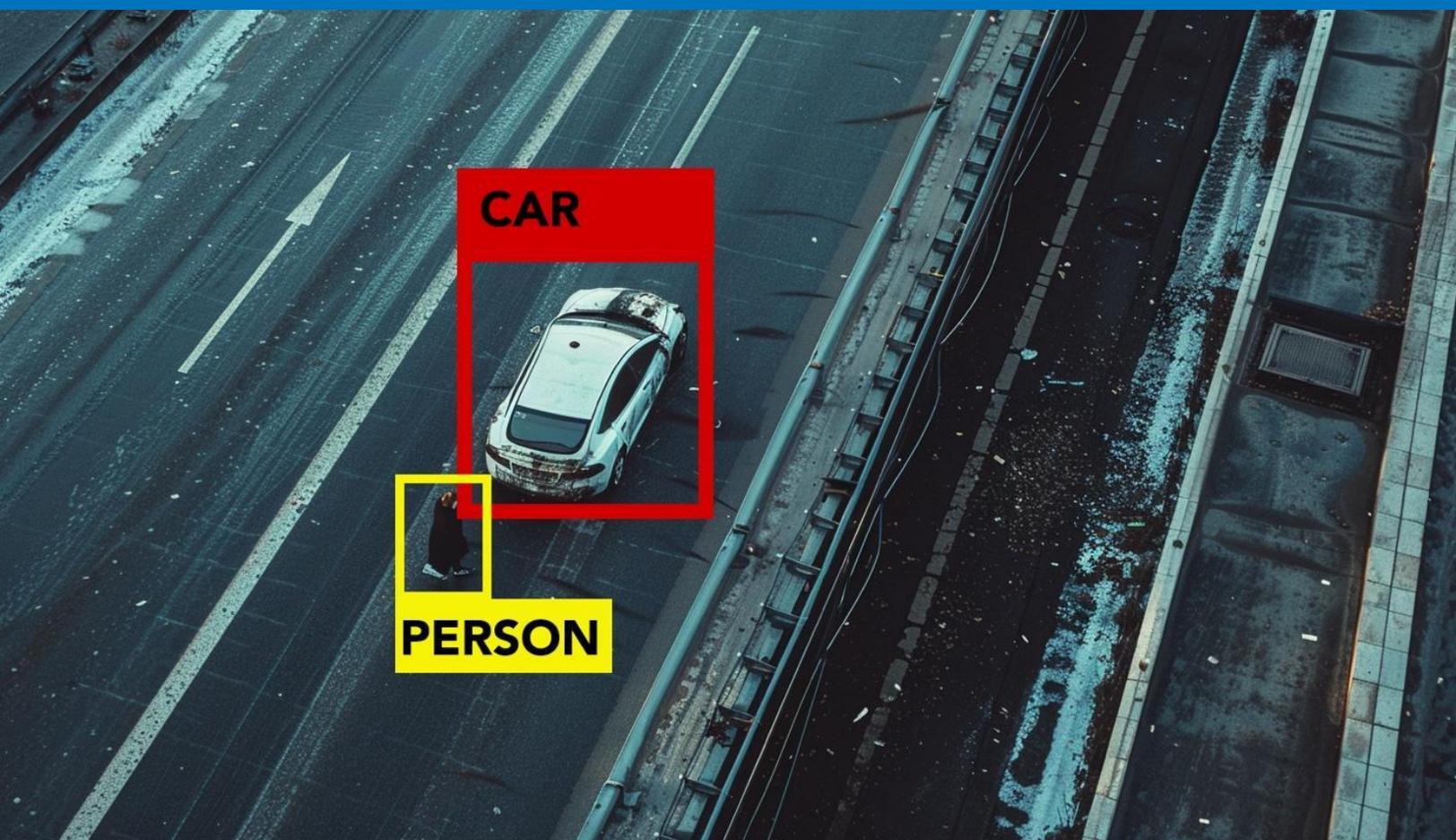
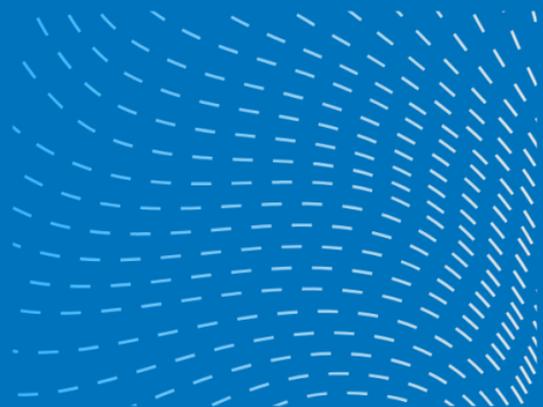


IPXAnalytics
Datasheet

Highways Module



IP Extreme Tecnologia Ltda.

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IPExtreme

Content

Highways Module	3
IPXAnalytics	3
Additional benefits:	4
Commercial video.....	4
Feature Examples	5
Object Counting	6
Integration	7
Customizations	7
Limitations and considerations	8
Maintenance and continuous improvement.....	9
Technical Sheet.....	10
Objects.....	10
Recommended minimum sizes for detection	15
How to identify the size of an object.....	16
Examples:.....	16
Optimal camera resolution for object recognition.....	19

Highways Module

Compatibility: IPXAnalytics PRO, 2.0 or higher.

IPXAnalytics

IPXAnalytics is a software that uses artificial intelligence to learn and detect events from surveillance cameras. The artificial intelligence is based on neural networks and LLMs, which are algorithms designed to mimic the behavior of the human brain. Compared to existing video analytics software on the market today, IPXAnalytics significantly reduces the number of false alarms.

PRO Module for Highways

In a context where safety and efficiency are essential for the success of highway operations, we present our advanced computer vision solution. Equipped with cutting-edge technology, our module offers a comprehensive set of capabilities, designed to instantly identify and respond to a variety of critical events on the roads.

Implementation Advantages

- **Rapid Incident Detection and Response:**

Our cutting-edge technology enables us to identify a wide range of events – from the presence of people on the road, to the detection of objects or animals on the road, stationary vehicles, and even signs of fire and smoke. With real-time alerts and intelligent data analysis, our solution empowers highway management teams to act quickly, minimizing disruptions and reducing the risk of accidents.

- **Increased Safety for Road Users:**

By automatically detecting situations such as vehicles traveling in the wrong direction, traffic jams and other dangerous behavior, the software works to prevent collisions and more serious accidents, ensuring the safety of road users.

- **Improved Operational Efficiency:**

In addition to promoting safety, our computer vision solution is a strategic tool for optimizing operational efficiency. Through object counting and detailed traffic flow analysis, we provide valuable insights for improving route planning, adjusting maintenance schedules, and better allocating available resources.

- **Simplified Integration:**

The software easily integrates with existing monitoring systems or even specific highway management platforms. With an open API, integration is straightforward, allowing for quick adaptation to the needs of your operating environment.

Additional benefits:

- Rapid response to incidents and emergencies
- Increased safety for road users and operators
- Optimized traffic flow and reduced congestion
- Reduced risks from immobilized vehicles or vehicles traveling in the wrong direction
- Simple integration with existing monitoring systems and open APIs to facilitate operation and data analysis

Commercial video

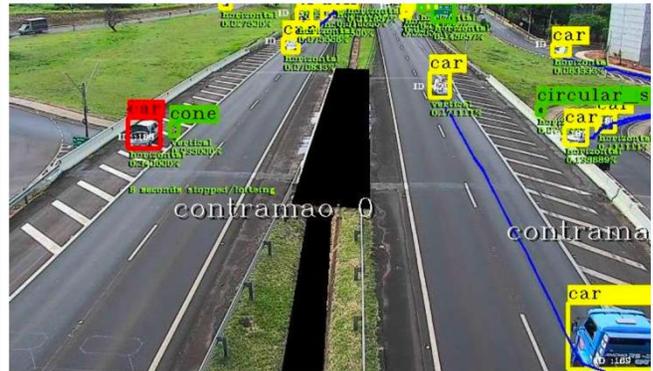


<https://www.youtube.com/watch?v=N4MQoHdXRpk>

Feature Examples

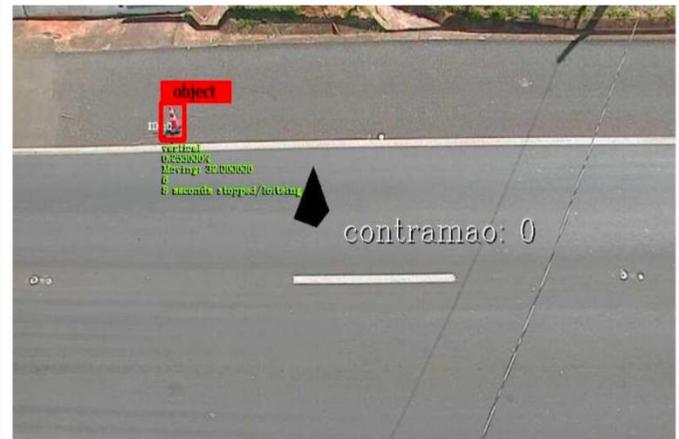
Stopped Vehicle

The software can detect stopped vehicles both on the shoulder and on the road, allowing the operator to be immediately alerted to any incidents that could compromise the flow of traffic or pose a risk on the highway.



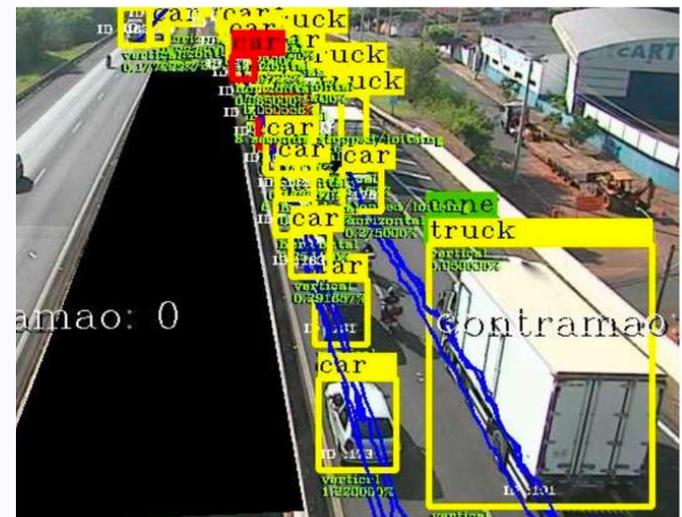
Object on the Track

The system is capable of identifying objects that do not belong on the asphalt, such as debris, cones out of place or other obstructions, issuing an alert so that the responsible team can take the necessary measures and avoid incidents.



Congestion

Using advanced vehicle flow analysis algorithms, the software detects congestion situations and automatically triggers an alert. This feature allows corrective actions to be taken to restore traffic flow and improve the operational efficiency of the road.



Wrong-way traffic

The platform identifies vehicles traveling in the opposite direction to the correct lane, a high-risk behavior that can lead to serious collisions. When detecting the wrong-way traffic, the system triggers immediate alerts so that authorities or operators can intervene quickly.



Fire and Smoke

IPXAnalytics integrates a module dedicated to fire and smoke detection. This functionality is capable of identifying the first signs of fire on the highway, allowing the operator to be promptly alerted to adopt emergency measures, contributing to user safety and road integrity.



Object Counting

IPXAnalytics allows object counting to be activated on cameras in order to measure the number of objects listed in this document for statistical purposes. It is important to note that counting should be activated with the camera tour disabled in order to save resources; the customer will have the option of activating the Enhanced Counting function integrated with the VMS.

It is important to note that the straighter the camera angle, the greater assertiveness the system will deliver. Example of positioning and operation:



https://www.youtube.com/watch?v=G0_s_JmnvSM

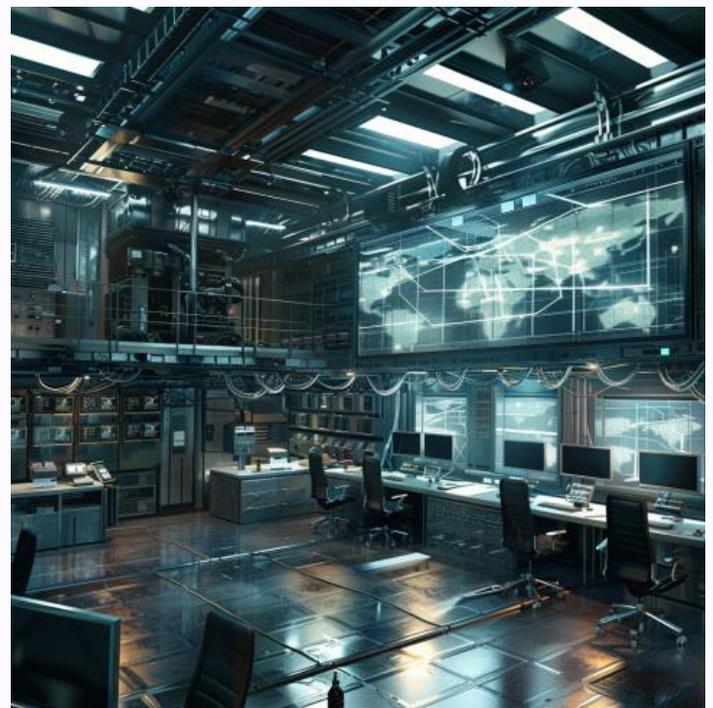
NOTE: the system interface may vary depending on the version purchased.

Integration

The software has an HTTP REST API that allows integration with any partner system. The software is integrated with the market-leading VMSs: Digifort, D-Guard, Milestone and Avigilon.

Please check with our team about any additional licenses required for third-party software integrations.

For more information: www.ipextreme.com.br



Customizations

In addition to the various features mentioned here, the software can also assist in numerous other situations. It is designed to be customized to meet the customer's needs. For example, in a production

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environment, the software can identify errors and critical failures in a specific part. To request a customization proposal, contact us on our website: www.ipextreme.com.br.

Limitations and considerations

We understand the importance of reliability in critical applications. Therefore, it is crucial to note that no AI software can guarantee 100% accuracy. Our solution offers robust and fast detection, but we always recommend maintaining backup systems and additional safety protocols to ensure a comprehensive response in emergency situations.

IPXAnalytics offers demo licenses and we recommend selling them to the customer only after successful testing in the desired environment.

The system's assertiveness exceeds 90% in ideal lighting conditions. The proportion of false alerts in total will be less than 10%.

It is important to note that the assertiveness of the alerts issued by the system can be influenced by external factors, such as:

- Environmental conditions (rain, fog, insufficient lighting);
- Obstructions in the image (dirt on the lens, vegetation, vehicles blocking the field of view);
- Improper installation of cameras (incompatible angle, height or focus);
- Incorrect configuration of PTZ camera presets or lack of periodic maintenance;
- Signal quality and video system stability.

The system will detect the objects indicated in this technical sheet as long as these objects are clearly visible in the image. IPX integrates PTZ camera presets. This way, the customer can slice the stretch into presets with zoom to ensure visibility.

Nighttime images need to have adequate lighting and the camera must compensate for the car headlights so that the object is visible in the image. We know from our experience that this is not always possible, which is why the highway module was also improved to work in low-light situations to trigger events from the car headlights. However, some alerts, such as detection of smaller objects, may be impaired by the lack of lighting.

IPXAnalytics was designed as a dynamic platform, capable of evolving along with the customer's operational environment. Unlike rigid solutions, our artificial intelligence model allows progressive adjustments over time, based on real data collected in the operating scenario itself.

Maintenance and continuous improvement

Real-world Improvement : As the system is exposed to different contexts and specific situations on the monitored highway, it can be fed back with new data to continually refine its accuracy. This includes adaptations to local characteristics such as traffic patterns, weather, lighting type and regional peculiarities.

Intelligent and Centralized Architecture : Thanks to its centralized inference architecture (GPU), new versions of AI models can be deployed remotely, without the need for physical changes to cameras or infrastructure. It is enough that the received images have the minimum quality required for efficient analysis.

Gradual Customization by Environment: Each road has its own particularities. Based on operational feedback and recorded occurrences, the system can be calibrated to prioritize certain events or adjust its sensitivity to specific conditions, resulting in a solution that is increasingly aligned with the customer's objectives and needs.

For these reasons, it is always recommended that the customer hire the manufacturer's maintenance and improvement services to keep their fleet updated with the best models and algorithms.

Technical Sheet

Examples and descriptions of objects:

Objects

The Highway Module can identify these objects:

- pessoa
- carro
- moto
- caminhao
- quadrupede
- placa_retangular
- placa_losangulo
- placa_circular
- luz
- onibus
- cone
- barreira

peessoa

This object represents individuals present in the highway monitoring areas, enabling the identification of potential risk situations, such as the presence of pedestrians on the road or near the road.



carro

Detects light vehicles, such as cars, contributing to traffic flow analysis and alerts in case of stopped vehicles.



moto

Identifies motorcycles, contributing to the analysis of traffic flow and alerts in the event of a stopped vehicle.



caminhao

Recognizes heavy vehicles, essential for monitoring traffic flow and alerts in case of a stopped vehicle.



quadrupede

Captures the presence of quadrupeds such as horses, cows and animals of similar sizes. Especially important in rural areas or near conservation areas, where animal crossings can pose risks to drivers. It is important to note that the algorithm can detect smaller animals, but the camera zoom must enlarge them so that they are visible as the animals shown.



placa_retangular

Detects rectangular-shaped traffic signs in order to avoid confusing them with other objects, bringing more assertiveness to the system.



placa_losangulo

Identifies signs in a diamond shape with the aim of not confusing them with other objects, bringing more assertiveness to the system.



placa_circular

Recognizes circular traffic signs, common in priority and warning regulations, with the aim of not confusing them with other objects, bringing more assertiveness to the system.



luz

This object is useful in nighttime scenarios without lighting, for detecting stationary vehicles.



onibus

Identifies buses and minibuses, essential for the analysis of public transport and the flow of large vehicles on urban and intercity routes.

**cone**

Recognizes traffic cones, used to delimit areas, guide traffic and signal construction work or accidents, helping with rapid intervention in risky situations.

**barreira**

Detects physical barriers such as guardrails, barriers and other obstacles that delimit the road, ensuring that obstruction and incident alerts are generated accurately.



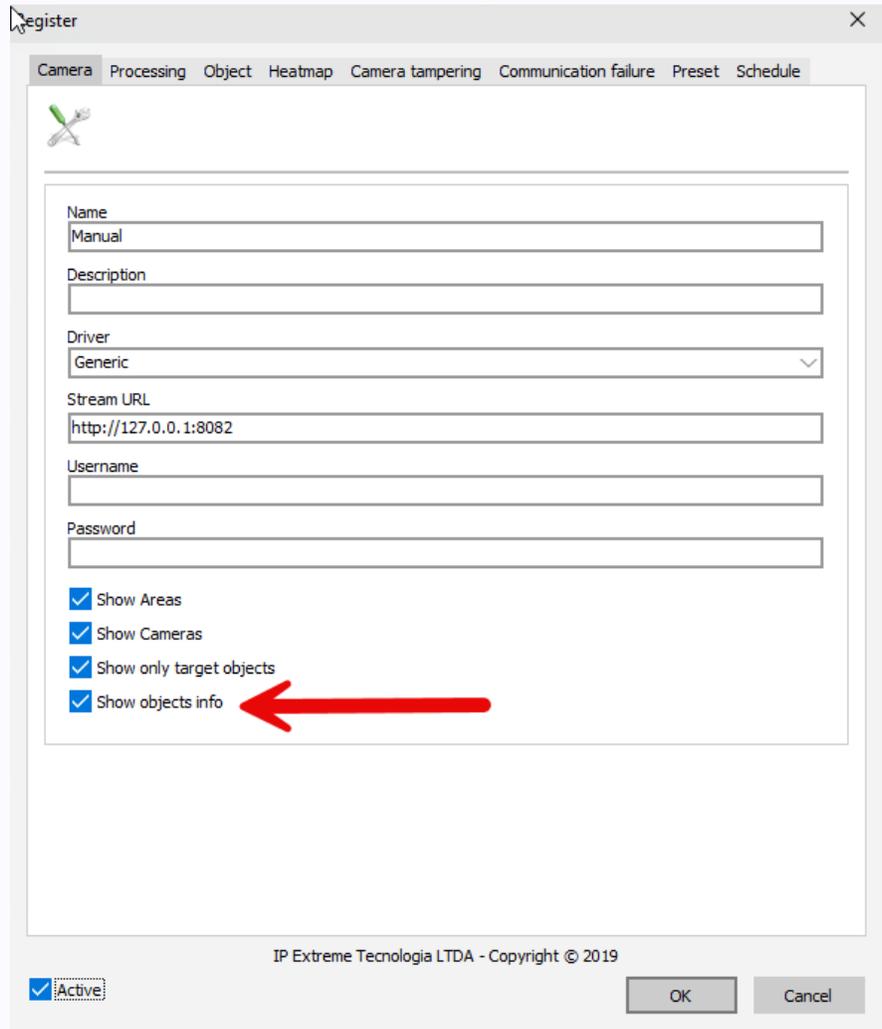
Recommended minimum sizes for detection

A common question is about where the camera should be installed for optimal detection. It is difficult to say with complete certainty because cameras can have different lenses, angles and zoom levels. The most important factors are the size of the object in the image and its visibility. The table below indicates the recommended minimum size of the object in the image as a percentage. The percentage refers to the relative size of the object, as there can be different types of resolutions and scaling. So when we say that an object is 1% in size, we are indicating that, for example, in a 512x512 image, the object would be 5.12 pixels by 5.12 pixels. See the next chapter for instructions on how to check the size of the object directly in IPXAnalytics.

Object	Minimum percentage size for identification	Camera height
peessoa	0.2%	15-20 meters
carro	0.5%	15-20 meters
moto	0.5%	15-20 meters
caminhao	0.2%	15-20 meters
quadrupede	1%	15-20 meters
placa_retangular	0.2%	15-20 meters
placa_losangulo	0.2%	15-20 meters
placa_circular	0.2%	15-20 meters
luz	0.2%	15-20 meters
onibus	0.5%	15-20 meters
cone	0.2%	15-20 meters
barreira	0.2%	15-20 meters

How to identify the size of an object

In IPXAnalytics, you can view the live image in two ways: using the debug mode or clicking View in the admin client. When registering a camera, in the first tab, check the "show object information" option. This option will display the size of each object detected in the image and its orientation (vertical or horizontal).



The screenshot shows the 'register' dialog box with the following fields and options:

- Name: Manual
- Description: (empty)
- Driver: Generic
- Stream URL: http://127.0.0.1:8082
- Username: (empty)
- Password: (empty)
- Checked options:
 - Show Areas
 - Show Cameras
 - Show only target objects
 - Show objects info (highlighted with a red arrow)

At the bottom of the dialog, there is an Active checkbox, the text 'IP Extreme Tecnologia LTDA - Copyright © 2019', and 'OK' and 'Cancel' buttons.

Examples:

A person detected in the image with a total size of 4.0%.

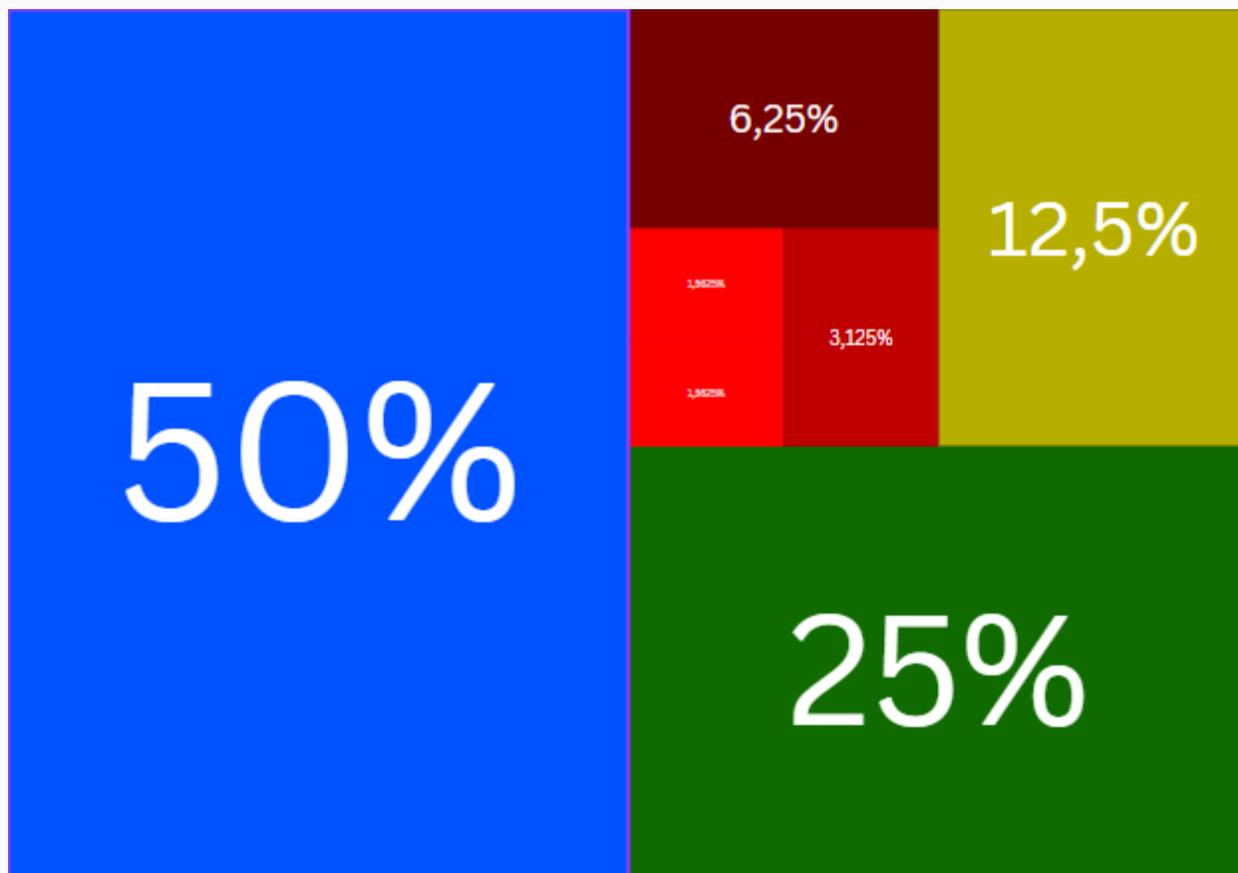


Helmet detected in the image with a size of 0.69%.



The image was created to visually illustrate the proportion of an object in relation to the total screen. It divides the space into different percentage areas, making it easier to understand the minimum size required for computer vision software to accurately recognize an object.

Each rectangle represents a specific fraction of the total screen, starting at 50% and successively subdividing each area into halves. This way, the user can intuitively understand how different sizes affect detection and what minimum dimensions are recommended for effective recognition.



Optimal camera resolution for object recognition

For effective object recognition, camera resolution is essential. The minimum recommended resolution for optimal performance is **512x512**. This resolution provides enough detail for accurate detection and classification while balancing computational efficiency. Higher resolutions, such as 1080p or 4K, require more processing power without significantly improving accuracy and can lead to diminishing returns. On the other hand, lower resolutions can result in blurry or distorted images, making object recognition more difficult. Therefore, a resolution of 512x512 is the ideal minimum for reliable and efficient object detection.

Low Resolution vs High Resolution Comparison:

