Persons or vehicles recognition and tracking for video surveillance systems

SentiVeillance SDK
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SentiVeillance SDK is designed for developing software that performs biometric face identification, detects moving pedestrians or vehicles or other objects and performs automatic license plate recognition using live video streams from digital surveillance cameras. The SDK is used for passive identification – when passers-by do not make any efforts to be recognized. List of possible uses includes law enforcement, security, attendance control, visitor counting, traffic monitoring and other commercial applications.

The SentiVeillance SDK allows to create applications for Microsoft Windows and Linux platforms.

- Real time pedestrians and vehicles tracking and classification.
- Biometric facial identification and matching against watchlist database.
- Automated license plate recognition (ALPR) for moving vehicles.
- Color, size and movement vector estimation for vehicles and other objects.
- Gender classification, age evaluation, facial expression and attributes detection.
- Automatic operation logs and reports events, adds new faces from video stream to watchlist.
- Large surveillance systems support with multiple cameras.
- Ready-to-use server for integration into video management systems (VMS) optionally available.
- Reasonable prices, flexible licensing and free customer support.
Features and Capabilities

The SentiVeillance 7.1 technology has these specific capabilities:

- **Real time performance.** SentiVeillance technology performs face recognition, pedestrian or vehicle classification and tracking in real time. The technology is designed to run on multi-core processors to achieve fast performance.

- **Three modalities for surveillance systems.** Depending on the surveillance system design, one of these modalities may be used:
  
  - **Biometric face recognition** algorithm is based on deep neural networks and provides these capabilities for surveillance systems:
    
    - **Multiple face** detection, features extraction and template matching with the internal database in real time.
    
    - **Facial identification** reliability enables using **large watchlist** databases.
    
    - **Face tracking** is performed in all successive frames from the video source until they disappear from camera field of view. The face tracking algorithm uses dynamic face and motion prediction models that make it robust to occlusions like other objects or even other faces. The algorithm is able to continue tracking a face even when it re-appears after being fully covered by occlusions (like walls, furniture, posters etc).
    
    - **Gender classification** (optional) for each person in the frame.
    
    - **Age determination** (optional) for each person in the frame.
    
    - **Smile, open-mouth, closed-eyes, glasses, dark-glasses, beard and mustache** attributes detection (configurable).
  
  - **Vehicle or human detection, classification and movement tracking** – performs object detection of moving and static objects in the scene, their classification and tracking until they disappear. These features are available for surveillance systems:
    
    - **Object classification.** SentiVeillance allows to perform object classification, locations and tracking based on its type. Currently these classes are available: Person, Car, Bus, Truck, Bike.
    
    - **Color estimation.** The algorithm returns most likely color estimation for cars and pedestrians. The estimated color values are: red, orange, yellow, green, blue, silver, white, black, brown, grey.
    
    - **Movement vector estimation.** The algorithm returns movement vector estimation values like: “north”, “south”, “south-east” etc.
    
    - **Tolerance to object visibility.** The detection algorithm works with partially visible objects and from great distance.
  
  - **Automated license plate recognition (ALPR)** – once a vehicle has been detected, SentiVeillance ALPR algorithm detects and reads the license plate:
    
    - **Traffic data processing.** SentiVeillance algorithms can simultaneously read vehicle license plates from multiple moving vehicles.
    
    - **Tolerance to camera position.** Depending on camera resolution, the ALPR algorithm can read license plates from longer distance and higher angle.
    
    - **Preventing cheating with replaced license plates.** Integrators can use vehicle recognition and ALPR modalities together for making software logic which checks if recognized license plate corresponds other registration data, like vehicle color or type, and not being spoofed or moved from another vehicle.

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- **Automatic operation.** A system based on SentiVeillance 7.1 SDK is able to **log on the fly** all events. It can be configured to automatically **report** events like match with a **watch list**, or perform automatic **enroll** from video.

- **Large surveillance systems support.** SentiVeillance 7.1 SDK allows to integrate its technology into surveillance systems with **multiple cameras**. A common PC with a GPU can process multiple video streams simultaneously.

- **Video files processing.** SentiVeillance also accepts data from video files. The video files can be processed in real time as coming from a virtual camera or can be processed at maximum speed depending on hardware resources available.
SentiVeillance SDK contents

SentiVeillance 7.1 SDK is based on the SentiVeillance 7.1 technology that is specially designed for integrating biometric facial recognition into video surveillance systems. Face templates created with SentiVeillance SDK are fully compatible with VeriLook SDK and MegaMatcher SDK multi-biometric technology.

SentiVeillance 7.1 SDK includes SentiVeillance component, which can process multiple video streams on the same PC or server. The SentiVeillance component supports three modalities: biometric facial recognition, vehicle/human classification and automatic license plate recognition. Also the SDK includes Device Manager library for Microsoft Windows and Linux that allows to perform simultaneous capture from multiple cameras.

Components | Microsoft Windows | Linux
---|---|---
• SentiVeillance component’s **Face modality** | license for 1 video stream | 
• SentiVeillance component’s **VH modality** | license for 1 video stream | 
• SentiVeillance component’s **ALPR modality** | license for 1 video stream | 
• Device manager library | + | +

Programming tutorials

• C++ | + | +
• C# | + | 
• Visual Basic .NET | + |

Documentation

• SentiVeillance 7.1 SDK documentation | + |

SentiVeillance Face modality

The Face modality from the SentiVeillance component performs real-time detection, biometric identification and tracking of all detected faces. The algorithms are able to track multiple faces simultaneously and match them with faces from internal database (i.e. a watch-list of suspects or a list of company employees). New faces may be enrolled to the database either automatically from video streams or manually as templates, which were created with VeriLook SDK. Person’s gender, age or facial attributes can be optionally determined for each person in a frame.

Programming samples from the SDK show how to use this modality.

A license for using the SentiVeillance Face modality on one video stream is included with SentiVeillance 7.1 SDK. Additional licenses or upgrade for the number of processed video streams in the existing licenses can be purchased any time by SentiVeillance 7.1 SDK customers.

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SentiVeillance VH (Vehicle/Human) modality

The VH modality from the SentiVeillance component performs real-time vehicle or human detection, classification and movement tracking. SentiVeillance algorithms allows to perform object classification, locations and tracking based on its type: Person, Car, Bus, Truck and Bike classes are supported. Also, color and movement vector estimations can be done for the objects.

ALPR modality (see below) can be used together with the VH modality to perform vehicle identification by its license plate.

Programming samples from the SDK show how to use this modality.

A license for using the SentiVeillance HV modality on one video stream is included with SentiVeillance 7.1 SDK. Additional licenses or upgrade for the number of processed video streams in the existing licenses can be purchased any time by SentiVeillance 7.1 SDK customers.

SentiVeillance ALPR (Automated License Plate Recognition) modality

The ALPR modality from the SentiVeillance component performs real-time vehicle license plate detection and recognition. SentiVeillance algorithms can simultaneously read vehicle license plates from multiple moving vehicles in road traffic. Depending on camera resolution, the ALPR algorithm can read license plates from longer distance and higher angle.

VH modality (see above) is recommended to be used together with the ALPR modality, as vehicles have to be detected before running the license plate recognition algorithm. Also, the VH modality can be used to obtain additional vehicle data (its color or type) for checking if license plate numbers correspond the vehicle registration data.

Programming samples from the SDK show how to use this modality.

A license for using the SentiVeillance ALPR modality on one video stream is included with SentiVeillance 7.1 SDK. Additional licenses or upgrade for the number of processed video streams in the existing licenses can be purchased any time by SentiVeillance 7.1 SDK customers.

Device Manager library

Device Manager library works under Microsoft Windows and Linux and provides functionality for simultaneous capture from multiple cameras. The library supports a range of high-resolution digital surveillance cameras and other cameras that provide DirectShow interface for Windows platform, or GStreamer interface for Linux platform.

The list of supported cameras is available below in the “System Requirements” section.

The Device Manager includes a plug-in framework that allows integrators to write plug-ins to support their cameras using the provided API. The SentiVeillance SDK documentation contains the detailed information and samples.

A video file can be also used as a data source for SentiVeillance. The input from the file is processed as coming from a virtual camera, thus the video is processed in real-time.
Basic Recommendations for SentiVeillance Usage

Face recognition accuracy of SentiVeillance heavily depends on the quality of a face image in a frame. There are some basic recommendations and constraints when using face recognition applications based on SentiVeillance SDK.

General recommendations

- **Image quality during enrollment is important**, as it influences the quality of the face template. Enrollment from photo or video stream is possible.
  - Several images during enrollment are recommended for better facial template quality which results in improvement of recognition accuracy and reliability.
  - Additional enrollments may be needed when facial hair style changes, especially when beard or mustache is grown or shaved off.
- **32 pixels is the recommended minimal distance between eyes** for a face on image or video stream to perform face template extraction reliably. **64 pixels or more** recommended for better face recognition results. Note that this distance should be native, not achieved by resizing an image.
- **1 MegaPixel** or better camera resolution is recommended for face enrollment and recognition. Make sure that native resolution is provided by a camera, as some cameras or webcams may scale up native images to higher resolution without image quality improvement.

Face posture

The SentiVeillance face recognition engine has certain tolerance to face posture:

- head **roll** (tilt) – ±15 degrees.
- head **pitch** (nod) – ±15 degrees from frontal position.
  - The head pitch tolerance can be increased up to ±25 degrees if several views of the same face that covered different pitch angles were used during enrollment.
- head **yaw** (bobble) – ±45 degrees from frontal position (configurable).
  - **±15 degrees default** value is the fastest setting which is usually sufficient for most near-frontal face images.
  - **30 degrees difference** between a face template in a database and a face image from camera is **acceptable**.
  - Several views of the same face can be enrolled to the database to cover the whole ±45 degrees yaw range from frontal position.
System Requirements and Supported Cameras

The requirements below are provided for a single computational node (PC or server) used to run the SentiVeillance algorithms. Multiple nodes can be connected together via network to support larger surveillance systems.

- **PC or server** with x86-64 (64-bit) compatible processor:
  - 3 GHz or better processor with 6 processor cores is recommended.
  - AVX2 support is highly recommended. Processors that do not support AVX2 will still run the SentiVeillance algorithms, but in a mode, which will not provide the specified performance. Most modern processors support this instruction set, but please check if a particular processor model supports it.

- **Graphical processing unit (GPU).**
  - a GPU is required if a SentiVeillance component with any of the supported modalities is run to process more than 2 video streams simultaneously.
  - NVIDIA GeForce GTX 1080 GPU or better is recommended for systems with up to 10 cameras.
  - Several GPUs can be used on the same machine to process larger number of video streams.
  - at least 6 GB of VRAM is recommended.
  - Compute Capability 3.5 or better should be supported by the GPU.
  - CUDA 10.1 toolkit or newer is required
  - cuDNN 7.5 library is required.

- **At least 8 GB of RAM.**

- **High-resolution digital camera(s).** Camera resolution may vary depending on the actual application. The recommended resolution is about 1 Megapixel, as processing video from cameras with higher resolution will require more free RAM and more powerful processor to keep the acceptable frame rate. These supported cameras are suitable for using with SentiVeillance 7.1 SDK:
  - Any IP camera, that supports RTSP (Real Time Streaming Protocol):
    - Only RTP over UDP is supported.
    - VLC framework can be optionally used for reading video streams.
    - H.264/MPEG-4 AVC or Motion JPEG should be used for encoding the video stream.
  - Any other high-resolution digital camera that is accessible using:
    - DirectShow or Windows Media or Media Foundation interfaces for Microsoft Windows platform;
    - GStreamer interface for Linux platform.
  - Any other device support can be added by customers using the provided Device Manager plug-in framework. Please refer to the SentiVeillance SDK documentation for the detailed information.

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Microsoft Windows specific:
  • Microsoft .NET framework 4.5 or newer (for .NET components usage).
  • Microsoft DirectX 9.0 or later.
  • Microsoft Visual Studio 2012 or newer (for application development under C/C++, C#, VB .Net)
  • Sun Java 1.8 SDK or later (for application development with Java)

Linux specific:
  • Ubuntu 16.04 OS
  • glibc 2.17 or newer
  • GStreamer 1.10.x or newer with gst-vaapi plugins installed for hardware accelerated video decoding
  • libgudev-1.0 219 or newer
  • wxWidgets 3.0.0 or newer libs and dev packages (to build and run SDK samples and applications based on them)
  • Sun Java 1.8 SDK or later (for application development with Java)
Technical Specifications

Below are provided specifications for SentiVeillance facial recognition modality.

4 % of the frame’s larger side (at least 32 pixels) is the minimal recommended distance between eyes for a face on video stream or image to perform reliable face tracking and template extraction. The speeds of face tracking, template extraction and matching against a watchlist database are dependent on actual size of a face in a frame, not on the size of the whole frame.

SentiVeillance has certain tolerance to face posture that assures face detection and tracking:

- head roll (tilt) – ±15 degrees from frontal positions.
- head pitch (nod) – ±15 degrees from frontal position.
- head yaw (bobble) – ±45 degrees from frontal position.

The performance specifications are provided for Intel Core i7-4771 processor, running at 3.5 GHz clock rate, and 1920 x 1080 pixels videos.

<table>
<thead>
<tr>
<th></th>
<th>More than 25 frames per second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame rate when tracking up to 5 faces</td>
<td>Less than 0.5 second</td>
</tr>
<tr>
<td>Face watch-list database matching time (1)</td>
<td>0.5 or 5.0 (configurable)</td>
</tr>
<tr>
<td>Single face record size in a template (kilobytes)</td>
<td>Limited by amount of free RAM</td>
</tr>
<tr>
<td>Maximum watch-list database size</td>
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</tbody>
</table>

(1) up to 20,000 face records in the database; larger database yields slower response time. Note that each person may be represented by several records in the database with different appearance variations, different capture angles etc.
SentiVeillance SDK Trial and Related Products

SentiVeillance 30-day SDK Trial is available for downloading at [www.neurotechnology.com/download.html](http://www.neurotechnology.com/download.html).

These products are related to SentiVeillance SDK (see the corresponding product brochure for more information):

- **SentiVeillance Server** – ready-to-use software for easy integration of biometric face identification and person tracking into video management systems (VMS).
- **VeriLook SDK** - for developing PC-based and web-based face identification software, with possibility to match near-infrared and visible light face images.
- **MegaMatcher SDK** – for development of AFIS or multi-biometric face, fingerprint, iris and palm print identification products.
Licensing SentiVeillance SDK

Product Development
An integrator should obtain SentiVeillance 7.1 SDK (EUR 790) to develop an end-user product based on SentiVeillance technology. The SDK needs to be purchased just once and may be used for all projects and by all the developers within the integrator’s company.

SentiVeillance 7.1 SDK includes:
- A license to use SentiVeillance component with **Face modality** on one video stream.
- A license to use SentiVeillance component with **ALPR modality** on one video stream.
- A license to use SentiVeillance component with **Vehicle/Human modality** on one video stream.

Each license has a specified **number of processed video streams**.

Integrators can obtain additional licenses or upgrade the number of processed video streams in their existing licenses if processing videos from more cameras or on more computers required for the development process.

Product Deployment
To deploy their developed products, an integrator need obtain licenses for particular components for every computer, where these specific component will be installed together with integrator’s product. Each license has a specified **number of processed video streams**. Integrators can purchase additional licenses or upgrade the number of processed video streams in their existing licenses for SentiVeillance components if required at anytime.

License activation options
The components are copy-protected. The following license activation options are available:

- **Serial numbers** are used to activate licenses for particular SentiVeillance components on particular computer or device. The activation is done via the Internet or by email. After activation the network connection is not required for single computer license usage.
  
  Note: activation by serial number is **not suitable for virtual environments**.

- **Internet activation.** A special **license file** is stored on a computer or a mobile or embedded device; the license file allows to run particular SentiVeillance components on that computer or device after checking the license over the Internet. **Internet connection** should be available periodically for a short amount of time. A single computer license can be transferred to another computer or device by moving the license file there and waiting until the previous activation expires.

- **Volume License Manager.** Licenses may be stored in a volume license manager **dongle**. License activation using volume license manager may be performed without connection to the Internet and is suitable for virtual environments. Volume license manager is **used on site by integrators or end users** to manage licenses for SentiVeillance components in the following ways:
  
  1. **Activating single computer licenses** – An installation license for a SentiVeillance component will be activated for use on a particular computer. The number of available licenses in the license manager will be decreased by the number of activated licenses.
  
  2. **Managing single computer licenses via a LAN or the Internet** – The license manager allows the management of installation licenses for SentiVeillance components across multiple computers in a LAN or over the Internet. The number of managed licenses is limited by the number of licenses in the license manager. No license activation is required and the license quantity is not decreased. Once issued, the license is assigned to a specific computer or device on the network.
  
  3. **Using license manager as a dongle** – A volume license manager containing at least one license for a SentiVeillance component may be used as a dongle, allowing the SentiVeillance component to run on the particular computer where the dongle is attached.
Licenses Validity
All SDK and component licenses are perpetual and do not have expiration. There are no annual fee or any other fees except license purchasing fee. It is possible to move licenses from one computer or device to another. Neurotechnology provides a way to renew the license if the computer undergoes changes due to technical maintenance.

Licensing Agreement

Note that you unambiguously accept this agreement by placing an order using Neurotechnology online ordering service or by email or other means of communications. Please read the agreement before making an order.

Other licensing options
- **VAR License.** The above described licensing model is intended for end-user product developers. Integrators who want to develop and sell a SentiVeillance-based development tool (with API, programming possibilities, programming samples, etc.), must obtain permission from Neurotechnology and sign a special VAR agreement. For more information please contact us.

- **Enterprise License.** The SentiVeillance enterprise license allows an unlimited use of SentiVeillance components in end-user products for a specific territory, market segment or project. Specific restrictions would be included in the licensing agreement. The enterprise license price depends on the application size and the number of potential users of the application within the designated territory, market segment or project. For more information please contact us.
Prices for SentiVeillance SDK

- The prices are effective June 13, 2019. The prices may change in the future, so please download and review the latest version of the brochure before making an order.
- Quantity discounts do not accumulate over time.
- Prices do not include local import duties or taxes.
- Product shipping costs depend on delivery country
- Customers with Solution Partner status are eligible for product discounts.

### SentiVeillance SDK

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
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<tbody>
<tr>
<td>SentiVeillance 7.1 SDK</td>
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### SentiVeillance components installation licenses (price per video stream)

<table>
<thead>
<tr>
<th>Modality</th>
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<tbody>
<tr>
<td>Face modality</td>
<td>€ 200.00</td>
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<tr>
<td>VH (Vehicle/Human) modality</td>
<td>€ 200.00</td>
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<tr>
<td>ALPR modality</td>
<td>€ 200.00</td>
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### License management

<table>
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<tr>
<th>License</th>
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<tbody>
<tr>
<td>Volume license manager</td>
<td>€ 16.00</td>
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### SentiVeillance SDK enterprise license

<table>
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<tr>
<th>Product</th>
<th>Details</th>
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<tbody>
<tr>
<td>SentiVeillance 7.1 SDK enterprise license</td>
<td>Contact us for more information</td>
</tr>
</tbody>
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SentiVeillance SDK and related products can be ordered:
- online, at [www.neurotechnology.com/cgi-bin/order.cgi](http://www.neurotechnology.com/cgi-bin/order.cgi)
- via a local Neurotechnology distributor; the list of distributors is available at [www.neurotechnology.com/distributors.html](http://www.neurotechnology.com/distributors.html)