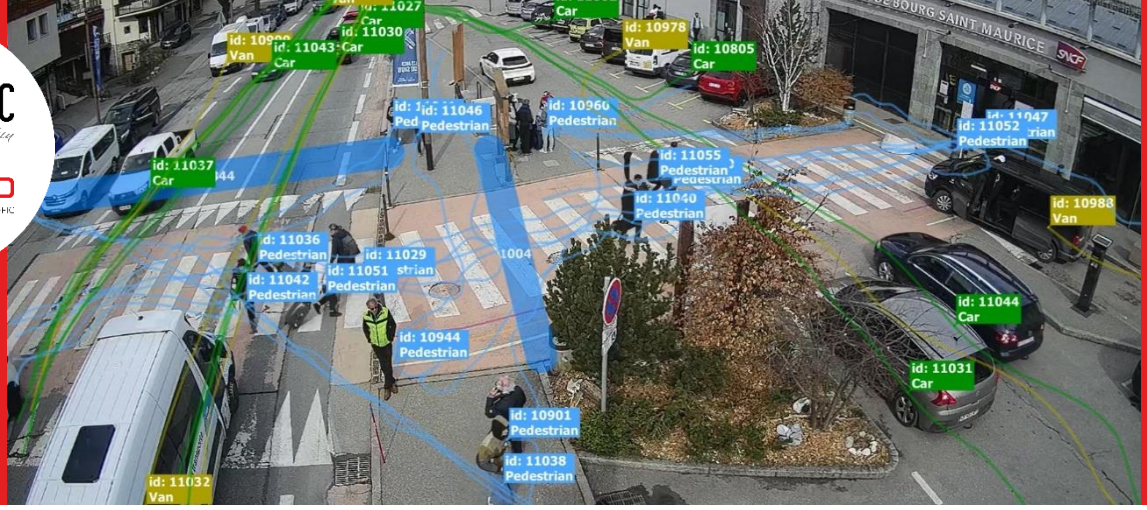


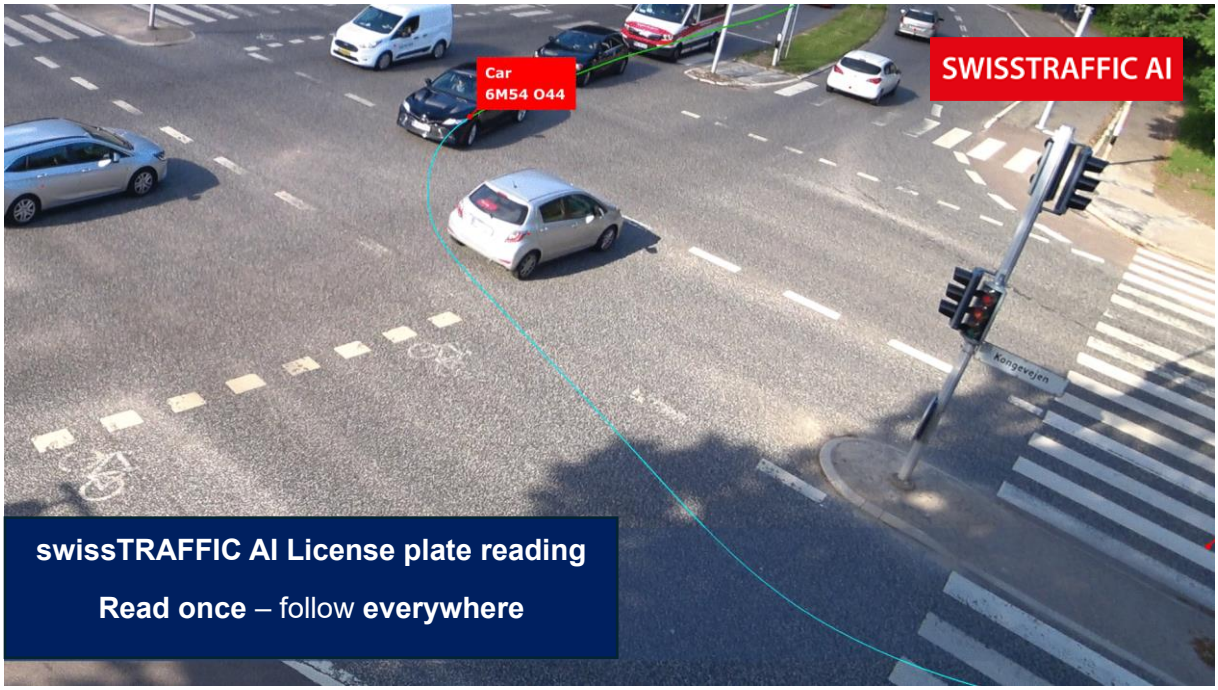
General FAQ

Recording guidelines and other topics. **Video recording guidelines**

License Plate Recognition - ANPR, LPR, NPR, ALPR

This article goes over the commonalities of swissTRAFFIC AI and TrafficSurvey LPR and links to articles breaking down each one separately.

Both TrafficSurvey and swissTRAFFIC AI have license plate reading functionality and their LPR capabilities have a couple of things in common. One of the commonalities is that once a license plate has been read it is associated with the trajectory for its whole duration meaning you can tell what is the license plate of a car even though its LP is no longer visible in the camera view. License plate reading must be done from light views from cameras ideally in 9-15 meter height so that the camera can see the license plate well. Both swissTRAFFIC AI and TrafficSurvey engines are quite flexible in terms of the angle at which it is able to read the license plate. As you can see in the GIF below



swissTRAFFIC AI

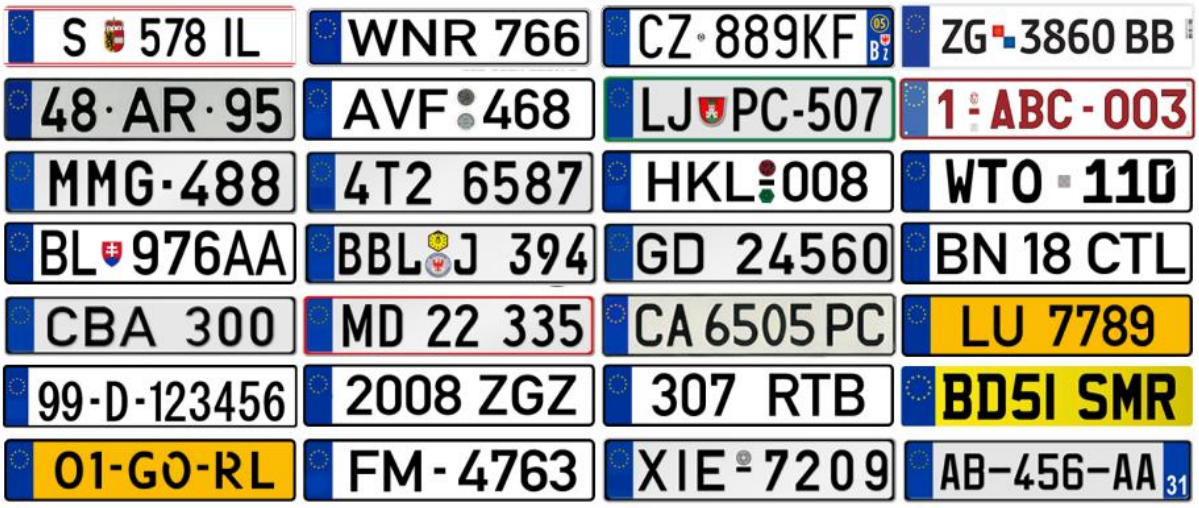
swissTRAFFIC AI uses a different engine from TrafficSurvey. swissTRAFFIC AI for Embedded AI and Professional (have a built-in LPR that is able to recognize all European and some Europe-similar license plates. We are flexible in terms of product development and we offer to train our neural networks and add license plate reading support for a given country based on your request. It would also be possible for example to read numbers on trains or shipping containers if you would like this feature implemented. swissTRAFFIC AI also has advanced functions that allow the creation of license plate whitelists and blacklists for example for finding lost vehicles or limiting access to a parking lot for residents only.

swissTRAFFIC AI Survey

swissTRAFFIC AI Survey can detect **all EU license plates** as well as most alphanumerical-only license plates. See the image below for examples of license plates that the swissTRAFFIC AI Survey LPR service can read. Please note that in order to read a license plate reliably, it should be at least 18pixels in the vertical dimension which is however easily achieve for most videos.

Which countries are supported?

swissTRAFFIC AI Survey can detect **all EU license plates** as well as most alphanumerical-only license plates. See the image below for examples of license plates that the swissTRAFFIC AI Survey LPR service can read. Please note that in order to read a license plate reliably, it should be at least 18pixels in the vertical dimension, but this is easily achieved for most videos. You can also test whether license plates will be read in your video for FREE by ticking the LPR option when doing the 5-minute free sample analysis. Please note that there a limit of 10x free sample analyses per 24 hours.



To offer higher privacy protection in regard to GDPR swissTRAFFIC AI Survey also allows irreversible License Plate Number hashing.

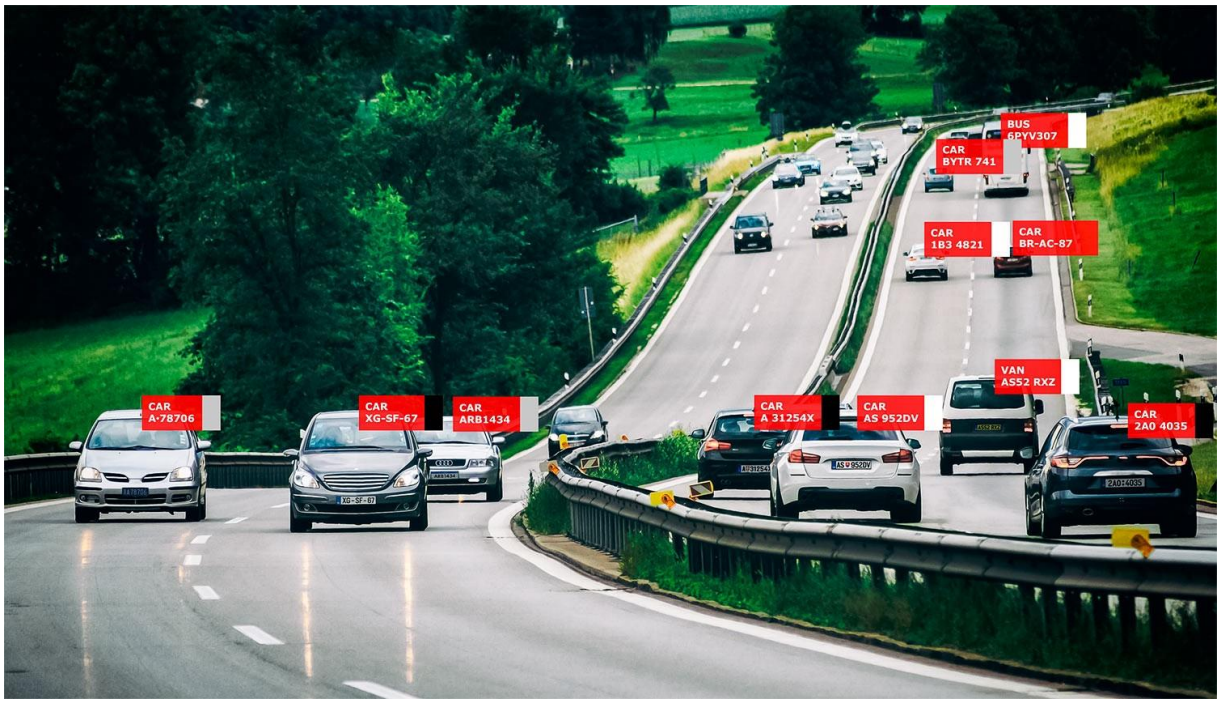
Track ID	Hash number	Entry Gate	Entry Time [s]	Exit Gate	Exit Time [s]	Colour
1	98254126	1	1.418083	4	9.634625	black
2	57835641	5	4.546208	6	11.803458	white
3	24863571	3	8.425083	4	16.683333	green
4	95134569	1	24.691333	2	32.157125	blue
5	53454526	1	26.526500	6	35.076708	black
6	14546468	3	30.780750	2	37.620917	red
7	10541564	5	32.949583	6	40.331958	orange
8	66985142	3	35.744042	6	42.917875	white
9	41364725	5	48.006292	6	56.473083	red
10	76423881	1	50.383667	4	57.599208	black
11	45889362	3	55.388667	4	63.271541	black
12	78674535	5	61.728333	6	68.818750	grey
13	16446947	1	65.523791	2	72.655916	red
14	64752136	3	77.660916	2	84.876458	orange

How to make a suitable video for License Plate recognition?

Here are general guidelines applicable for both swissTRAFFIC AI and swissTRAFFIC AI Survey to ensure high reliability of the number plate detection:

- Good enough resolution specifically the height of the letters and signs on the license plates should be at least 18 pixels in order to read the license plate reliably
- Use High-quality video output (FullHD or 4K)
- Number plates must not be blurred and must be easily readable and visible to the naked eye
- Number plates must not be overexposed (with too much light) or underexposed
- Number plates must not be deformed (for example by interleaving or by the rolling shutter effect)

Example picture where LPR is possible. Ideally, the camera should be higher than this.



How to record video using drone?

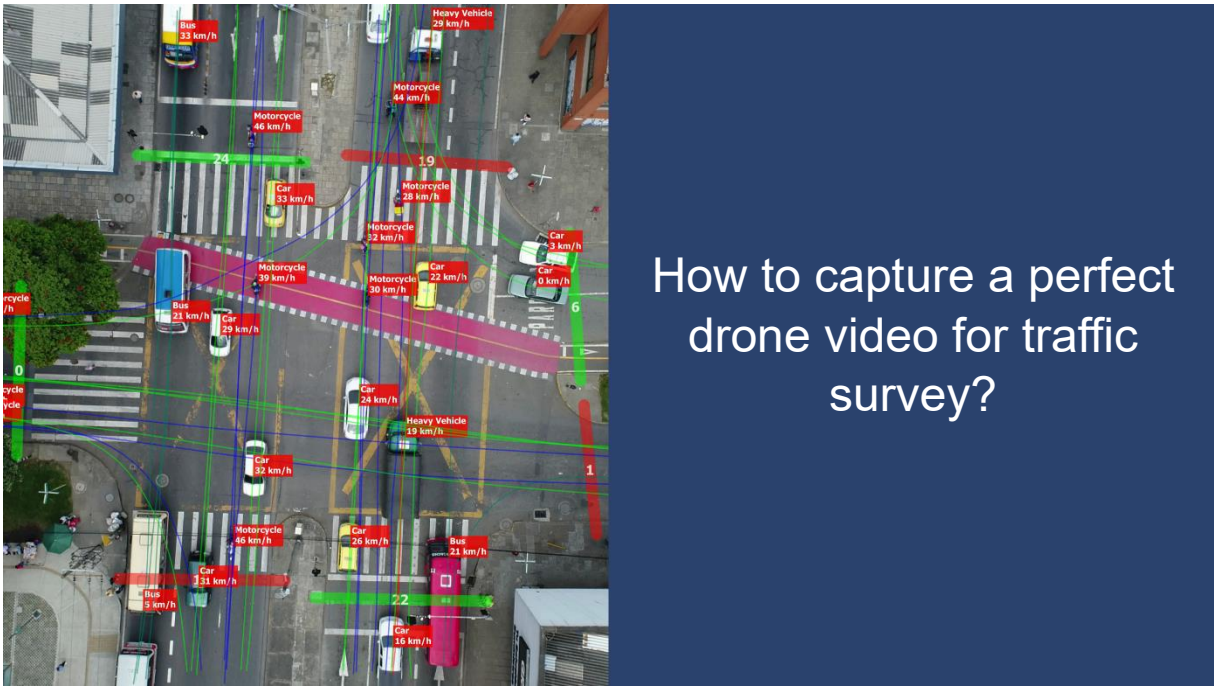
The key aspects are optimal drone position, resolution, framerate, bitrate and scene acuity

If you have **nice, sharp, and stable** footage of your favorite roundabout, you can probably just **upload it straight away to the DFS AERIAL service**. A simple rule of thumb: if you feel comfortable telling a bus from a truck on the footage, then our AI will probably feel the same way... and reward you with accurate results. Make sure you only upload videos that do not have any major changes in zoom, rotation or general scene coverage. The video should be looking at the same scene for the whole duration. If it is not, such sections need to be cut out before uploading.

When thinking about the **design** of your **traffic survey**, here are a few points to observe:

- **Legislation and safety**. First things first – it is always a good idea to fly your drone responsibly.
- **Acquisition geometry** – position and elevation of the drone, lens used
- **Scene acuity and exposure** – make sure the footage is as crisp as possible
- **Resolution, framerate, and bitrate** of the video footage

You can check our video tutorial first to get the feeling of the process:



Legislation & safety

Before the recording itself, always check the legal constraints for the planned mission. Legislation differs from country to country and sometimes it is required to use services of a professional pilot with the necessary permissions. There is a predefined maximum flight altitude for drones in many countries (usually 120 meters), as well as a minimum safety distance (usually 50–120 meters away from objects). If the recording is carried out by a

professional pilot, it is possible to gain permission for different conditions. Always take the possible risks of technical failure into consideration.

- Make sure you observe the **maximum allowed altitude of flight** in your country and **don't breach any safety zones** around the part of the infrastructure you are going to study.
- It is a good practice to **check for NOTAMs and active airspaces** around your study area before setting off from your office.
- You might need to **coordinate with Air Traffic Control** or other responsible bodies.

If you do not want to carry out the recording yourself, do not hesitate to **contact us**. We have a network of experienced and certified pilots all around the global. We will provide you with consultations of your project and its requirements in order to find the most suitable solution. We can also carry out the recording for you.

The angle of recording / drone position

In terms of accuracy of vehicle localization, the **ideal camera position is directly above the analysed intersection** — the so-called nadir or TOP-DOWN view. At this position, the camera is the most sensitive to position changes of objects in the scene. At the same time, **dynamic occlusions between individual objects are minimized**. Unfortunately, drone flight above a traffic node is not always possible due to safety regulations and applicable legislation. In a situation like this, a simple rule applies — go as close and as high as possible.

The procedure is as follows:

1. Fly with the drone to the **nearest possible** place to the middle of the intersection.
2. Ascend to the **maximum possible elevation** while making sure pixel resolution of monitored objects is more than 32x32 pixels which is the recommended minimum size to be able to reliably detect and classify objects. You can use a longer focal length lens (zoom in) – this way you reduce optical distortions of the lens and more importantly the perspective distortion.
3. Check the **incidence angle** – the lower the better:

- 0 degrees means that the drone is directly above the intersection. This is the **most desired nadir** or top-down view.
- 45 degrees means that the drone altitude is the same as its distance from the center of the intersection. This is still a suitable configuration.
- > 55 degrees – expect a notable drop of the vehicle localization accuracy (please note that this does NOT hold for DETECTION or for CLASSIFICATION)

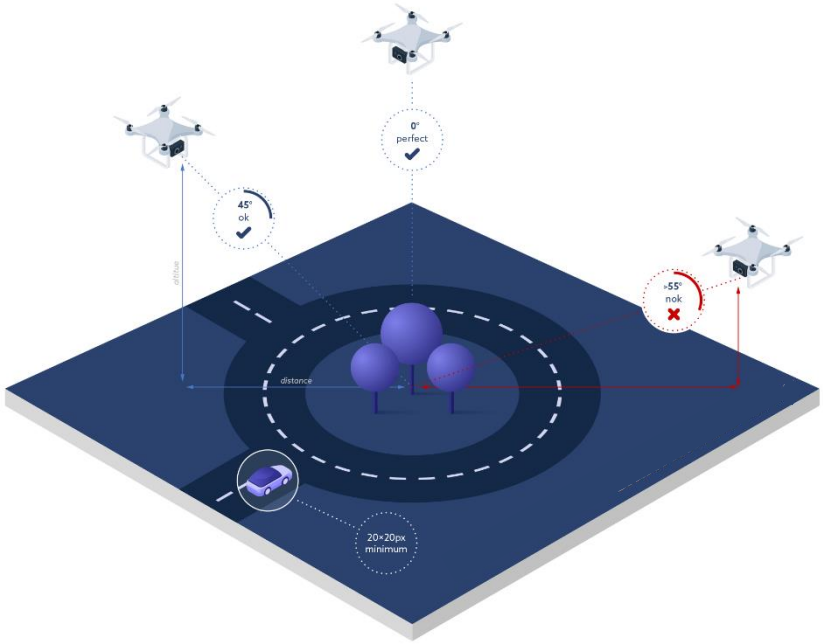


Figure: three situations: 0° = ideal position, 45° = ok, altitude is the same as the distance from the center of the intersection, 55° = drone should be higher. If you want to detect pedestrians and cyclist you need partial side view meaning the range should be between 45°-15°.

Further recommendations:

Position the drone so that dynamic and static **occlusions are avoided**. Occlusions increase the probability of failure of object tracking and of disengagement of continuous trajectories - in other words, one object would have a higher number of shorter trajectories. SWISSTRAFFIC system is robust against short occlusions, but long occlusions can cause the disengagement of continuous trajectories into more parts.

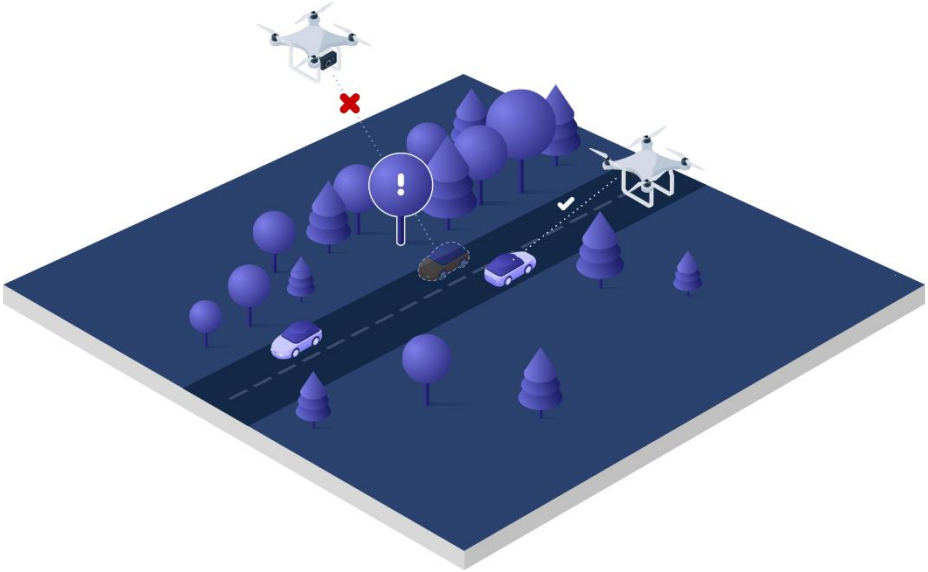


Figure: two situations — long occlusions are problematic, but the system is robust against short occlusions.

Try to **keep the drone stable during recording**. Do not change the drone position or camera attitude and zoom when recording. All **parameters should be fixed** before the start of recording. Ideally, use a gimballed camera. If you have the option, select a lens with lower distortion. A rule of thumb here is that the higher the focal length, the lower the distortion. In other words, try to **avoid fish-eye lenses** where possible. At least if you are looking for precise speed and acceleration data.

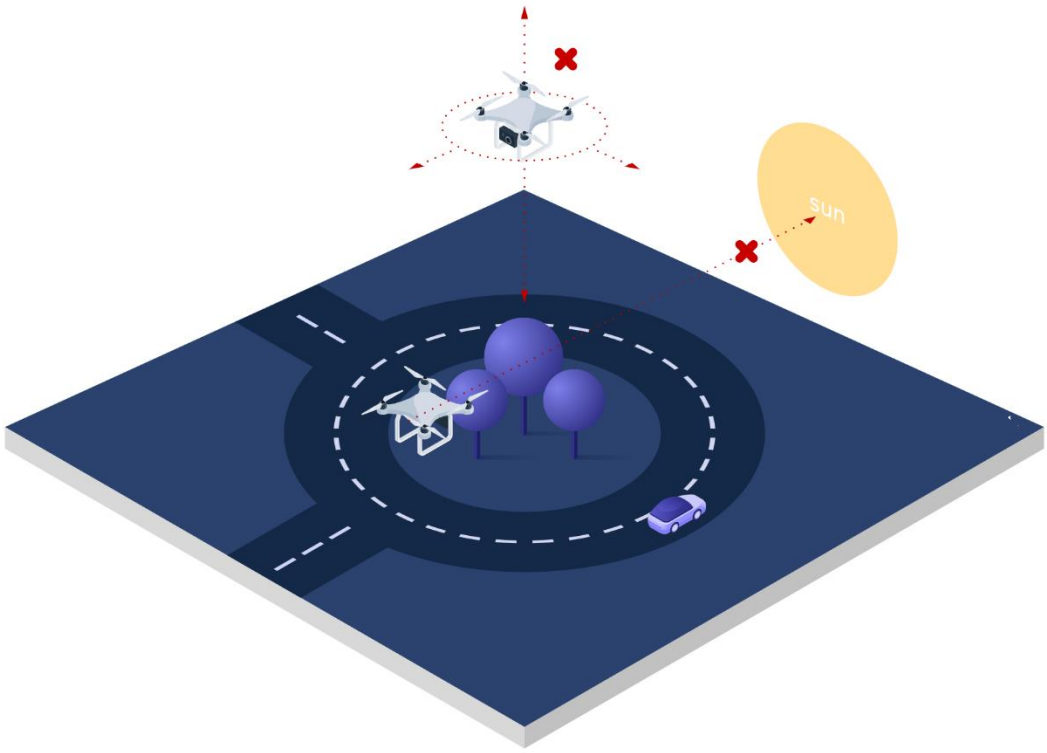


Figure: two situations — try to avoid changing the drone's position when recording, and also avoid recording against a strong source of light.

Scene acuity and exposure

Try to **capture a clear scene with good contrast and brightness**. Try to avoid parasitic optical phenomena in your camera take. These may be caused by the sun or another strong source of light. Always orient the camera to keep strong light sources away from the frame. Takes of scenes with the sky should be avoided.

Figure: three situations - nok: too bright (left), ok: ideal (center), nok: dark, blurred due to long exposure time (right).

Focusing and exposure control should ensure the vehicles / objects are **not blurred** in a take. Objects should be contrasting but not overexposed nor too dark. This should be considered even at the expense of other parts of the shot. In the case of night recordings or recordings at low light conditions, it is important to ensure that traffic elements are visibly identifiable besides vehicles.

Camera footage should be stable and free of vibrations or image deformation (so-called "jello"). These artefacts produced by a combination of drone vibrations and rolling shutter of many cameras decrease the accuracy of our results by a significant margin. Try to use gimballed cameras, damping elements, and other means to avoid these parasitic artefacts. **Important - do not add your logos or timestamps into your video, as this could negatively impact subsequent video stabilization.**

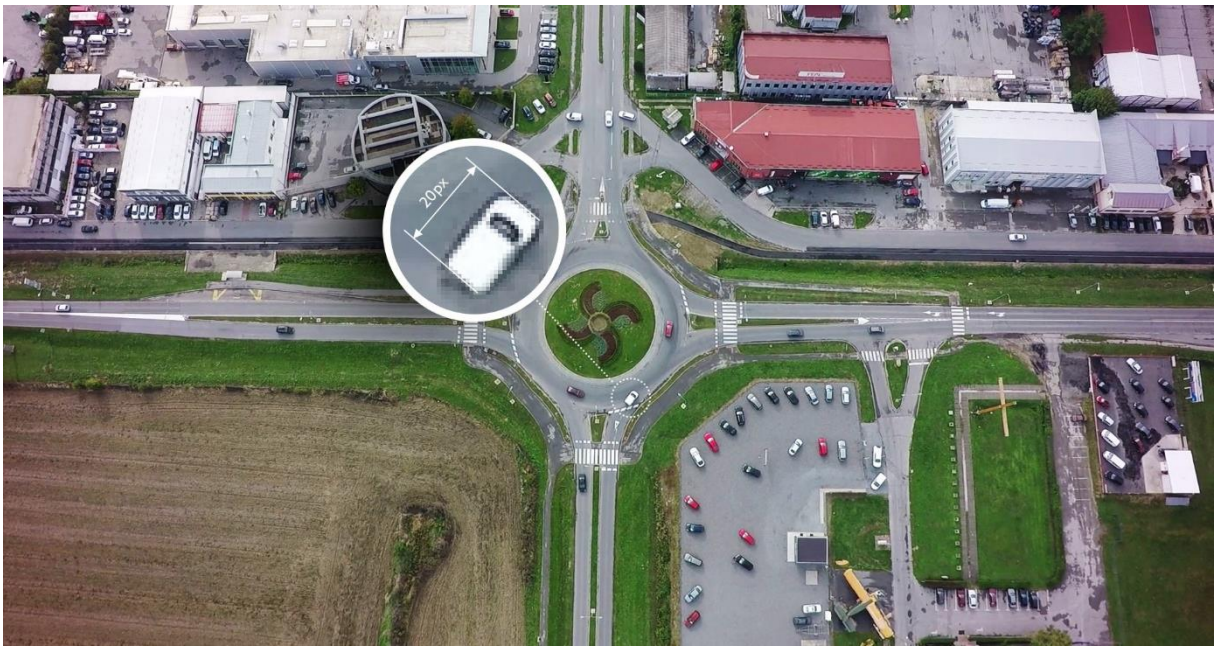
The resolution, FPS, and bitrate

Resolution is a key attribute for the detection and classification of objects. The minimum recommended size of an object within the image needed for detection and classification is 32x32 pixels. The maximum size of the object for correct detection is **150x150 pixels** in the whole monitored area within the intersection. Detection of pedestrians and cyclists with AERIAL can be more complicated so try to get more pixels for these if you want them detected as well. Also, note that the detection of pedestrians in crowds has lowered accuracy. Object size depends on the following parameters:

- Image resolution
- Drone's position — altitude/angle
- The mutual position of a monitored object and a drone/camera

A common rule is that if you record the video with maximum resolution used by modern cameras (e.g. 4K or even 8K), it will be sufficient, as it is always possible to reduce the quality, but not the other way around. The following is a simple guide for resolution and the most common wide-angle cameras:

- For distances between the camera and the scene center shorter than 120 meters, FULL HD (1920x1200) resolution will be sufficient, but it is better to use a higher resolution (2k/4k)
- For distances between 120 meters up to 300 meters, use 4K video resolution



Framerate represents the sampling frequency of measurements. For vehicle speed up to 70 km/h, it is possible to use a framerate of 15 FPS. For vehicle speed over 50 km/h, it is better to use a sampling frequency around 25 FPS. Sampling frequency over 35fps has no further positive effect on the quality of measurement, but only makes the video and its size unnecessarily large.

The final quality of the video is also greatly influenced by bitrate settings. At FULL HD videos, coded with the H.264 coding format, the bitrate should be at least 10 Mbit/s. At 4K videos,

coded with H.264, a minimum of 20 Mbit/s is necessary. The video must not be blurry, pixelated, or with any signs of damage caused by compression algorithms.

Tip for beginners: record your video with 4K resolution, 25 FPS and standard bitrate (approx. 20 Mbit/s)

By following these rules you will get suitable videos for automatic processing to extract super-accurate data for your traffic study. Before the final recording, we recommend carrying out a test flight or make a few sample recordings in order to get acquainted with the basic principles. If you have any questions, do not hesitate to **contact us**.

How to set up fixed CCTV cameras for video analytics?

A few tips and tricks to make our AI happy ... so that it can give you the best results and make you happy as well.

To put it in a nutshell, **the better the input, the better the results**! If you have clear and stable footage where you are happy to tell a bus from a van, then you probably need not read any further. Do you want to know a bit more? We have a few recommendations for you to enjoy the best possible results from your setup.

The **SWISSTRAFFIC Light** engine can process data from any video input such as static/handheld consumer camera or footage from an existing CCTV infrastructure. For the best traffic analysis results we recommend the following **input video parameters**:

- resolution: 1280×720 or more
- bitrate: 5 Mb/s or more
- framerate: 25 fps or more
- min.traffic object size: 32px in one dimension
- continuous video without cuts
- no camera movement

We also recommend minimizing occlusions in the scene. It is useful for the input video to be **as stable as possible**. Try to avoid vibrations, re-composition, or generally any movement of the camera during the whole video acquisition. If not a permanent installation, we recommend using a tripod or magic arm to provide a solid support to your camera. It is much more convenient for you as well.

Example of the configuration best suitable for DFS LIGHT analysis:

- elevation of the camera: 10m
- resolution: > HD
- optics FOV: 90°
- the angle between the imaging axis and the ground plane: 45°

Different configurations are acceptable as long as the basic requirements are fulfilled. The most important parameter is the **incidence angle**: it should always be in the **range of 30–60°**. A few good-practice examples:

Do I need any special cameras to use TrafficSurvey or swissTRAFFIC AI?

No, you don't. You can use your existing cameras

You can capture your video using most commercially available **drones** and **standard or panoramic cameras.** You can even shoot your video using your mobile phone or Miovision camera. All you have to do **is follow some basic rules** for making videos suitable for SWISSTRAFFIC AI analysis - these for **drones** and these for **standard cameras**. In addition, we have a stabilization as an integral component of the Aerial platform so we measure accurately even with minor camera movements.

If you are not sure about your equipment, do not hesitate to **contact us**! We can also help you with format or size conversion and with the anonymization of your data.

SWISSTRAFFIC can also analyze within 360°

Our algorithms will detect individual **moving and static traffic participants** with all physical aspects of their presence on the scene, like their positions, object category, colors, and trajectories. There is **a wide variety of traffic data** types which we are capable to collect from the video, including passage time, gap time, time to follow, speed, and many more features.

We will be happy to answer any questions you may have. Contact us!

SWISSTRAFFIC can handle analyze even the low-quality video taken by Miovision scout

Can you analyze night video or video captured during bad weather conditions like rain or fog?

Yes, we can. The rule is simple - if you are able to recognize the objects in the video, our AI will be able to do it too.

Our traffic AI is trained **on millions of hours** of traffic videos captured in **all weather conditions** including snow, rain, fog, dark or overexposed scenes. Due to the long-term development of the key components of automatic traffic data extraction, the system is **extremely robust and highly reliable** in all mentioned cases.

For best results, keep in mind these **two basic rules**:

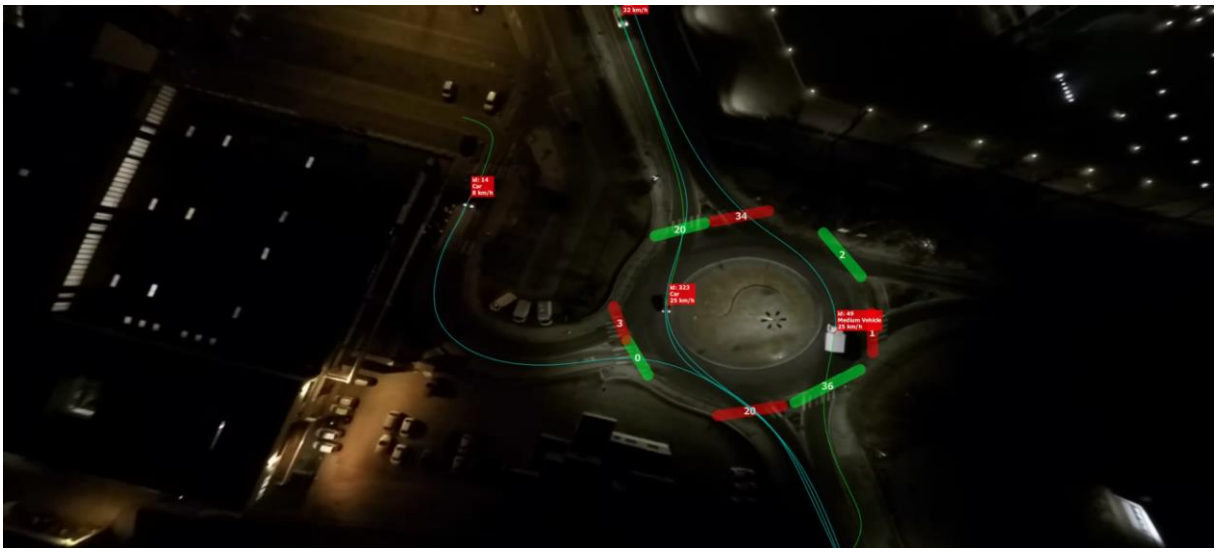
- If you are able to recognize the objects in the image, SWISSTRAFFIC will be able to do as well.
- The better the video input, the better the traffic output. Read our recommendations on how to record the video from **drones** or from **standard cameras**.

With SWISSTRAFFIC, you always have **backdoors** even for bad video inputs or uncertain situations!

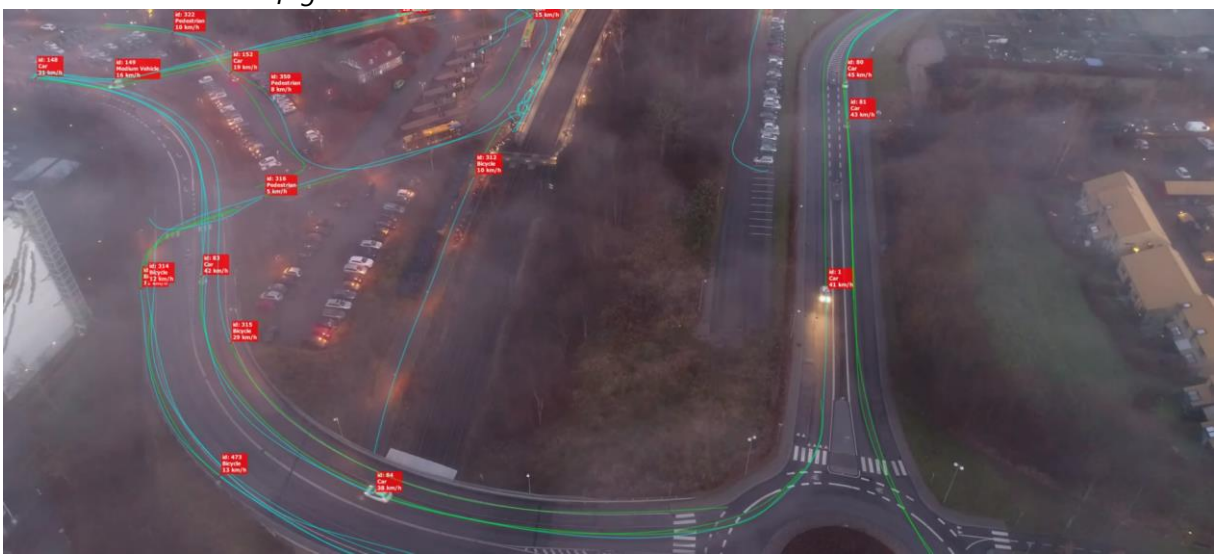
- Test our traffic AI on your concrete video for free - 5 minutes for each video is analyzed **without charge**. So you can check the quality of the **fully automated extraction** in your video before you paid for the full analysis.
- **Guarantee of 100% results** - with this additional paid service, SWISSTRAFFIC will extract the maximum what is technically possible to mine from your video footage - the output will **be further validated**.

We will be happy to answer any questions you may have. Contact us!

SWISSTRAFFIC at night



SWISSTRAFFIC in the fog

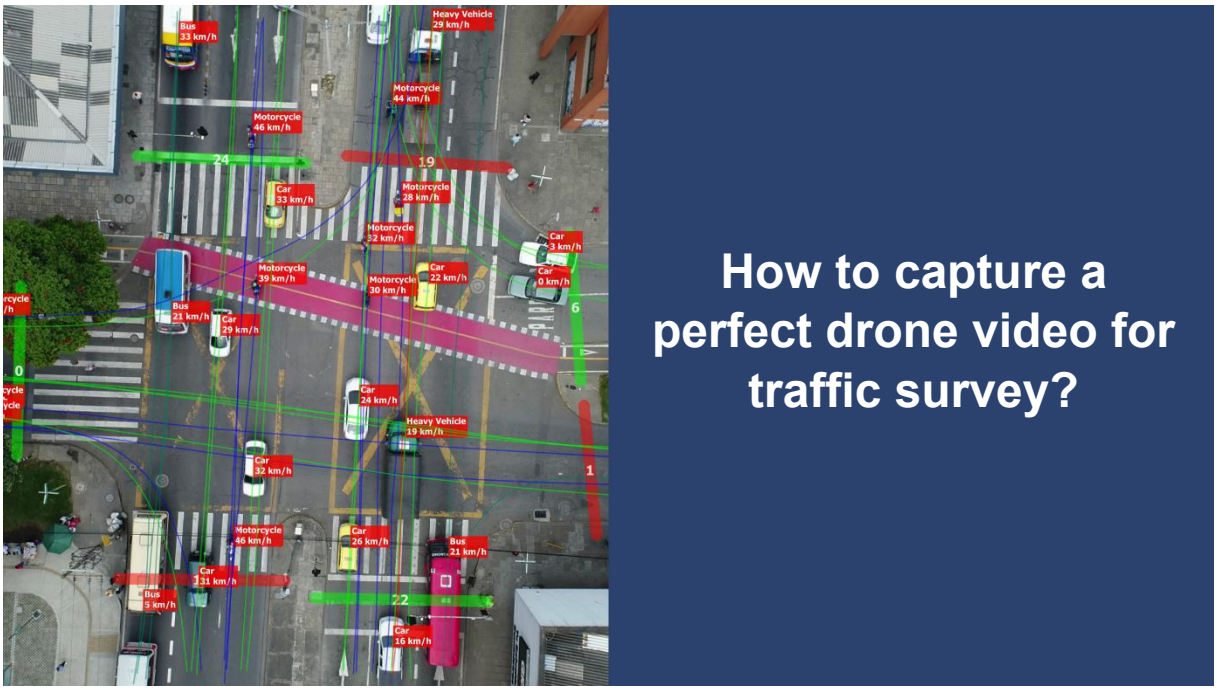


What are the requirements for the videos to get accurate results?

The better the quality, the better the outcome, that is a simple equation.

SWISSTRAFFIC processes videos from both **drones** and **standard** or **panoramic cameras.** However, both of these types have slightly **different recording quality requirements.** So we've prepared **detailed instructions** to make sure your video provides the best suitable results for your traffic survey.

Contact us for more information.



Do you perform video analysis in real-time?

We even offer you two solutions of real-time analysis.

Yes, we offer several **real-time traffic analysis** solutions, both **centralized** (server-based) and **decentralized** (camera-based data processing). Specifically, these product lines are:

- **swissTRAFFIC Embedded AI** - onboard video analytics from live camera streams
- **swissTRAFFIC Professional** - video analytics on your local servers or in the cloud

swissTRAFFIC Embedded AI - convert any camera into a smart traffic sensor

swissTRAFFIC Embedded AI is a **HW series** of **deep-video analytical embedded devices** that convert any camera into **a smart sensor** for various **smart city tasks** such as adaptive traffic control, traffic monitoring, parking management, crowd management, etc. Live camera streams are processed **on-board** in the swissTRAFFIC Embedded AI unit and, therefore, there is **no need to transfer** image data via the network. swissTRAFFIC Embedded AI series is based on the most powerful video analytic **deep-AI processors** and is especially useful for situations where you need to:

- get traffic knowledge in real-time
- limit data bandwidth from the sensor
- process data locally because of privacy
- have fully independent sensory system on the connectivity

swissTRAFFIC Professional - process hundreds of live camera streams on your local servers

swissTRAFFIC Professional solution is designed for centralized processing of **many camera streams** to monitor traffic and pedestrians for **smart cities**, surveillance centers, etc. swissTRAFFIC Professional solution can be deployed **on local operator servers** (you have full control over your data - nothing leaves your network) or analyze via our **cloud service.** It is an easily scalable system with **minimal operating costs**, designed for cases with more than 10 cameras.

Contact us for more information.

Do you provide stabilization of the video?

For aerial videos captured by drones - YES. For ground videos captured by fixed cameras - NO.

In short, depending on the video you want to process:

- **SWISSTRAFFIC AERIAL** - you will always receive consistent traffic data in time and space which is not affected by unwanted movements of the drone. Stabilization is an integral part of our processing.
- **SWISSTRAFFIC LIGHT** - we do not stabilize the videos as it is intended for the analysis of the records captured by fixed cameras.

Though the **modern drones** are super stable, it is still not possible to record longer aerial videos in the exact same viewpoint and **digital stabilization is required** (all tiny camera movements are multiplied with the distance - this is the physics). Therefore, the sophisticated digital stabilization must be and is **an integral part** of **SWISSTRAFFIC Aerial**. For that reason, our outputs are robust to small movements of UAV/drone during the recording caused by wind, operator, etc. The stabilization is also needed if you want to get **super precise** vehicle positions, speeds, accelerations for advanced traffic analysis such as safety analysis or capacity estimation.

We will be happy to answer any questions you may have. Contact us!