Axis people-counting technologies

Aspects for system integrators and end customers

September 2020

Table of Contents

1 Introduction

People-counting technologies are widely used in many types of businesses and public locations. By automatically counting the number of persons that enter and exit, people counters provide visitor statistics that enable businesses to analyze trends and optimize their operations.

This white paper presents the basics of video-based people counting analytics. It pays extra attention to the factors that influence accuracy and what you as a system integrator or end customer can do to ensure an optimal installation. This paper also outlines the 2D and 3D people-counting products in Axis portfolio and their typical use cases.

2 Background

Figure 1. People counting offers retailers and other service industries a way to capture and analyze customer data from their locations.

In retail, knowledge of the number of visitors in different stores, as well as in different areas of a store, provides management with possibilities to calculate conversion rates, evaluate campaigns, and allocate staff to the areas where they are needed most. For museums and libraries, people counting can help collect visitor statistics, which may be required in order to receive the appropriate government funding. Sports facilities, event companies, and many other types of organizations may also need to monitor the number of visitors or so-called foot traffic or footfall of their establishments.

Visitor statistics is a factor with a potentially large financial impact and it's imperative that the people-counting algorithms are reliable and that the people-counting devices are installed in a way that optimizes their operating conditions.

Today, there is a variety of people-counting equipment available, ranging from low-end infrared beams to high-end sensors based on camera or radar technology. Each technology comes with pros and cons, but Axis focuses on camera-based solutions where a camera acts as a sensor that provides data. Axis people counting includes tools for easy deployment, maintenance, and data collection.

Figure 2. A people counting system requires a counting device and applications that manage and visualize the data.

Camera-based people counting may give rise to concerns about privacy and data security. Many applications, including Axis people counting products, come with the possibility to disable the video stream and store nothing but the numeric count data.

3   How does people counting work?

The camera to be used for people counting is typically placed above the area where you want to count entries and exits. Authorized users can then view real-time and historical statistics from any device and location. The system is easy to add to an existing IP network.

People-counting applications are typically designed to count objects with the characteristics of an adult pedestrian. They register moving objects of a set minimum height within the counting zone, an area set by the user within the camera's field of vision. The exact height limitation of the object depends on camera model, camera lens, and the selected counter sensitivity, but the software generally discounts children and objects such as shopping carts and luggage. The algorithms often have the ability to adapt the counting zone to various types of entrances, for example, revolving doors, escalators, and elevators. Ideally, cameras can also be paired to enable counting across large entrances.

People counting can be based on a monoscopic camera (having one lens, or sensor), in which case it can be referred to as a 2D solution. 2D people counting recognizes objects moving in one plane in the camera's field of view and can identify them as people due to their overall size and movement.
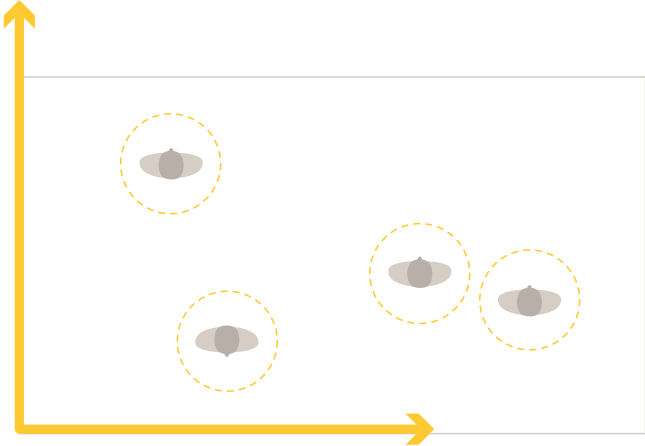

Figure 3. A 2D solution registers moving objects on one plane, seen from above.

People counting can also be based on a stereoscopic camera (having two lenses, or sensors), which is referred to as a 3D solution. Stereo imaging enables the creation of a three-dimensional depth map that helps improve the accuracy by overcoming challenging situations where there are shadows, strong sunlight, glares, or high flows of people to or from a location. The depth map also allows the 3D people counter to avoid counting objects below a set minimum height, such as carts and strollers. In addition, there is no need to remove merchandise, displays, or shelves in the counting zone.
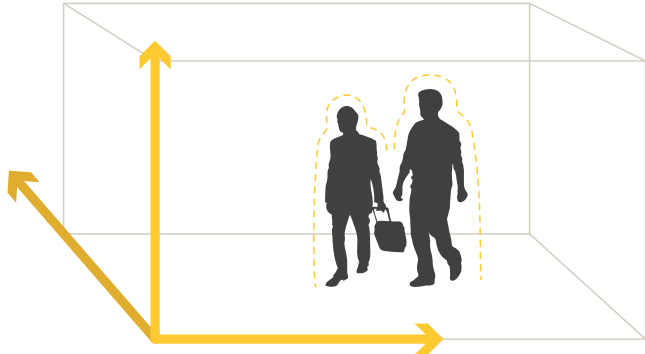

Figure 4. A 3D solution uses information from its two sensors to evaluate depth in the image (while still registering from above).

With higher processor capacity in modern cameras, leading algorithms for 2D people counting today offer an accuracy in line with 3D people counting. But due to the stereo vision, a 3D solution may be more suitable for crowded scenarios and scenes with challenging light conditions. For example, in an

environment with intense sunlight, a 3D solution is able to filter out the shadows, while a 2D solution might produce false counts by interpreting shadows as people.

Figure 5. A scene with challenging light creating long shadows. A 3D people counter will immediately determine that the shadow has no depth, and discard it.

4   Axis people-counting products

People-counting video analytics software can come embedded in a dedicated camera or as a separate software that can be uploaded to a camera of choice. Axis offers the analytics AXIS People Counter, which can be uploaded to any compatible Axis camera, and AXIS P8815-2 3D People Counter, which consists of a dedicated camera with embedded analytics. Both solutions provide reliable results when properly installed in suitable locations.

AXIS People Counter is a 2D solution that can be used on a wide range of Axis cameras. This makes it an easy addition to a surveillance site standardized on a specific Axis camera model or when there are special requirements on camera capabilities and features.

AXIS P8815-2 3D People Counter is a custom-designed stereo camera for professional 3D people counting. It's easy to install with the application pre-loaded and no need for any additional license for the people counting application. It's versatile and can be installed in challenging situations with high demand on accuracy, high traffic flows, difficult light conditions, and advanced counting zone configuration.

5   Integration and data management

Axis people counting applications are edge-based, meaning that they store the data directly on each camera, requiring no other hardware. Edge-based people counting has several advantages besides being cost-effective. At the location, there is less equipment that takes up space, needs to be maintained, and supported. Storing data on the edge also reduces the bandwidth requirements.

There are many ways for an authorized user to access the data. For example, you can view or download real-time or stored counting data and statistics in the application's webpage. You can also use the data push functionality to send data automatically to a remote HTTPS destination. Static raw data can be downloaded in various formats through an open API (application programming interface) in the camera. The people counting solutions can also be used with AXIS Store Data Manager, which is a locally run software for easy integration of data with third-party business intelligence applications, or the web-based statistical service AXIS Store Reporter, which is ideal for multi-site and multi-camera installations.
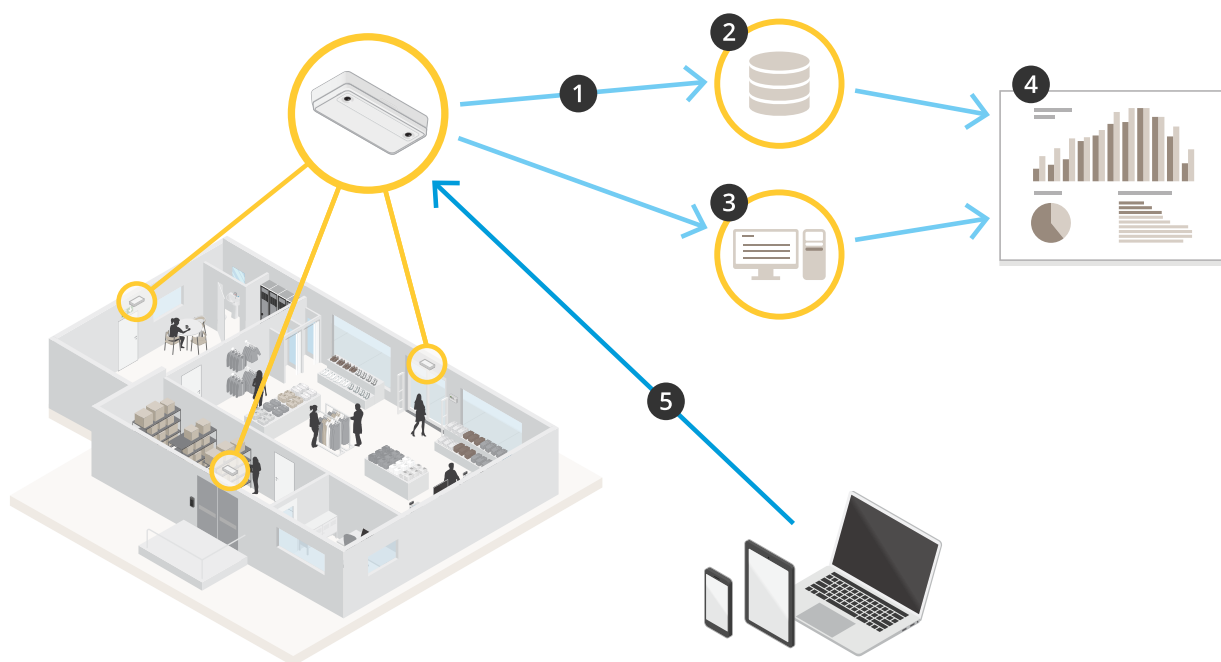

Figure 6. Integration of people counting is possible through automatic data push (1) to a remote HTTPS destination where a database (2) or service such as AXIS Store Data Manager (3) stores the data. The collected data can be visualized using a reporting platform (4). Alternatively, third-party applications request data directly from the device through a built-in API (5).

6 Accuracy

The accuracy of people-counting analytics is a complex matter that neither can nor should be reduced to a general accuracy percentage. Every installation is different, and the accuracy will depend on an intricate mix of environmental factors, which is not reproducible between sites.

6.1 About general accuracy statements

At Axis, we don't provide an overall accuracy number of our people-counting products. Such a number would be correct only in a laboratory test setup, which would inevitably be different between different manufacturers. In order to be able to state a value, such as 97% accuracy, you would have to make estimations of so many factors that depend on the environment and the installation choices. In order to avoid any misleading accuracy declarations, Axis focuses on offering the expertise of our sales engineers, online tools, and recommendations regarding the installation environment to help our customers provide optimal conditions for reliable people-counting.
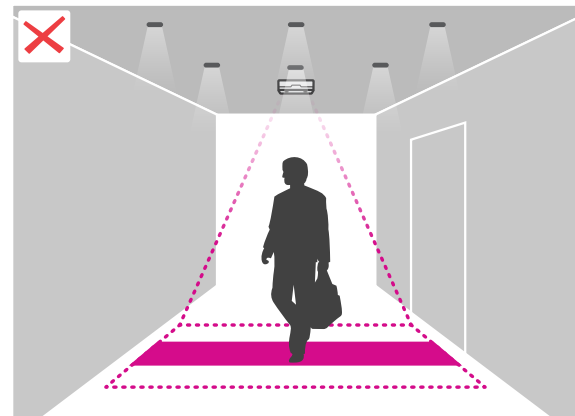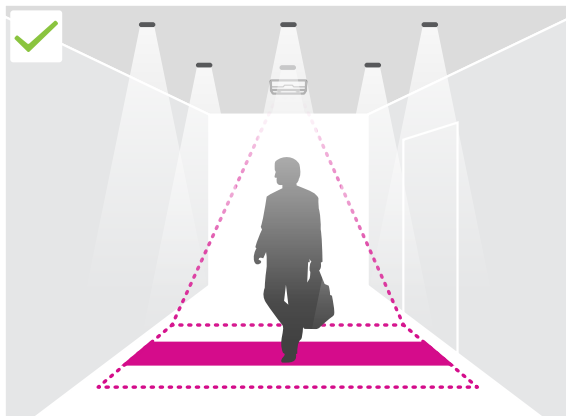
6.2 Environmental factors

Installation considerations for optimal results:

- Place the camera straight over the area where people are walking. Make sure that it is looking straight down and is not tilted.
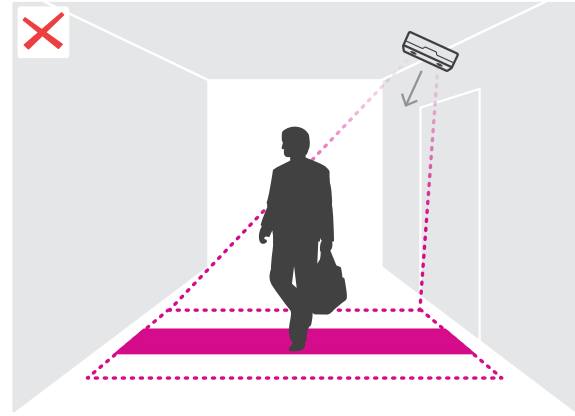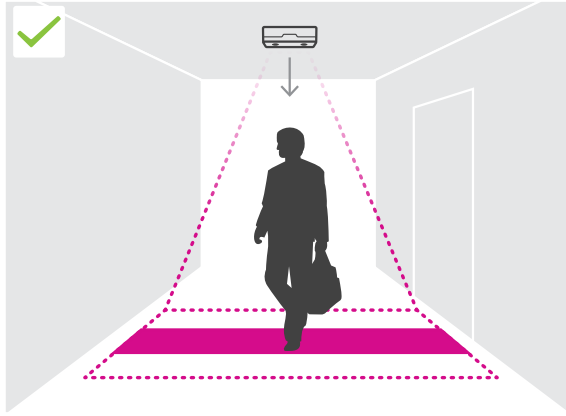
- Place the camera where there is enough light but avoid having direct sunlight into the counting zone.

- Place the camera where there are no moving objects interfering with the counting zone, for example, doors that open into the zone.
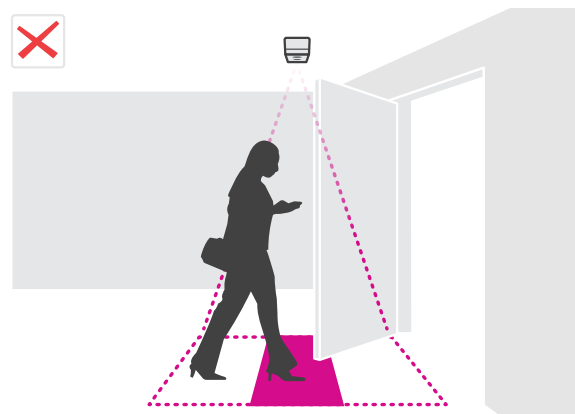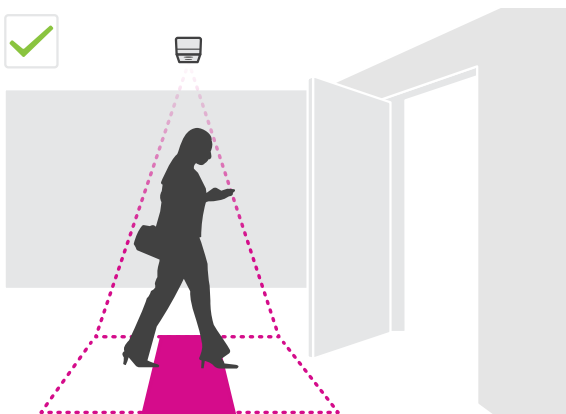
- Use the appropriate number of cameras to suit the width of the entrance. If the effective counting zone doesn't cover the whole entrance width, adjust the camera placement or review the number of cameras. Axis provides tools that can help you choose the right design and number of cameras based on height and width of the entrance.

6.3 Testing the accuracy of your installation

You can test the accuracy by performing manual counting for a period of time, either in person or using live-streamed or recorded video and compare the count with the analytics-counted result for the same period. However, it should be noted that manual counting is far from 100% accurate, especially in crowded scenarios with many people entering and leaving at the same time.

The recommended way of assessing the accuracy through manual counting is the following: Start by measuring accuracy for people going in only. Make a note of the total count on the counting unit and immediately start counting people manually until reaching 200 people going in. Immediately note the total count on the counting unit and compute the difference which will be #IN. The error percentage is given by the formula (#IN - 200)/2. Then repeat the same procedure for people going out.

Another method is to compare IN minus OUT for a period. A simple measure is to compare the total number of people entering and exiting a facility over a day. The deviation between entering (IN) and exiting (OUT) is calculated to get an accuracy value each day of the month. A common formula is given by: *(IN-OUT)/(IN+OUT)x200* which gives the error percentage. This method may get complicated if there are several entrances to the facility. In that case, counting must be done at all entrances and exits and compared with the total count, and the accuracy of a single specific sensor unit can't be measured.

6.4 Installation support

The web manuals provide guidance on how to install Axis people-counting products for optimal counting accuracy. The product pages on axis.com also link to other resources, for example:

- AXIS P8815-2 3D People Counter Deployment Tool: provides guidance on how many devices you need to ensure proper coverage as well as proper distance between the devices.

- Camera selector for retail analytics: lists camera models that are pre-calibrated to achieve the best accuracy for AXIS People Counter analytics.

- Installation and configuration videos.

About Axis Communications

Axis enables a smarter and safer world by creating solutions for improving security and business performance. As a network technology company and industry leader, Axis offers solutions in video surveillance, access control, intercom, and audio systems. They are enhanced by intelligent analytics applications and supported by high-quality training.

Axis has around 4,000 dedicated employees in over 50 countries and collaborates with technology and system integration partners worldwide to deliver customer solutions. Axis was founded in 1984, and the headquarters are in Lund, Sweden

AXIS®
COMMUNICATIONS