote control distance of 80-100 meters since we will be operating nearby. The drone's weight is also a crucial factor, but given that the thermal camera + ESP 32 setup will be lightweight, the main aspect that might affect the drone's proper functioning is its power source, considering that batteries can be relatively heavy for a drone. Ideally, the drone would weigh around 100g.

9. Testing and validation metrics

The optimal thermal camera would be able to detect at long distances, have a temperature range of -40° to 300°, and the highest resolution possible. For our proof of concept, a thermal camera with a resolution of 768 pixels (32x24), a temperature range of -40° to 300°, a detection distance of up to 9 meters, and a weight of 3.5g is sufficient. The ESP 32 weighs 10g, so we need a drone that can carry at least 13.5g + a battery between 3.3V or 5V.

Key aspects to evaluate include:

Measuring the system's accuracy in correctly identifying potential fire areas, which involves comparing the drone's detections with actual fire events.

Assessing the rate of false positives (incorrect fire alerts) and false negatives.

Measuring the time between the detection of a fire by the drone and the transmission of alerts or relevant data to the ground control center. A quick response time is essential in emergency situations.

9. Testing and validation metrics

Evaluating the stability of the thermal camera during the drone's flight and the accuracy of thermal readings to ensure the reliability of captured information.

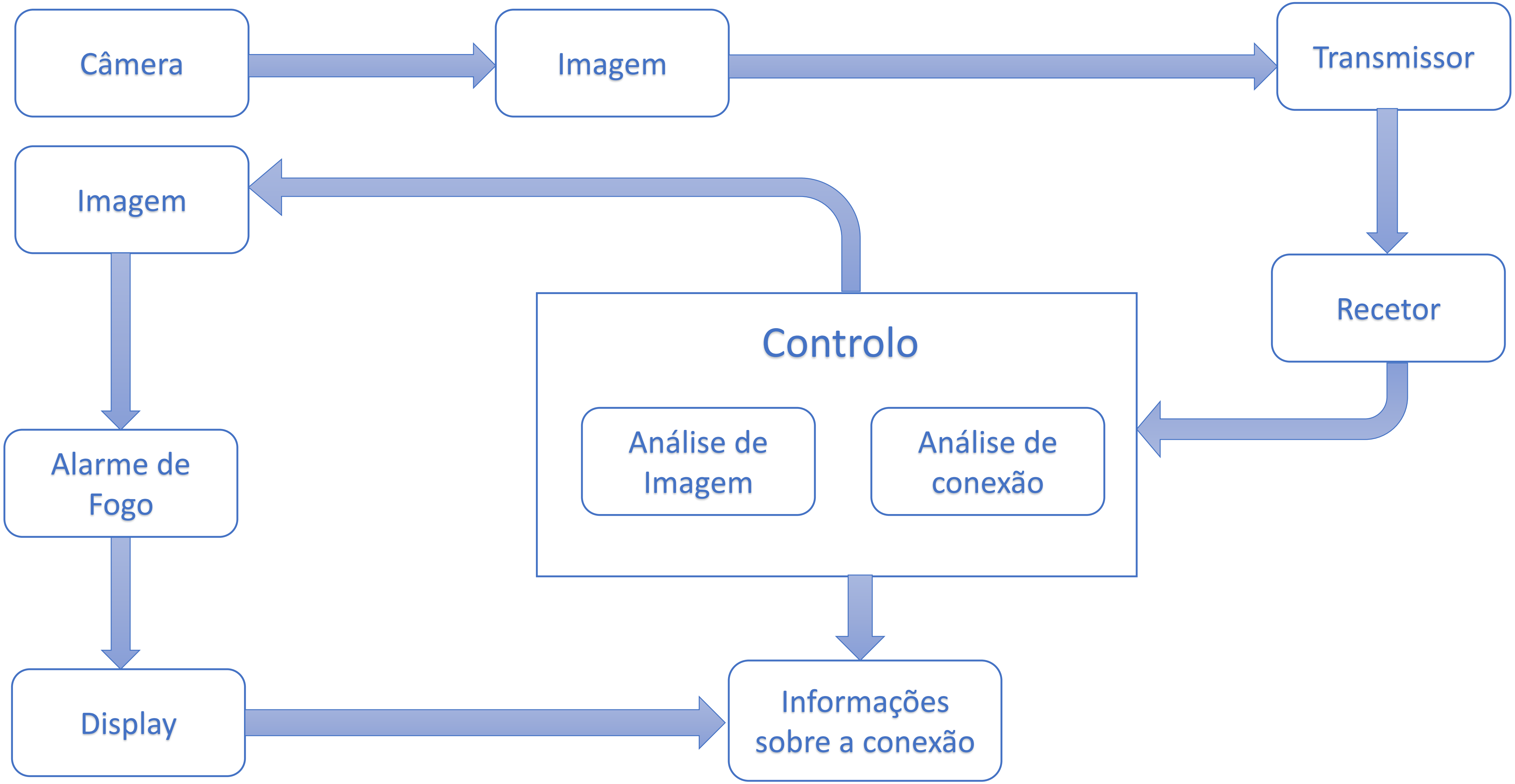
Measuring the effectiveness of the drone in covering a specific area during a mission, assessing the drone's autonomy, and its ability to perform extended missions. This includes testing its resistance to weather conditions and its capability to safely return after detecting a fire.

Conducting tests in adverse conditions, such as strong wind, low visibility, or extreme temperature variations, to ensure reliable system performance in various scenarios.

Assessing the effectiveness of integrating the drone system with existing alert systems, ensuring rapid and accurate communication with relevant authorities.

Testing the drone in different environments, such as urban areas, forests, and mountainous terrains, to ensure the system's adaptability to various operational contexts.

9. Testing and validation metrics



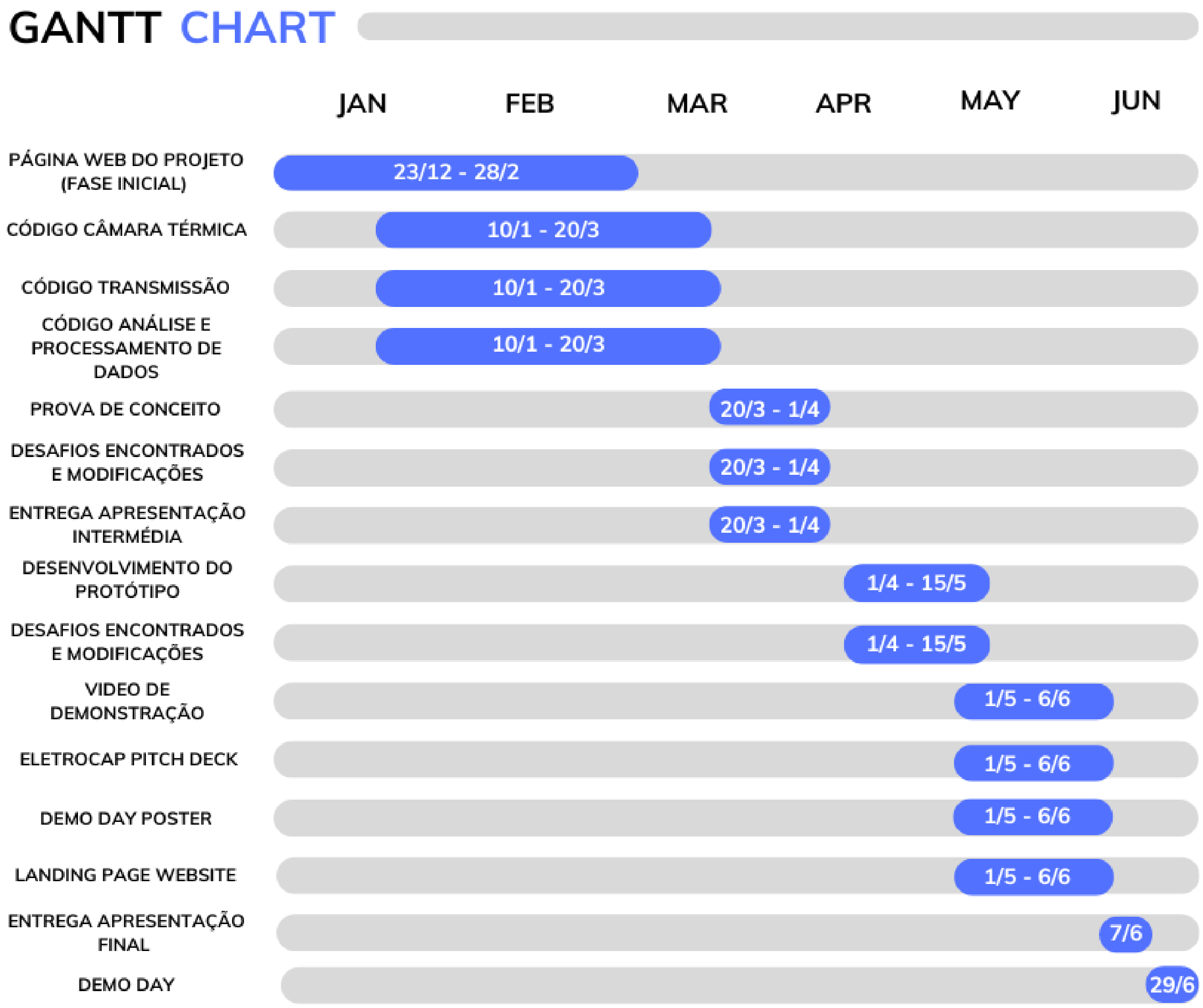
10. Division of labor (I)

André Alves	Catarina Salazar	Inês Coelho
Main role	**Main role**	**Main role**
Eletrocap Project Proposal	Eletrocap Project Proposal	Eletrocap Project Proposal
Código câmara térmica	Página Web do Projeto	Página Web do Projeto
Código transmissão	Código análise e processamento de dados	Código análise e processamento de dados
Prova de conceito	Prova de conceito	Prova de conceito
Mid-program pitch deck	Mid-program pitch deck	Mid-program pitch deck
Desenvolvimento do protótipo	Desenvolvimento do protótipo	Desenvolvimento do protótipo
Video de demonstração	Video de demonstração	Video de demonstração
Eletrocap Pitch Deck	Edição do vídeo demonstração	Demo day poster
Landing page website	Landing page website	Landing page website

11. Division of labor (II)

Inês Martins	José Marques	Pedro Rodrigues
Main role	**Main role**	**Main role**
Eletrocap Project Proposal	Eletrocap Project Proposal	Eletrocap Project Proposal
Página Web do Projeto	Código câmara térmica	Código câmara térmica
Código análise e processamento de dados	Código transmissão	Código transmissão
Prova de conceito	Prova de conceito	Prova de conceito
Mid-program pitch deck	Mid-program pitch deck	Mid-program pitch deck
Desenvolvimento do protótipo	Desenvolvimento do protótipo	Desenvolvimento do protótipo
Video de demonstração	Video de demonstração	Video de demonstração
Demo day poster	Edição do vídeo demonstração	Eletrocap Pitch Deck
Landing page website	Landing page website	Landing page website

12. Schedule


GANTT CHART
JAN
FEB
MAR
APR
MAY
JUN
PÁGINA WEB DO PROJETO (FASE INICIAL)
23/12 - 28/2
CÓDIGO CÂMARA TÉRMICA
10/1 - 20/3
CÓDIGO TRANSMISSÃO
10/1 - 20/3
CÓDIGO ANÁLISE E PROCESSAMENTO DE DADOS
10/1 - 20/3
PROVA DE CONCEITO
20/3 - 1/4
DESAFIOS ENCONTRADOS E MODIFICAÇÕES
20/3 - 1/4
ENTREGA APRESENTAÇÃO INTERMÉDIA
20/3 - 1/4
DESENVOLVIMENTO DO PROTÓTIPO
1/4 - 15/5
DESAFIOS ENCONTRADOS E MODIFICAÇÕES
1/4 - 15/5
VIDEO DE DEMONSTRAÇÃO
1/5 - 6/6
ELETROCAP PITCH DECK
1/5 - 6/6
DEMO DAY POSTER
1/5 - 6/6
LANDING PAGE WEBSITE
1/5 - 6/6
ENTREGA APRESENTAÇÃO FINAL
7/6
DEMO DAY
29/6