



## BAR CODES IN INTRALOGISTICS – HOW TO TACKLE COMMON PROBLEMS

**WHITE  
PAPER**

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# Bar Codes in Intralogistics

According to market analysts the global intralogistics market is expected to surge at a compound annual growth rate of 15.5 percent from 2020 to 2030<sup>1</sup>. To achieve this growth rates, the technical innovation in the intralogistics supply chain needs to continue to move forward. A key factor for innovation in intralogistics has always been the application of bar codes. This has led to the idea to provide a white paper which highlights typical challenges in bar code reading and demonstrates how these can be addressed with the help of innovative image processing libraries that can already be purchased today.

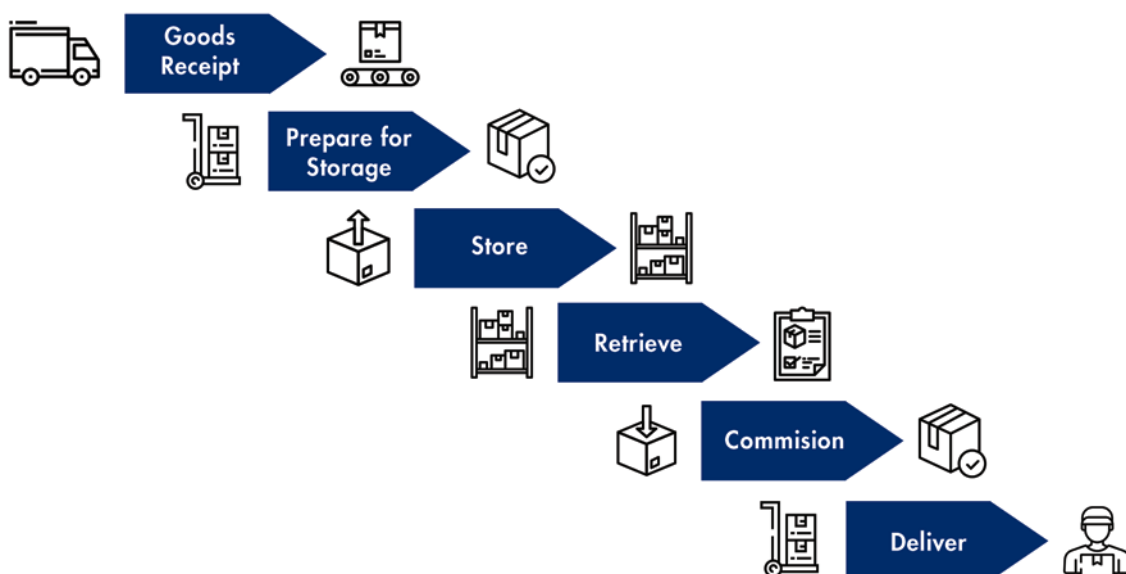
## Short History of Logistics and Bar Codes

In former times the transportation in plants relied on simple equipment, like bag carts, trolleys and overhead cranes. During the 1950s this situation changed, due to new transportation methods. Pallets and forklift trucks developed by the military found their way into the industry through standardized loading devices in the shape of containers and the pallets pushed the development of stacker cranes. Because of the new needs of the buyer's market in the early 1970s the industry needed new solutions for warehousing. This was the reason that a patent from 1952, which was initially used to label railroad cars, made its way into warehousing and finally in 1974 into the supermarkets. In June 1974 at a Marsh's supermarket in Ohio a chewing gum pack with the first bar code ever in a supermarket was sold and started the still ongoing revolution of logistics.

In 2003/2004, the term "intralogistics" was created by the Intralogistics Forum of the German Engineering Federation (VDMA) in order to distinguish the constantly increasing demands on the logistical flow of materials and goods that take place within a plant from the transport of goods outside a plant. The simple "transport, handle, store" has become a highly complex matter with automated high-bay warehouses, autonomous vehicles and digital goods distribution systems.

The VDMA defines "intralogistics" as follows: "Intralogistics refers to the organization, control, implementation and optimization of the internal flow of materials, the flow of information and the handling of goods in industry, retail and public facilities." This definition helps to differentiate intralogistics from general logistic processes and helps sharpen the perspective for the processes explained further in this paper.

Common process chain in intralogistics



<sup>1</sup> [Robotics and Automation News \(2021\)](#)



# Applications for Bar Codes in Intralogistics

Bar codes have revolutionized warehousing and the industry in general and we cannot imagine a world without them. There are many applications where bar codes help to steer the flow of goods through a warehouse. In this white paper we will take a closer look at the most important ones which usually play a key role in every warehouse. Because other solutions like RFID tags, laser-based bar code readers or 2D data codes add often unwanted complexity, image-based bar code reading is more and more the solution of choice to optimize the intralogistics process chain – therefore we focus on applications for image based bar code reading in this paper.

## Identification and Parts Tracking

Identification in a warehouse is a crucial process to track parts from incoming to outgoing and provides a constant stream of data regarding the location of a part and its progress through the intralogistics chain of processing. Tracking the parts with bar code labels enables a clear view of every part in the warehouse and gives access to a history of whereabouts of every part.

## Palletizing

Palletizing can be at the interface intralogistics/logistics or part of an intralogistics distribution process. Palletizing is a vital part in order to distribute goods to different warehouse locations or even to deliver the goods to the final customer. Bar codes help to steer the stream of goods to the right locations and separate the goods according to the needs of the intralogistics process chain.

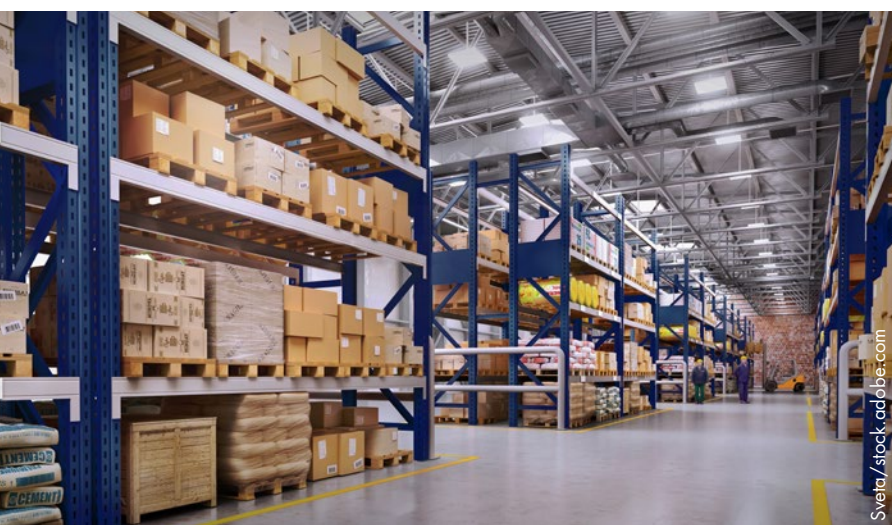
## Manual Induction

While more and more automatization and automated processes are part of the intralogistics process chain, manual induction of parts and goods still plays a vital role in many warehouses and distribution locations. While simple handheld scanners still hold a huge market share, there are more innovative solutions arriving at the market. For example, some manufactures offer augmented reality applications, where the bar code automatically provides the information for the worker about the part. With collaborative robotics on the rise, many human-machine-interactions can be expected to change the manual induction process in the future.



*Manual induction of goods is often still a part in the process chain of many intralogistics processes.*





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## Warehouse Management

Bar codes enable a sophisticated warehouse management with real time overviews and intelligent distribution algorithms in place. Intelligent algorithms make it possible to store goods in a 'chaotic' warehouse and optimize the use of the available space and resources.

*Warehouse management with ERP systems is not thinkable without identification.*

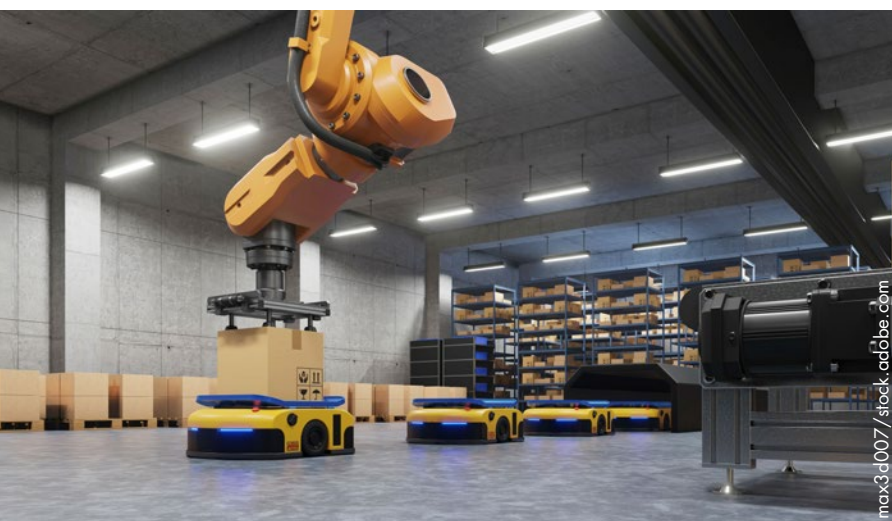
## Sorting and Shipping

While labeled cases enable tracking goods and parts in charges, labeled parts can be individually sorted and commissioned for shipping and distribution. Bar codes help to identify parts, charges and enable to mix and sort products as needed.

*Commissioning, sorting and delivering goods is a process which relies on the labeled products, in order to get every order traced and sorted.*



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## Automated guided vehicles (AGVs)

Automated guided vehicles (AGVs) as well as storage and retrieval units become more and more part of the automated warehouse. Bar codes enable them to load and unload their cargo at the desired locations fully automatically.

*Automated guided vehicles deliver goods automatically to free storage spaces*

# Common Complications

## Caused by the Setup

Complications in bar code reading are often caused by the environmental conditions in a warehouse, like inhomogeneous lighting or due distance variations between the image acquisition device and the object.

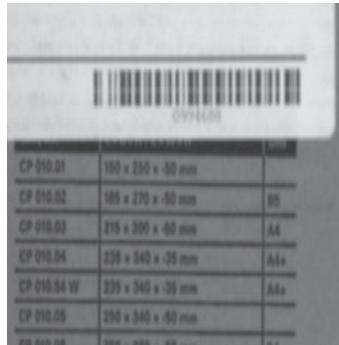
### Illumination problems

Inhomogeneous illumination can lead to errors in the bar code detection algorithms.



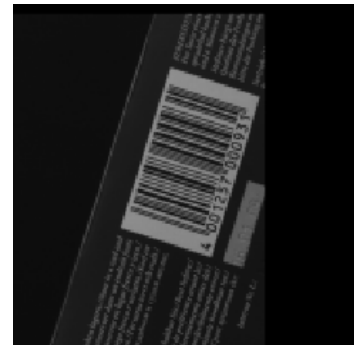
### Blurring

If the image is out of focus, the extraction of the bars can be obstructed.



### Resolution limits

If the bar code bars are hardly separable due to the resolution of the image, the reading often fails.



MVTec Software GmbH

## Caused by Handling and Processing

Furthermore, the perils of the transport process can often cause additional complications in bar code reading, e.g., damaged codes.

### Damaged codes

Due to handling difficulties during transport bar codes are often damaged.



### Disturbed codes

Wrapping foil on e.g. pallets can be obstructing for the bar code reading.



### Print growth/print loss

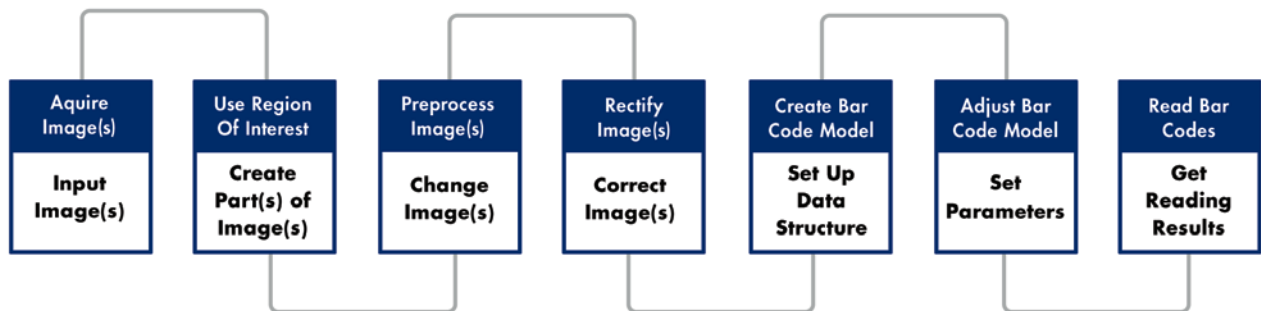
Print growth and print loss error caused by faulty adjusted print equipment.



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# Solution Strategies

Modern image processing libraries offer multiple possibilities to tackle the challenges shown above. MVTec HALCON for example offers a comprehensive vision toolbox with various analysis tools which can be used to check image and code quality.



General processing pipeline to read bar codes as it is proposed for the different tasks involved in bar code reading.  
(Source: [HALCON Solution Guide](#))

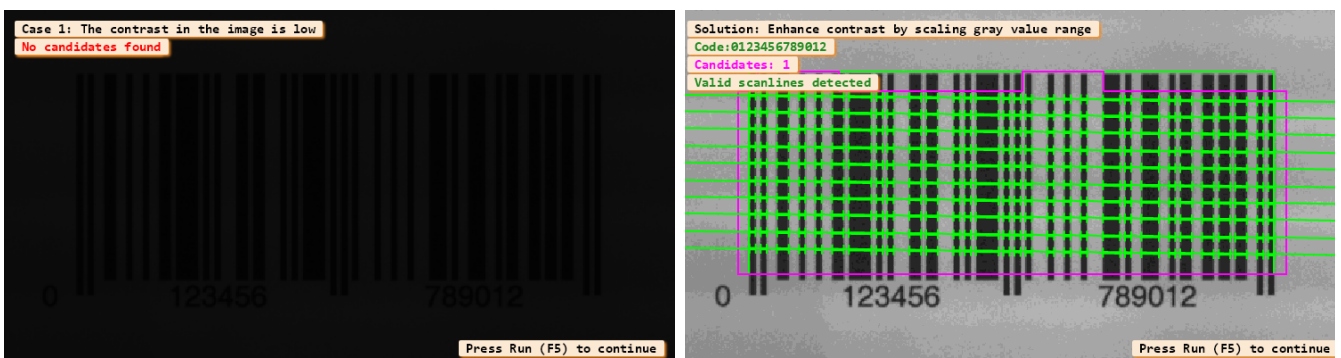
## Multiple Reads

The most common solution for problems caused by the setup is to move the camera and take a series of images. This often makes it possible to get at least one good image and that is how most of the image-based handheld bar code readers handle these problems. While it is a simple solution, it is often not applicable in the general process, as sometimes there is only a single image available. In that case, other methods to mitigate the problem need to be used. We will illustrate those in the following.

## Preprocessing

In general, bar code reading means extracting edges along lines (often called scan lines). Therefore, a strategy to mitigate challenges caused by low contrast or bad resolution is to improve the edges on the image in order to extract those scan lines with higher precision. Improvements can be achieved through contrast enhancement, upscaling, gray value scaling and sometimes contrast inversion.

In HALCON for example, this can be achieved with the operators **emphasize** for contrast enhancement, **zoom\_image\_factor** for upscaling, **scale\_image** for gray value scaling and **invert\_image** for contrast inversion.



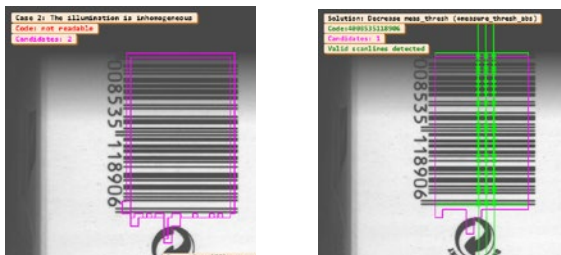
Scaling gray values in order to make a low contrast image readable.

# Adapt Extraction Parameters

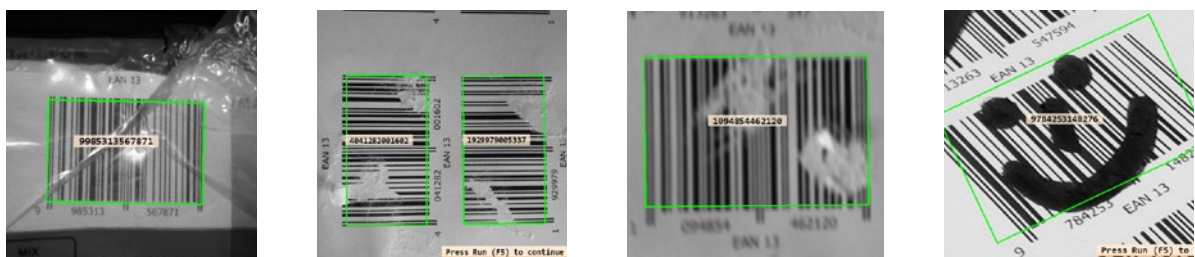
While one strategy can be to improve the image in order to deal with challenges caused by the setup, another strategy is to change the edge extraction parameters and to reconfigure the scan line parameters (e.g., how many to use to read a bar code). This strategy most often leads to success if the bar code is damaged or distorted or blurred.

## Manual Adaption

Image processing libraries often offer a variety of parameters which can be individually adapted for the reading process. This flexibility can help to address difficult challenges. The damaged, blurred and disturbed bar codes shown on page 6 could for example be read by the bar code reader of the HALCON library without any adaption of parameters, as the default parameters are already chosen automatically. So, choosing the right machine vision library for a task has significant implications when it comes to efficiently and effectively solving identification tasks in the intralogistics process chain.



*Solving the bad illumination challenge with an adapted parameter, in this case the threshold for the scanline edge detection.  
(Source: MVTec Software GmbH)*



*Disturbed, damaged and blurred bar codes read without any parameter adaptations.  
Modern image processing libraries utilize years of experience in order to have robust default parameters. (Source: MVTec Software GmbH)*

## Training

In addition, many machine vision libraries also offer the possibility to learn the best extraction parameters using training images. This simplifies the process of parameter adaption if the reading situation is reproducible.



## Subpixel Bar Code Reading

MVtec HALCON even offers another feature for bar code reading in warehouses. Overview images with low resolution of the single bar codes can be read through the propriety technology of subpixel bar code reading. This enables the software to read many bar codes with bars smaller than one pixel.



*In many warehouses, image acquisition devices often take huge overview images of shelves with bar codes. Due to the large field of view the resolution of the single bar codes is not optimal. Subpixel bar code reading enables to solve those problems.*

## Summary and Outlook

In this white paper we have discussed the utilization of bar codes in intralogistics and shed a light on the different applications, common complications and possible solution strategies, offered by modern machine vision libraries. Bar codes are still the fundamental choice for identification tasks in the intralogistics process chain, as their great versatility makes them suitable for many possible application scenarios. Due to the support of Arm®-based platforms, libraries like HALCON can already be deployed with very cost-efficient hardware and therefore it will be possible to automate every process chain step for a reasonable price.

The future still holds a lot of new technical applications for bar codes in intralogistics: Machine vision libraries will for example increasingly support cloud applications, which enable distributed bar code reading and edge applications, and also deep-learning-based solutions, which will improve and simplify bar code reading and boost further applications. Bar code tracing and checking will enable warehouses without any operator and will therefore further revolutionize the intralogistics process chain.

# You need Help Tackling a Problem within Your Machine Vision Application?

You are facing a problem with an identification application or another machine vision application in your warehouse or intralogistics process? You would like to know how to solve it with MVTec software?

Send us your software application design and our experts will review it!

## Benefit from our worldwide partner network

You will get help quickly and easily: Send us the details of your image processing application via our inquiry form. We will find the regional partner for you, who will contact you usually within one week with a draft solution. This partner will then also be available to answer any further questions you may have.

Best of it: This service is free of charge and without obligation.

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