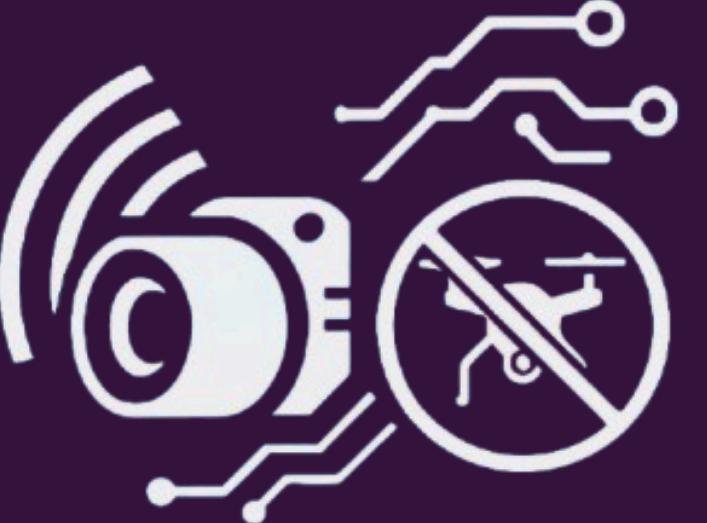




TÉCNICO  
LISBOA



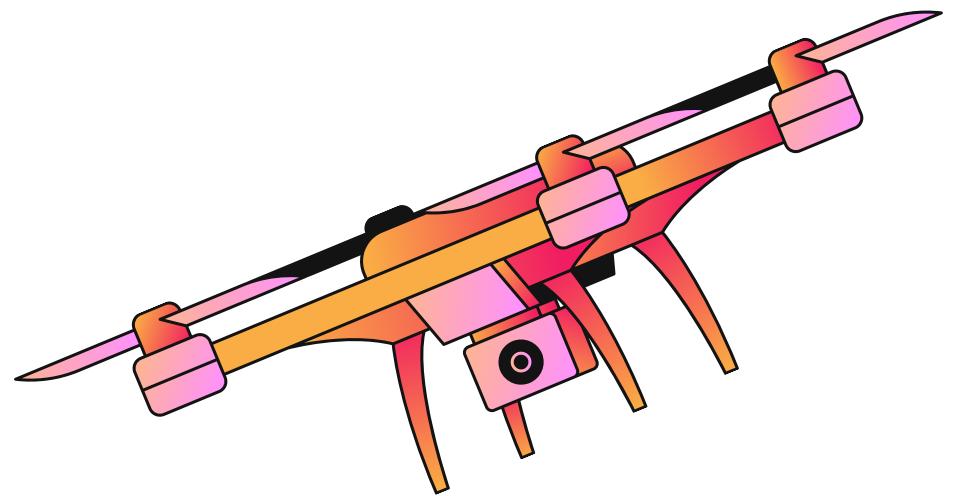
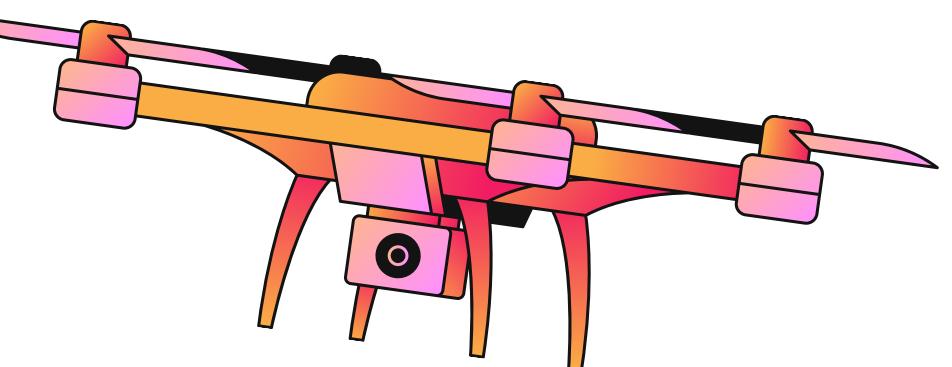
# SENTINEL

Anti-Drone Detection for Communication Jamming System for  
Security Forces

Guilherme Martins 106274; Afonso de Mello 107495; Guilherme Luís 106755;  
Francisco Rodrigues 106695; João Firmino 107485; Rodrigo Sanguino 84342

**Team 25**

# Problem Definition

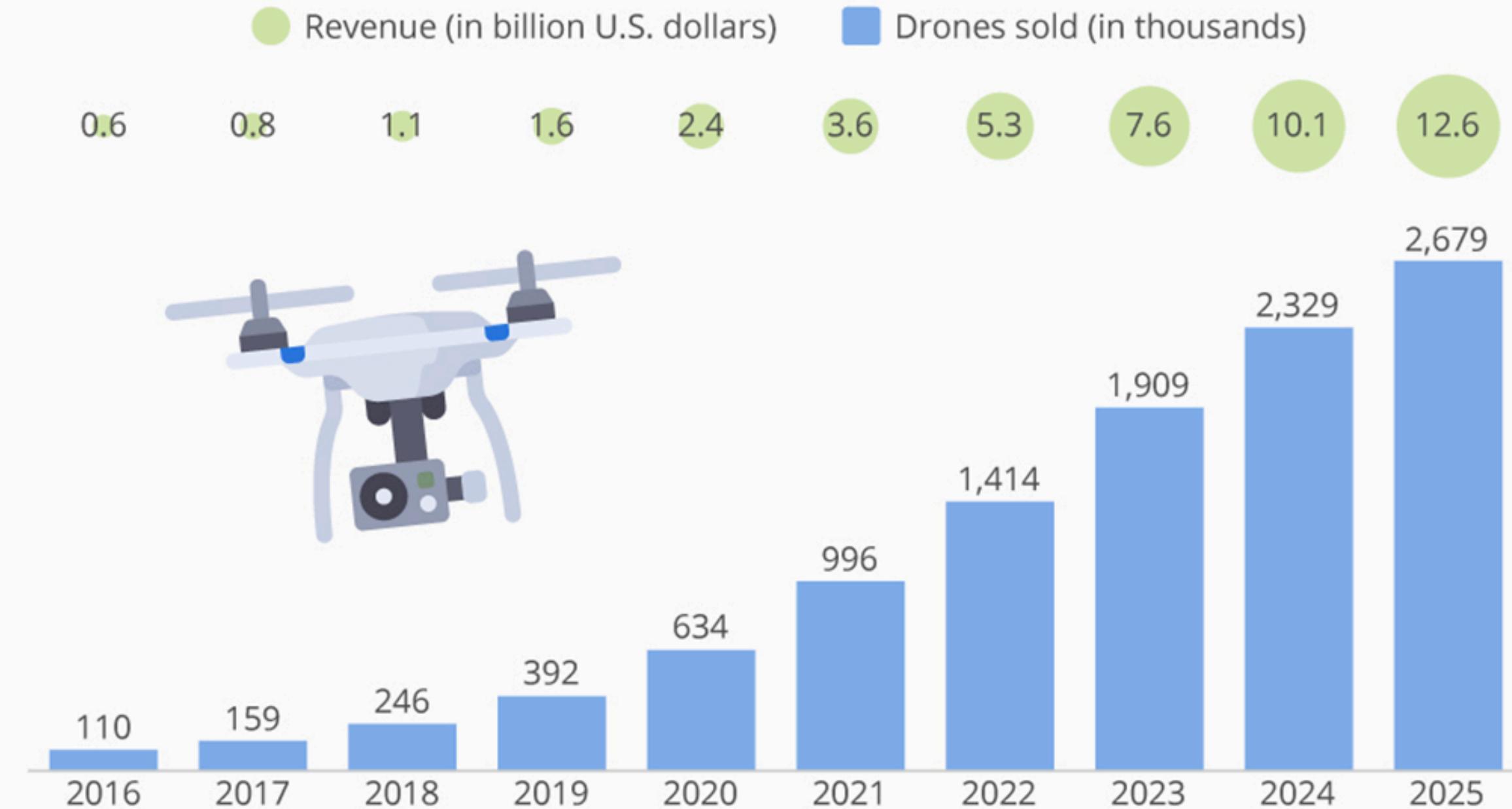


## Growth of drone usage

Drones have gained widespread use for a variety of applications, from recreational flying to industrial uses like surveillance, monitoring, and package delivery.

### Commercial Drones are Taking Off

Projected worldwide market growth for commercial drones



@StatistaCharts

Source: Tractica

statista

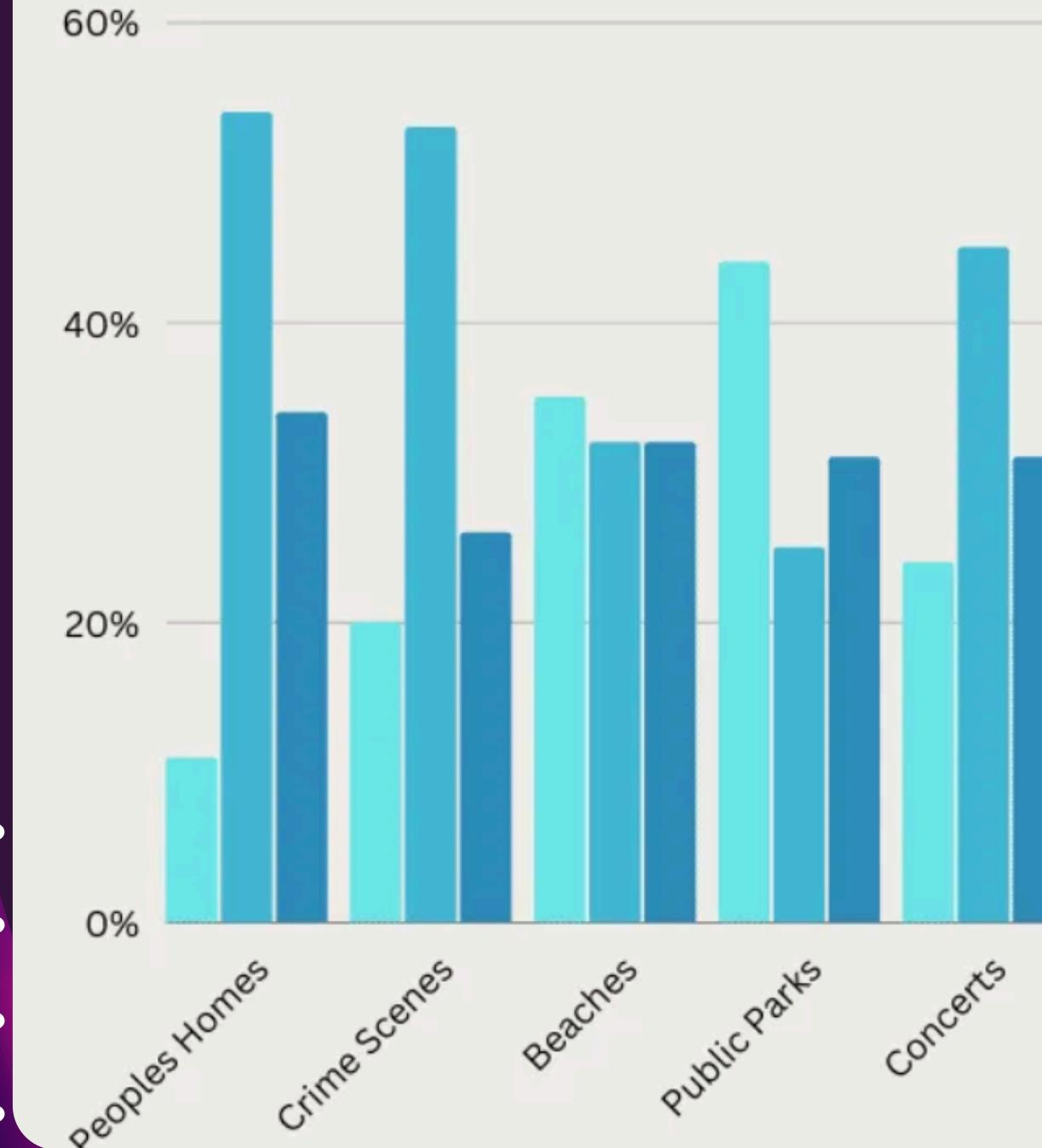
## Unauthorized surveillance of private areas

Drones increasing use has also led to significant security concerns.

Unauthorized drones, especially those used for illegal surveillance or nefarious purposes, pose a threat to privacy, security, and public safety.

Do you think that private citizens should or should not be allowed to pilot drones in the following areas?

Yes    NO    Depends

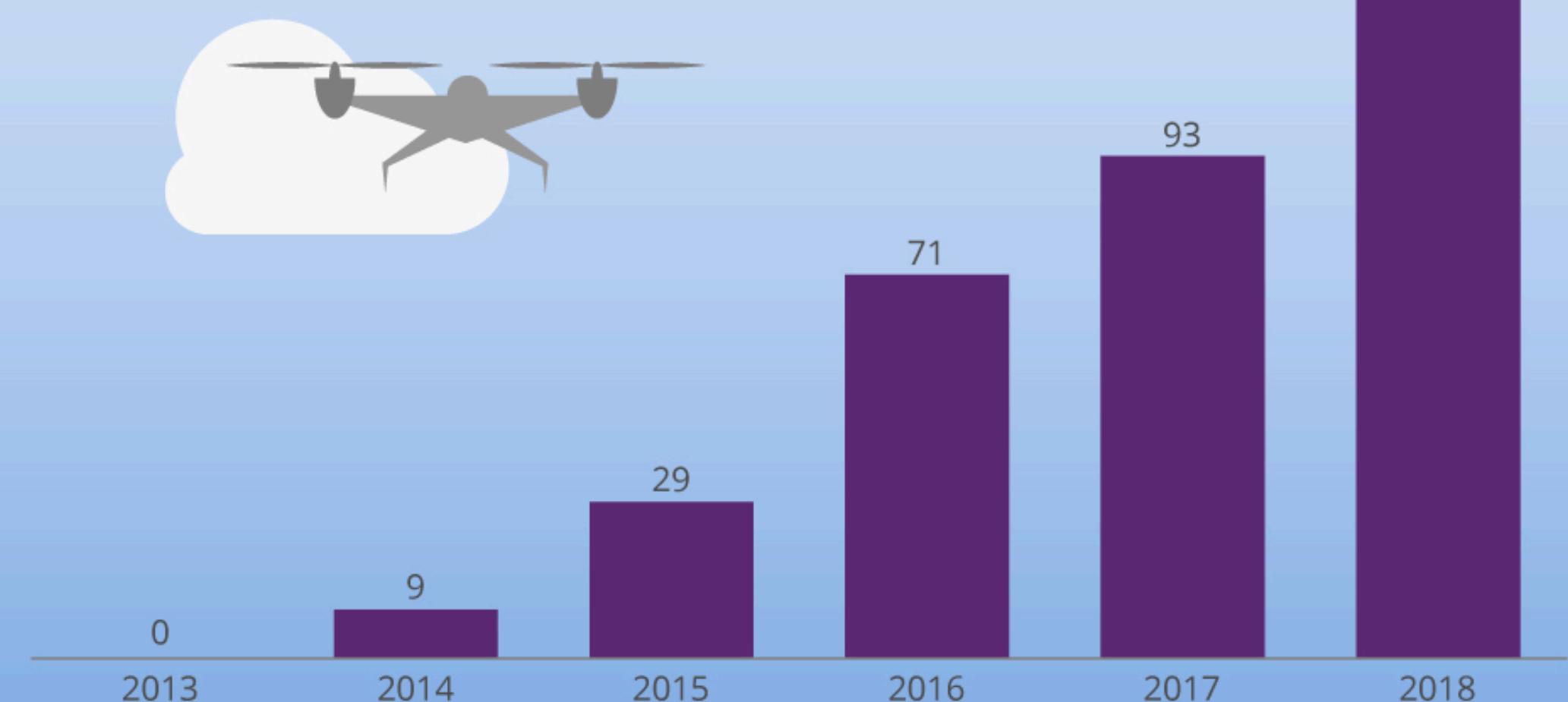


## • Drone Intrusions and Security Threats

Security forces often struggle to detect and stop UAVs due to their small size, mobility, and secure communications, making threats like espionage or attacks harder to prevent.

### Drones: A Rising Menace To UK Aviation

Near-misses between drones and planes in the UK\*



\* Includes civilian and military air traffic  
Source: UK Airprox Board

statista

# Project Objectives



## Detection

Detect unauthorized drones using radars, computer vision and machine learning

## Jamming

Develop and test jamming techniques for drone neutralization



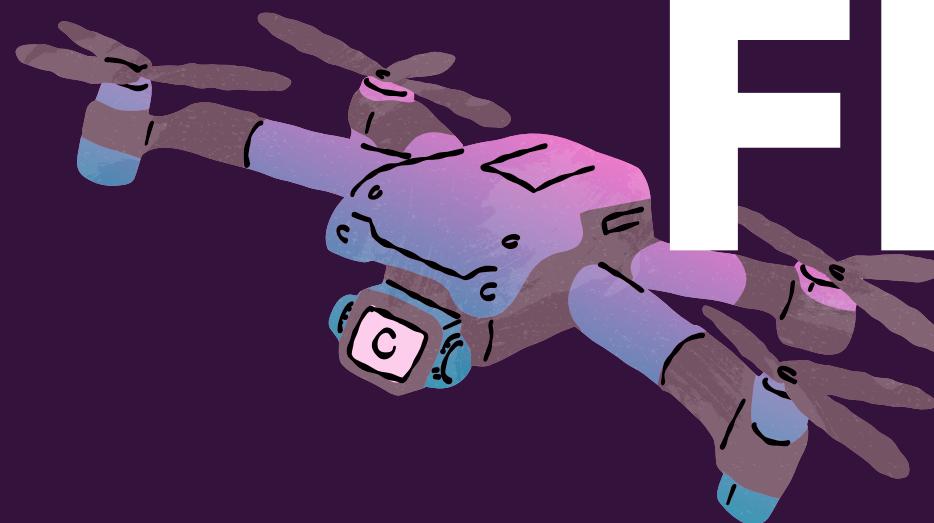
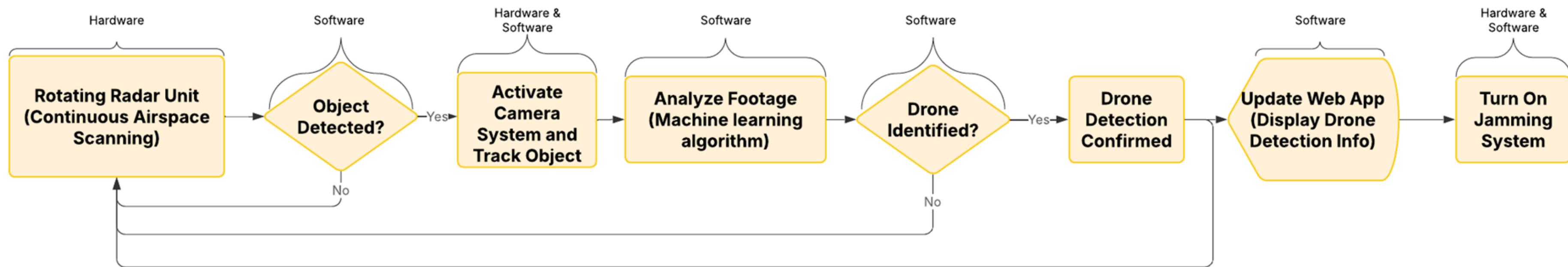
## Real-Time Alert

Implement a real-time monitoring and alert platform

## Adaptability

Ensure system adaptability for various security scenarios

Sentinel  
Anti-Drone System



# FLOWCHART

Full objectives flowchart

# Our Solution

We developed a computer vision-based drone detection system featuring a rotating camera that tracks drones in real time, using machine learning to distinguish them from other airborne objects, complemented by a web app for live monitoring

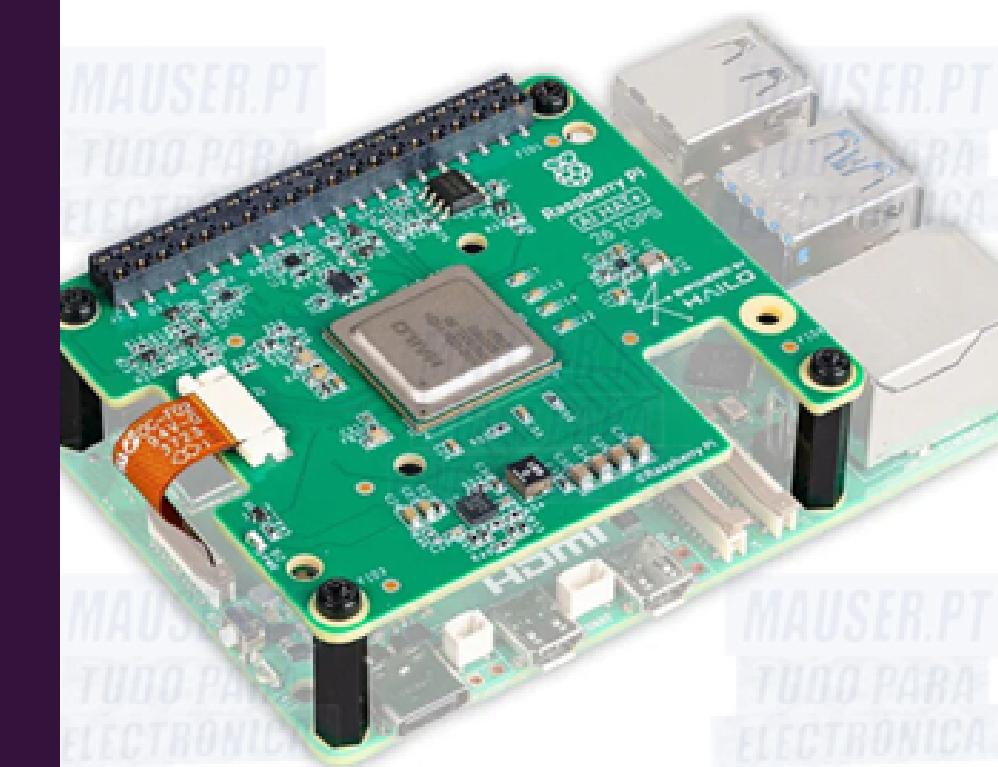


# Components

Raspberry Pi 5 8GB



Raspberry Pi - 12MP 76°

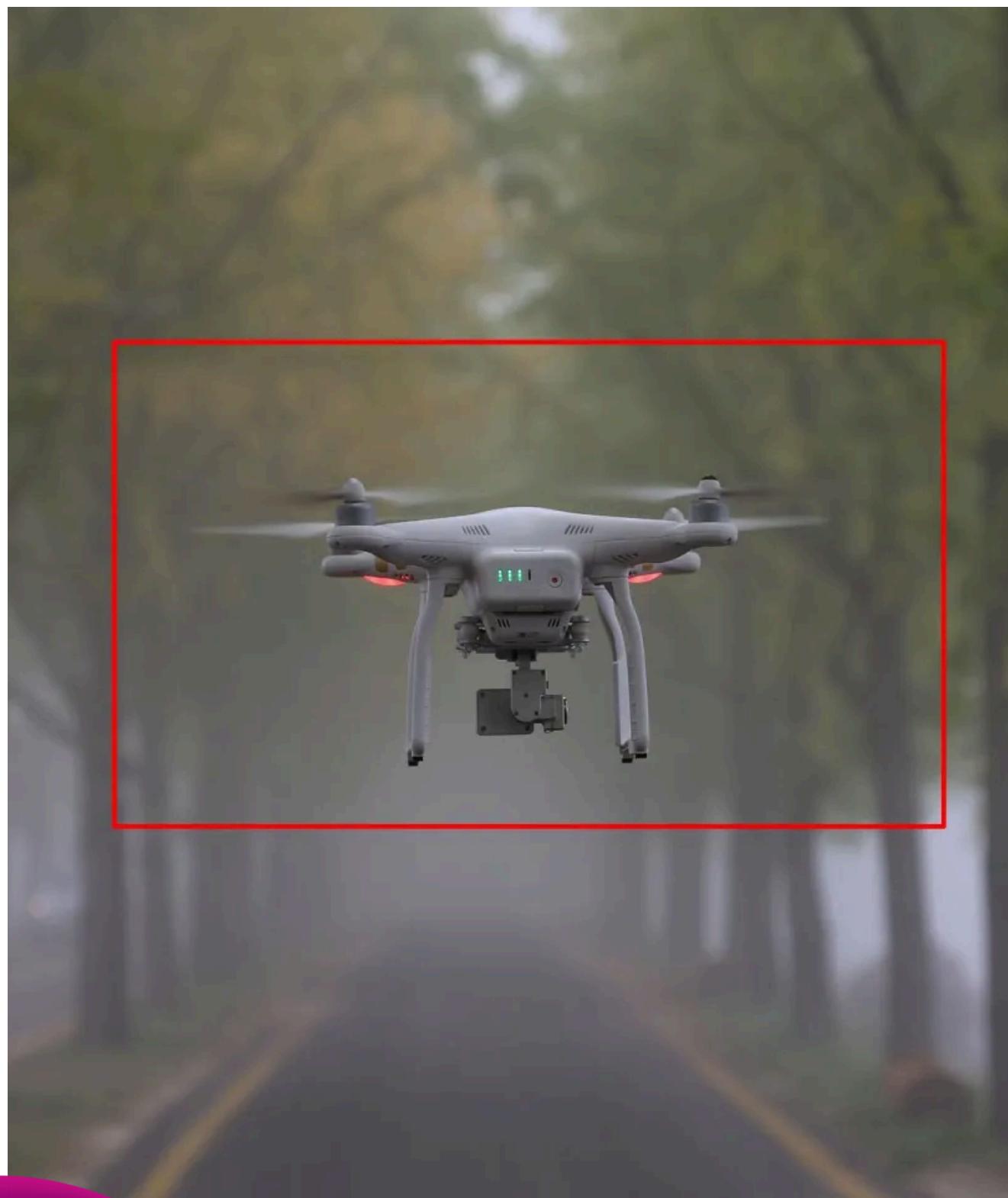


Placa HAT+ with AI Hailo accelerator



Micro servo rotors

# Technological solution



## Drone Detection Systems

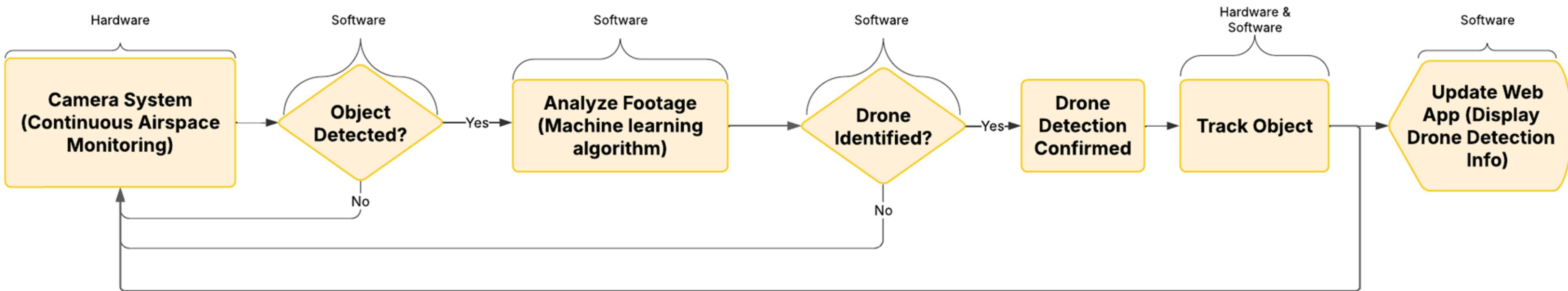
Optical sensors (such as cameras and infrared systems), radar, acoustic sensors and Rf Receivers to visually detect and track drones

- • • •
- • • •
- • • •
- • • •
- • • •

## Machine Learning Algorithms

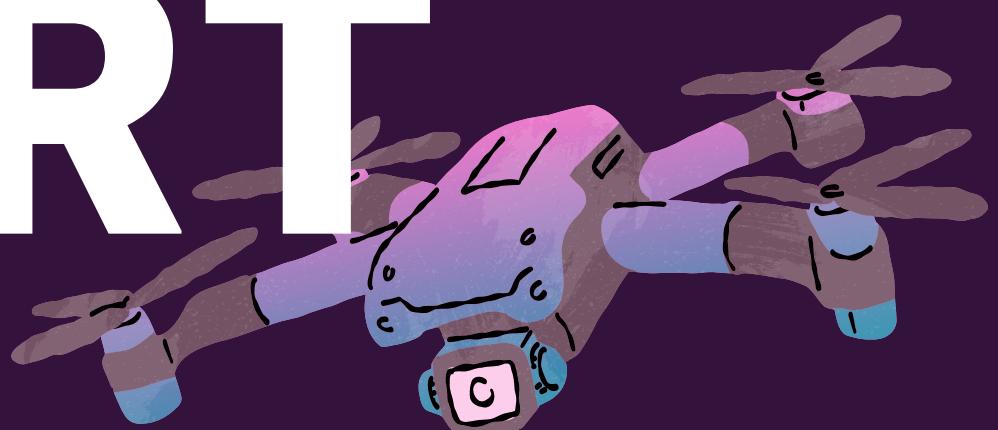
To distinguish drones from other flying objects, such as birds, based on detected video

**Sentinel**  
Anti-Drone System



# FLOWCHART

Technological solution flowchart



# 3-Mode Solution

# Sweeping

The camera continuously pans (“sweeps”) the sky in defined increments



# Detection

Detects drones via our real-time image-detection neural network

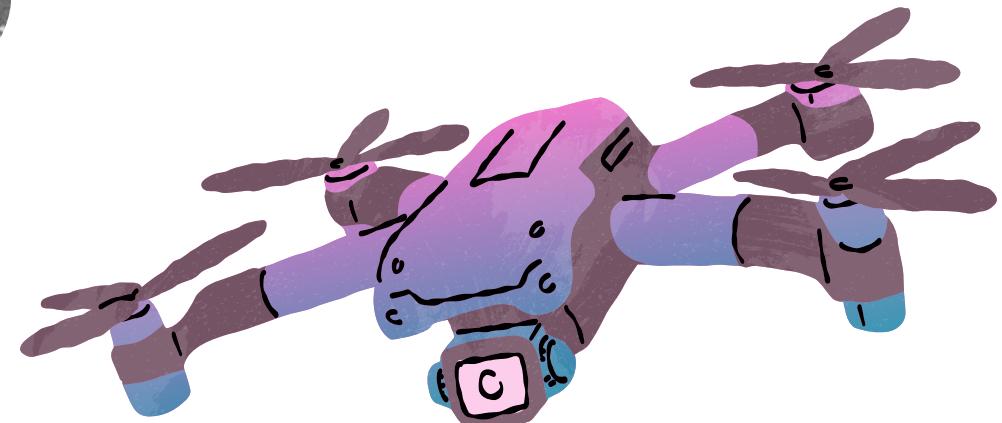
# Tracking

The dual-rotor mount follows the drone's movements to keep it centered

# Sweeping Mode



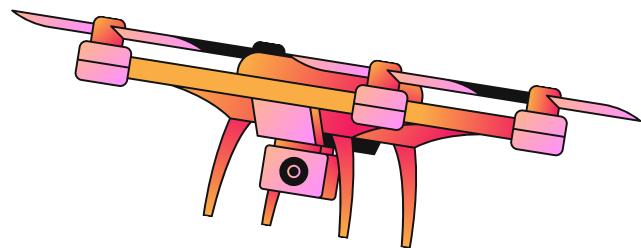
**Proactively  
searches for any  
UAV intrusions  
across the entire  
field of view**



# Detection Mode



The camera instantly locks onto the target. A snapshot and timestamp are sent to the web application.



# Live Detection Data

Detection events from our anti-drone system

 System Online

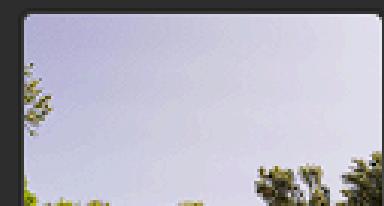
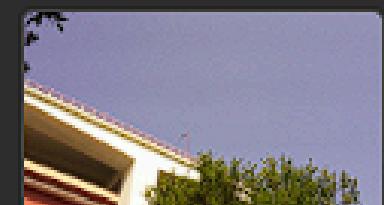
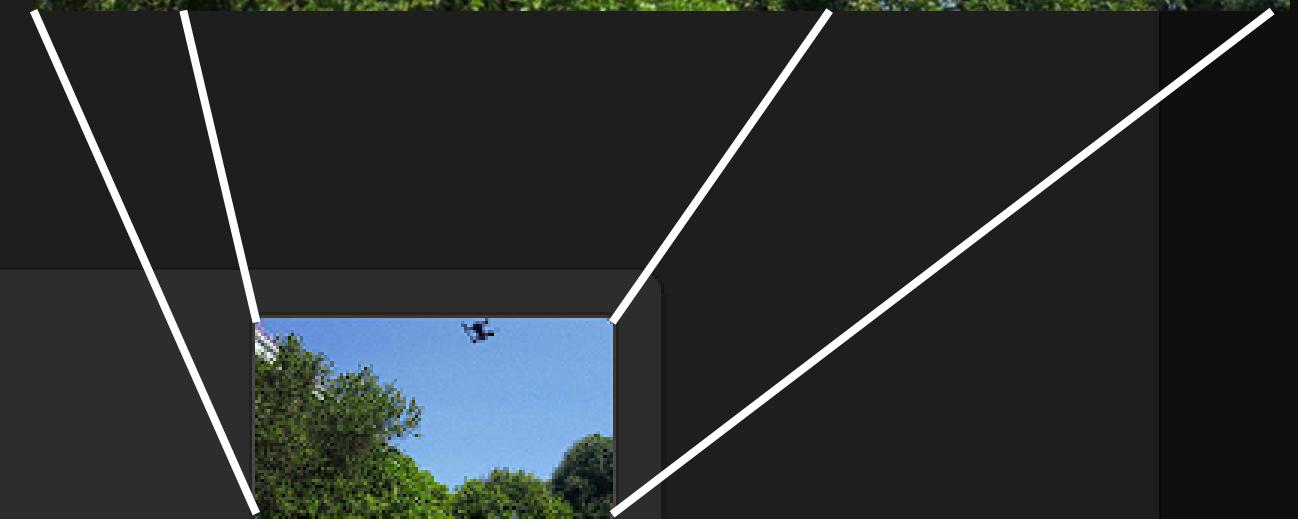
 Refresh Data

 Pause Auto-Update

**Event: drone\_detected**  
ID: -OSKNKL8G3Hk9fiQ1Rbd  
6/9/2025 4:48:51 PM

**Event: drone\_detected**  
ID: -OSKNEJFqDvJBuYIVmDZ  
6/9/2025 4:48:27 PM

**Event: drone\_detected**  
ID: -OSKN8aROWtTINIHYIYr  
6/9/2025 4:48:03 PM



# Tracking Mode



**After detection, the system tracks the drone down. Demonstrating how an attached directional jammer or antenna could remain pointed at the drone for neutralization.**

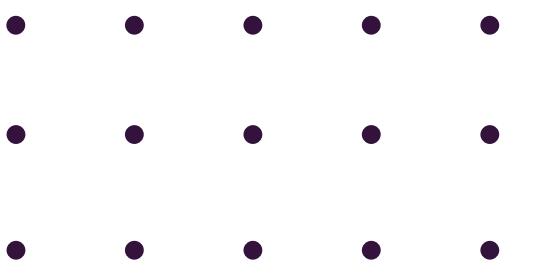
# Solution Beneficiaries



**01**

## Security Agencies

Security forces, military personnel, and border control entities that need to protect restricted or high-risk areas against drone incursions



THALES

## Target customers



**02**

## Governmental institutions

Authorities responsible for overseeing national security, airports, government buildings, and sensitive locations



TEKEVER

**03**

## Private Sector

Organizations and industries concerned with protecting infrastructure, assets, and sensitive data from unauthorized aerial surveillance



## Competitors

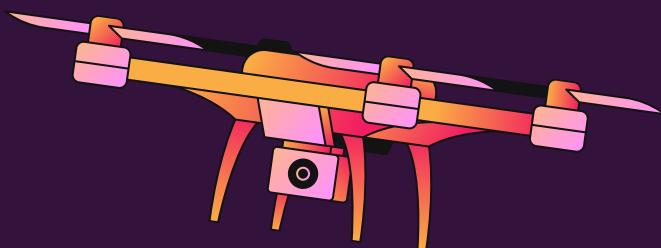
Current counter-drone solutions like radar, acoustic sensors, and RF jammers work in some cases but often face key issues:

- Bulky and Expensive
- Lack of Autonomy
- Limited Adaptability
- Poor Discrimination
- Low Scalability



# Us vs Them

## Our system is:



### Autonomous

Our system operates independently by detecting, identifying, and tracking drones in real time without the need for constant human intervention.

### Easy to adapt

The modular design and flexible software make it simple to adjust the system for different environments and security needs.

### Highly scalable

The solution can be easily expanded to cover larger areas or integrated into existing security infrastructures.

# Costs & Benefits

## Low Cost Implementation

Can be deployed using existing surveillance cameras in critical infrastructures

## Automated Alert Platform

Fully autonomous system requiring no human intervention for detection or tracking

## Scalability & Future Integration

System architecture allows integration of jamming modules in the future. Camera tracking mechanism enables precise targeting of drones with potential RF neutralization systems.



# The Team



**Guilherme Martins**

Project Manager



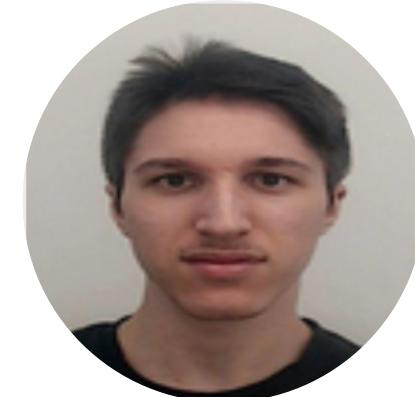
**João Firmino**

MLA Specialist  
& Website developer



**Afonso de Mello**

Backend developer



**Guilherme Luis**

Poster Maker



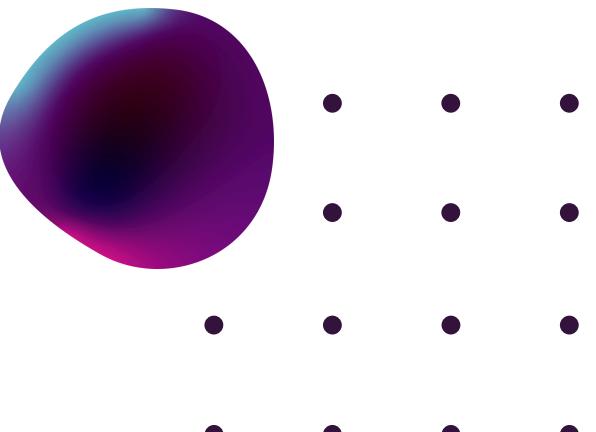
**Francisco Rodrigues**

Prototype designer



**Rodrigo Sanguino**

Video Maker





**Tenente Coronel João Boita**

Scientific Advisor - Air Force



**Major Francisco Machado**

Scientific Advisor - Air Force



**Prof. João Felício**

Coordinator

# Advisors and Mentors



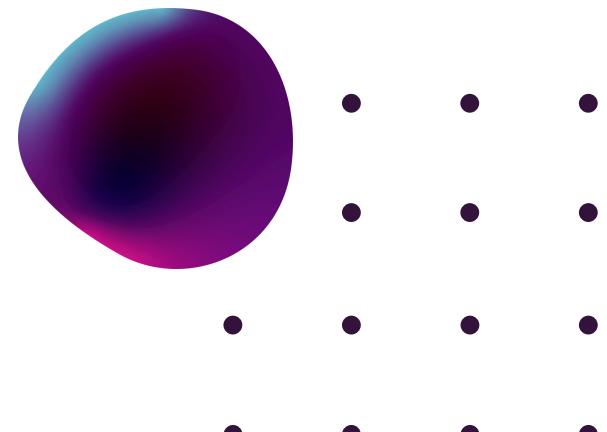
**Prof. Emmanuel Cruzeiro**

Co-coordinator



**Prof. João Gonçalves**

Mentor



# Team members' contributions

<b>Guilherme Martins</b>	<b>Management and coordination</b>	<b>Engagement with Partners &amp; interviews</b>	<b>Blog Update</b>	<b>PowerPoint Maker</b>	<b>Rotor Code development</b>	<b>Video maker</b>
<b>João Firmino</b>	<b>MLA Training and validation</b>	<b>Website Development</b>	<b>Blog Development</b>	<b>Rotor Code development</b>	<b>Video maker</b>	
<b>Afonso de Mello</b>	<b>Engagement with Partners</b>	<b>Web-App Development</b>	<b>Backend Development</b>	<b>Blog Update</b>		

# Team members' contributions

<b>Francisco Rodrigues</b>	<b>Prototype assembly</b>	<b>Interviews</b>	<b>Metalworker</b>	<b>Poster Maker</b>
<b>Guilherme Luís</b>	<b>Rotor Code tweaking</b>	<b>Poster Maker</b>	<b>Video Maker</b>	
<b>Rodrigo Sanguino</b>	<b>Rotor Code tweaking</b>	<b>Video Maker</b>	<b>Poster Maker</b>	



# Portuguese Air Force

# Expertize

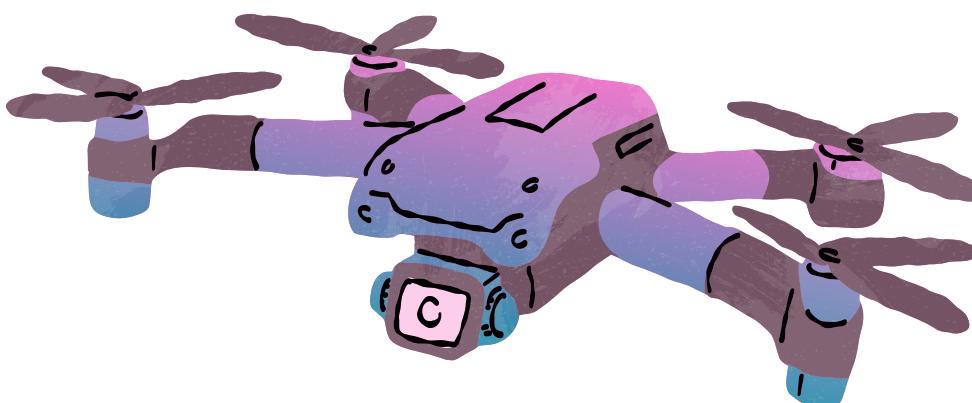
THALES

# Thales

Know-How

# Partners

- The image features a repeating pattern of small, solid dark purple dots. These dots are arranged in a grid-like structure, with horizontal and vertical spacing between them. The background is a uniform light gray color, providing a subtle contrast to the dark purple dots. The overall effect is a clean, modern, and minimalist design.



**MAUSER.PT**  
**TUDO PARA**  
**ELECTRÓNICA**

# Mauser

# Components

# THANK YOU



Website



Video