



Sentinel is a system that recognizes people in a video feed and is able to follow their movement through a venue over time.

Applying object recognition techniques, Sentinel recognizes human shapes from images in a video stream based on their appearance, including features like bulk, clothes color and height. This enables Sentinel to discern people from the background and to enable implementing capabilities such as people counting, tracking people's movements and searching for a like match among individuals previously "seen" by the video cameras.

How it works

Sentinel processes digital video streams from one or more cameras deployed around the monitored area. It is often possible for the system to use cameras already installed in a venue.

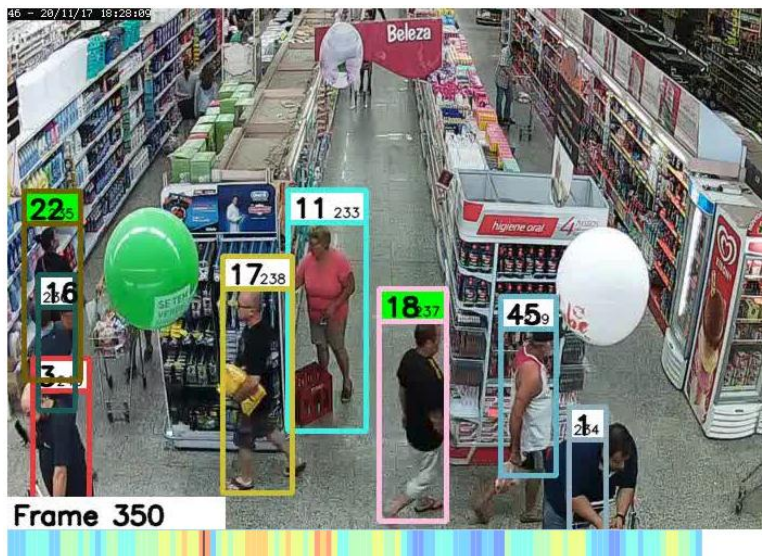
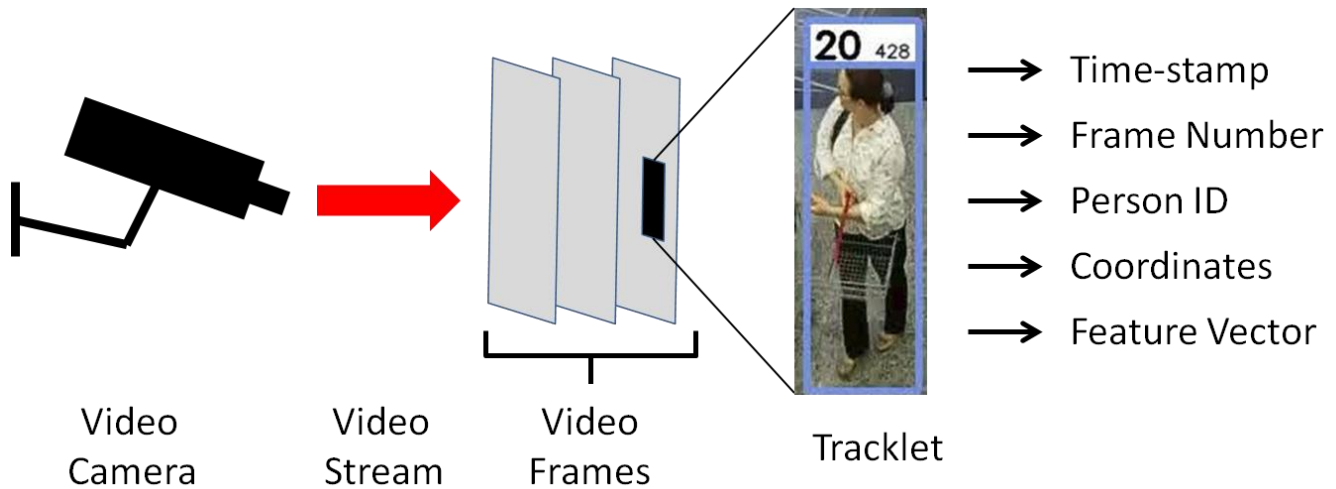


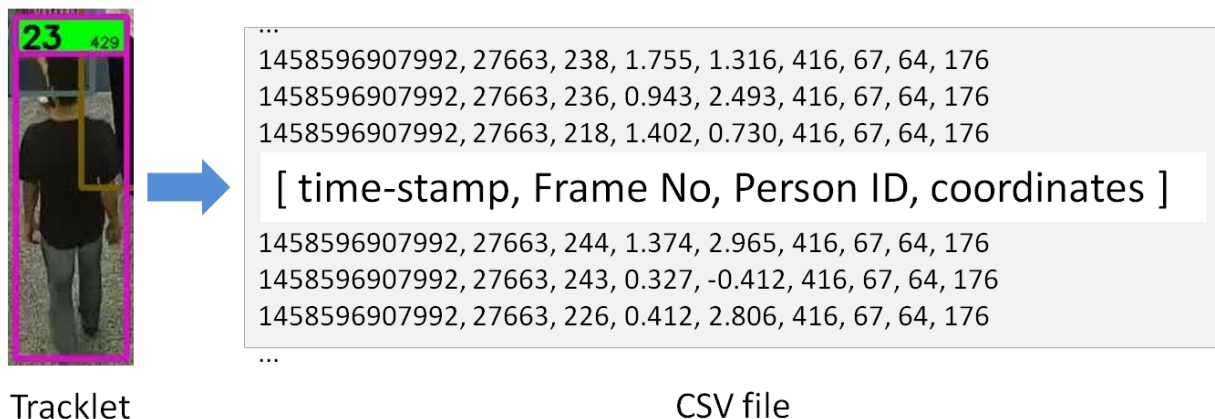
Figure 1 Sentinel operating in a retail store

Recognizing people in video streams is done as follows:

- Sentinel analyzes images from the video streams, recognizing people, assigning each of them a unique **Person ID**, as well as a **Feature Vector** that encodes the person's appearance.
- The actual image of each individual recognized by the system is saved as a **tracklet**. All tracklets are collected into a database, each of them identified by a **Tracklet ID**.



- For as long as a person remains in the camera's field of view, their ID remains unchanged. That person's location and movements are then tracked over time.
- Sentinel creates a **record** for each tracklet. The record includes: timestamp, **Frame Number**, Person ID, Feature Vector and coordinates which identify the specific tracklet within a frame. This data enables historical search of individuals whose appearance matches those in a given tracklet.
- Periodically, Sentinel outputs a CSV file containing data from records of people recognized by the system during the previous time window. The time window covered by a CSV file is configurable. By default, CSV files are output every 5 minutes.



- An external system may periodically upload and convert these CSV files issued by Sentinel to build other applications. For example, a dashboard with search functionality based on individuals' appearances.

Recognizing individuals

Note that Sentinel's functionality is not face recognition but a complementary technique that can recognize and follow individuals even when they face away from the camera.

Person ID	Note that the same person may be assigned different IDs at different times. If individuals leave the scene and later re-enter it, new IDs may be assigned to them if their appearance is somewhat different because of varying lighting conditions.
Crowds	Recognizing people in a busy scene is challenging. Occlusion (people obscured behind other people) and groups where individuals cannot be picked apart are real possibilities. People counting applications must take into account that these counts are approximate.
Recognition	People on screen must be at least 30 PX wide to be recognized.
False positives	Some anomalies should be expected, such as recognizing a human shape displayed on a poster as if it were an actual individual in a scene.

Video Streams

Digital / analog video	Sentinel can process video streams from digital and analog cameras. Analog camera streams must go through a DVR to provide remote access.
Color video	Visible color video streams are recommended.
Black & White video	Supported.
Infrared video	Not supported.
Resolution	Camera resolution depends on scene complexity: <ul style="list-style-type: none"> Monitoring a close up view: 320x240 PX may be sufficient. Monitoring a busy scene: 1,280x720 PX / 720P / HD is required.
Frame rate	At least 7 frames per second (fps); 10fps or more is recommended
Scene lighting	Must have good visible lighting conditions. Works fine in outdoors settings unless there are extreme lighting conditions like sun shining directly on the camera.
Video accessibility	Video stream must be accessible remotely through a URL. Processing of standalone video files is supported for integration with analog cameras and other video management systems.
Angles of view	Angles of view up to 90° are supported.

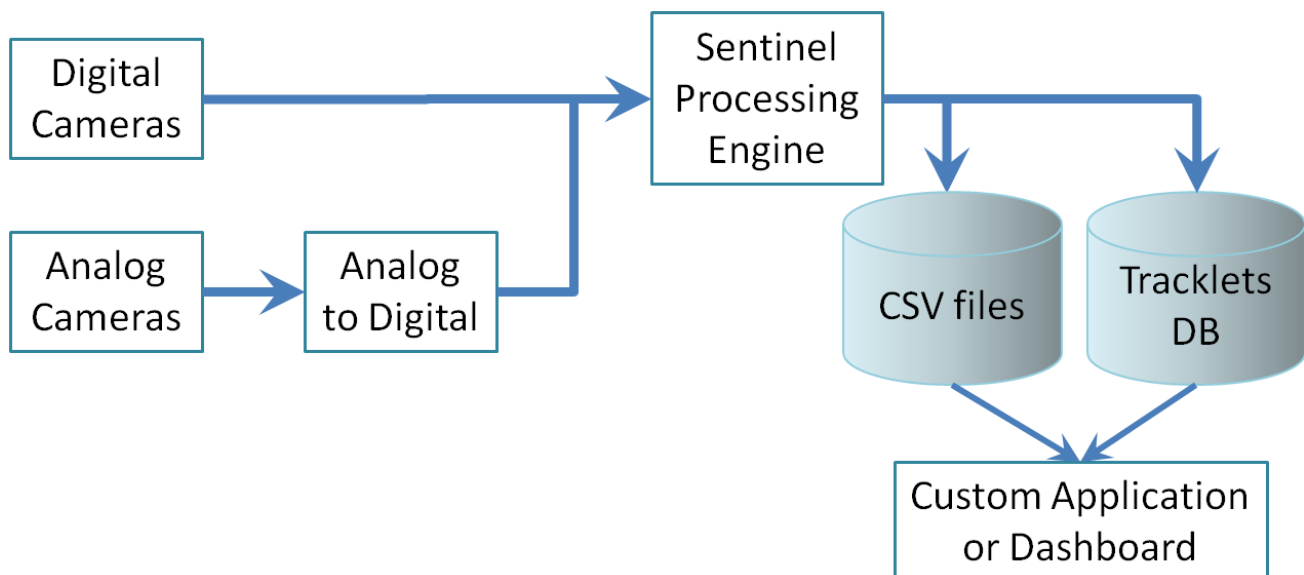
CSV Files

Each record in the file has these fields:

Timestamp	Default format is UNIX Epoch time in milliseconds. Alternatively: number of milliseconds elapsed since the beginning of the video.
Frame Number	Every frame in a video stream is assigned a consecutive number.
Person ID	As assigned by the processing engine.
Coordinates	Describe a tracklet's position and the box that surrounds the tracklet on the frame: <ul style="list-style-type: none"> Tracklet X, Y: mid-point of the tracklet's bottom (i.e. at the person's feet) Box position & dimensions on the frame: X, Y, width, height (Unit: pixels)

System architecture

Sentinel runs on a local server, receiving video streams from one or more cameras. All streams contribute to Sentinel's tracklets database, each tracklet identified by a **Tracklet ID**. Each tracklet represents an instance of a person being detected, tracked and tagged with a **Person ID**. The sum of all active Person IDs at any one time enables people counting, and can also be used for building heat maps of human activity in the venue.



Integration with Sentinel can be implemented in multiple ways. The simplest is to have both CSV files and tracklets be memory resident, for faster search. A custom dashboard may provide system management and monitoring functions, in addition to capabilities for visual comparison search through the tracklets database.

Features



An individual's location in a venue, computed by Sentinel's processing engine software.



Location is provided as latitude, longitude and level.



Sentinel can be used in venues that may be fully indoors, outdoors or a mix of both.



Once properly calibrated, Sentinel delivers average location accuracy better than 1 inch or about 2.5 centimeters.



Search Alike enables finding video images of people previously seen by the system whose appearance matches a specific individual.

System Components



One or more **video cameras** deployed in a venue.



Sentinel **processing engine** software to analyze the video stream captured by the cameras.



An online **dashboard** for managing the site's data.

For more information

Visit our website: <https://www.sentinelcv.com/>