Symbol Reconstruction in Barcoding Applications

Symbol Inconsistency
and Reconstruction Technology

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Symbol Reconstruction in Barcoding Applications

This white paper discusses the challenges associated with capturing data when symbol orientation and quality cannot be predicted. Ensuring readability for inconsistent symbols requires the use of symbol reconstruction technology. Topics of this paper include:

       - Data Capture Challenges
       - Symbol Reconstruction Methodology
       - Rotated Symbols
       - Damaged Symbols
       - Low Aspect Ratio Symbols
       - Configurable Symbol Reconstruction Parameters
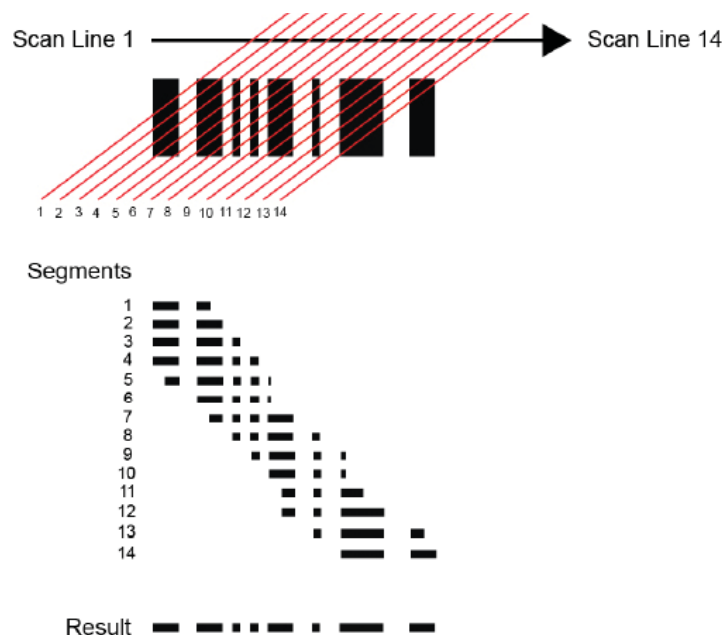
Microscan Systems, Inc.

Data Capture Challenges

Industrial environments present many data capture challenges, some of which are damaged symbols, partially covered symbols, poorly printed symbols, and variation of label placement. Symbol quality, location, and orientation cannot always be controlled. Labels containing linear symbols (Code 39, Code 128, Interleaved 2 of 5, and UPC/EAN, for example) can be torn, partially obscured, overprinted, or underprinted due to variations in print mechanisms. For industrial tracking and traceability to be reliable, symbols must be decoded regardless of damage, label tilt, or any other discontinuities.

A number of industrial automation vendors have addressed the issue of symbol damage with several product introductions in recent years. These products address the need for reliable decoding capabilities in rugged industrial settings. Recent technology, known as barcode stitching or symbol reconstruction, among other terms, allows scanners to rebuild data from damaged or poorly positioned symbols by "stepping though" the elements (bars) in multiple stages and then combining the successfully decoded regions into completed symbol data output.

Symbol Reconstruction Methodology

Symbol reconstruction methodology uses an algorithm that pieces together discontinuous symbol data from multiple scan lines, as demonstrated in this simplified example:
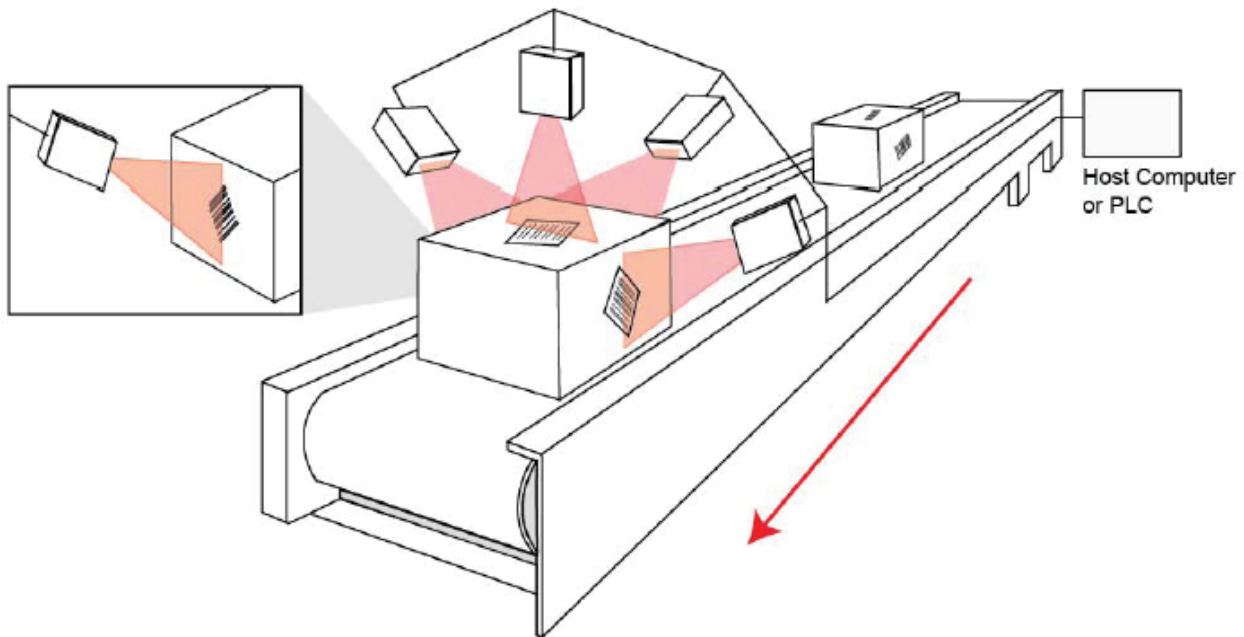
The example illustrates in very general terms how the decoding algorithm combines several incomplete segments of a rotated or damaged symbol into the equivalent of a complete scan line. The data from that complete scan line is then output from the scanner to a host system.

The illustration shows the scan lines intersecting the symbol elements (bars) at an angle, demonstrating how the algorithm reconstructs data from tilted symbols. Reconstruction of damaged symbols is achieved similarly—by combining multiple small, undamaged and decodable "chunks" of symbol data into a single, continuous data string.

Rotated Symbols

In some packaging applications, operators may have little or no control over label placement, which can lead to unexpected symbol orientations. Symbol reconstruction allows the scanner to decode tilted symbols that would otherwise result in No Reads. The image below shows single-line laser scanners decoding rotated symbols. A single-line scan beam is preferable to a fixed raster when performing symbol reconstruction on rotated symbols.

Damaged Symbols

Track, trace, and control applications have the potential for symbol damage as parts move through the manufacturing process. Symbol damage can take many forms, including torn labels, eroded ink from friction or moisture, or unintended markings that partially obscure the symbol. Symbol reconstruction algorithms are able to identify multiple undamaged areas of a symbol and then piece together those areas to create the equivalent of a complete scan line. The complete data string from that scan line is then sent to the host.

Using symbol reconstruction technology, this Code 39 symbol with tilted and partially-obscured elements (bars) was successfully decoded by a QX-830 laser scanner from Microscan. The reconstruction algorithm enabled the scanner to work around the tilted and blocked elements by combining multiple decodable segments into a complete symbol decode.
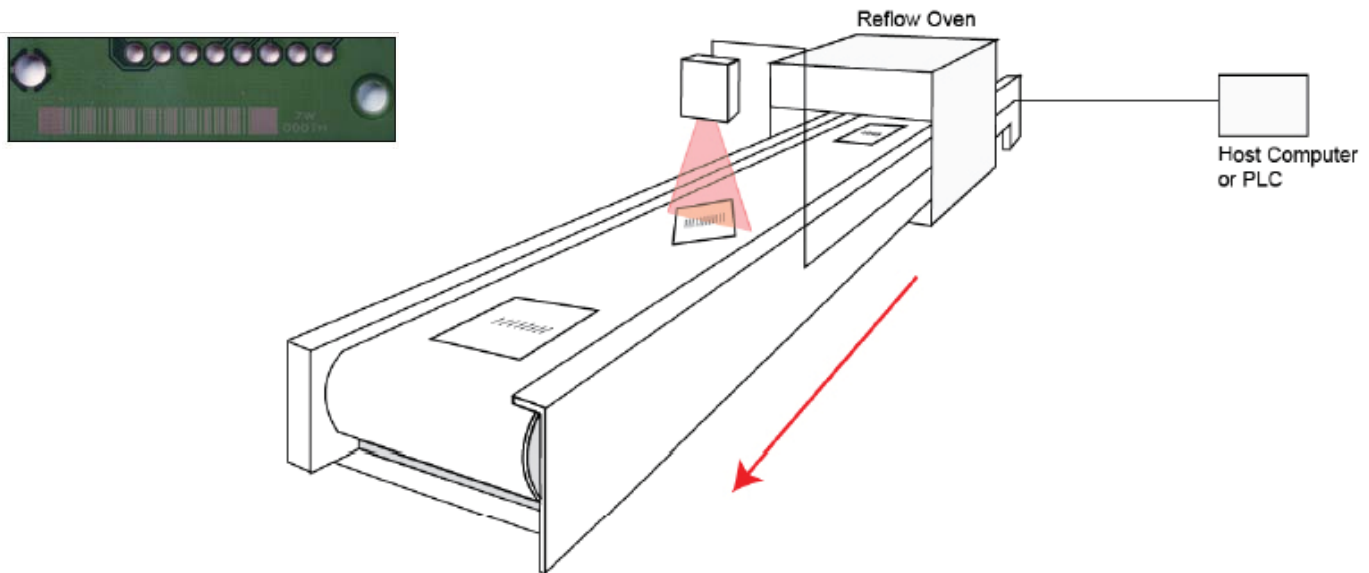

This Code 39 symbol was also decoded by a QX-830 scanner using symbol reconstruction. The reconstruction algorithm enabled the scanner to decode the symbol as a whole, despite the multiple locations of interference in the upper right and lower left corners of the symbol, and the mark intersecting several of the middle bars.

Low Aspect Ratio Symbols

Symbols with low aspect ratio are often difficult for traditional laser scanners to decode, due in part to the fact that placement cannot always be controlled to ensure that the scanner will be able to achieve a continuous scan line through the entire symbol. In applications where there is little or no ability to control the rotation of symbols, a single-line laser scanner will provide the best decode performance. In applications where control of symbol rotation is possible, a fixed raster scanner will provide the best decode performance.

It is also important to note that slow-to-average line speeds (1 to 15 inches per second) offer greater flexibility and reliability when choosing the ideal laser scanner for a given application. The image below shows a laser scanner decoding a low aspect ratio symbol on a printed circuit board in an electronics manufacturing application.

Configurable Symbol Reconstruction Parameters

Symbol reconstruction parameters allow the user to determine the level of redundancy (the degree of redundancy check that will be used to qualify the reconstruction results) and effort (the amount of processing that will be applied to the reconstruction process) that will be used by the scanner in attempting to decode a candidate symbol. The purpose of redundancy checking is to ensure that the symbol has been decoded correctly. The redundancy check is used to qualify the result of the symbol reconstruction process. Set the redundancy to Low, Medium, or High, depending on the quality of symbols being used in the application. If the application is using high quality symbols, the Low setting provides satisfactory redundancy checking. A higher level of redundancy ensures greater data integrity, but may also require a higher level of effort to decode. The purpose of the effort parameter is to determine the amount of time the system will spend identifying candidate symbols and the amount of processing (Minimum, Medium, or Maximum effort) applied in reconstructing and decoding those symbols. A higher effort level may slow decode performance as the scanner runs through all options for reconstructing and decoding the symbol.

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