SPOTLIGHT feature

LIMS & Lab Automation

Barcoded Tube Rack Readers for Automation

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There are several manufacturers of 2D-barcoded rack readers for SBS/SLAS format tube racks and virtually all of them claim that their unit can be integrated with a laboratory liquid-handling robot. So how easy it is in reality?

Why add a barcode reader to the automation platform?

This may seem obvious, but there are actually good reasons not to add the reader to the platform. Most robots are designed with a certain number of spaces on the 'deck', or operational area, in which defined functions can be carried out. Whilst it is true that the robot can be specified with more or less deck positions, the initial cost of the instrument increases as more positions are added. If the throughput of a laboratory using barcoded tubes is relatively low, it may not be sensible to dedicate one area of the deck just to hold a barcode rack reader. Instead the stand-alone unit can be on the bench nearby or in the sample processing area.

When to add a reader?

As throughput increases, it makes more sense to integrate a barcode rack scanner directly with the robot. Firstly, it saves bench space and secondly it can help to eliminate errors between reading the rack at a remote location and positioning it on the robot deck. This is normally caused by switching the orientation of the rack during transfer, which sounds simple and obvious, but occurs more often than you might think! However, a linear, or 1 dimensional, barcode on one short edge of the rack can help to eliminate this issue, as the rack can then only be read in one, correct, orientation. Many barcode rack scanners can also be fitted with a linear reader to facilitate this, but robots can also carry their own linear barcode readers.

Where to put the reader?

There are two options for integration with an automation platform, either on-deck or off-deck. Off-deck in this case would mean adjacent to either the left or right short side of the system and this can be the most convenient position, especially if the reader is rather high in construction. On-deck allows easier access by the gripper arm and dispense needles in most cases, but can, of course, take up more than one plate position with most reader designs. The exception is the Ziath Express (*Figure 1*) which has a footprint not much greater than an SBS plate/rack and therefore only uses one position on some automation platforms. Another consideration will be where to run the power, signal and control cables for the scanner. In some basic units, these may be combined into one cable, usually a USB, but this limits the amount of power available for illumination of the rack underside during reading.

Figure 1: Express linear reader with TraceTraq 0.75ml yellow push caps.

How high can you go?

Reader height is a big consideration if an on-deck integration is required. Some manufacturers of camera-based readers use relatively tall housings in order to achieve the longer focal length necessary to read tubes of different base heights - that is the height of the tube base in the rack relative to the scanner glass. The apparent depth of field and the point of sharpest focus are critical to successful reading. By using pin-hole cameras with a longer focal length, the depth of field can be increased, but at the expense of a higher instrument. Ziath has solved this problem in the Datapaq Mirage design (*Figure 2*) by using a 45-degree mirror to maintain focal length while reducing the height of the instrument. In the Datapaq Express design from Ziath, four separate cameras are used to divide the rack image which is later re-combined in software. By imaging only part of the rack area with each camera, the focal length can be shorter than that of a full rack imager and the scanner height can again, be kept to a minimum. A similar strategy is employed in the Ziath Cube scanner (*Figure 3*) which uses two cameras to image the larger cryo-racks, in addition to the SBS format.

Figure 2: DataPaq Mirage reader.

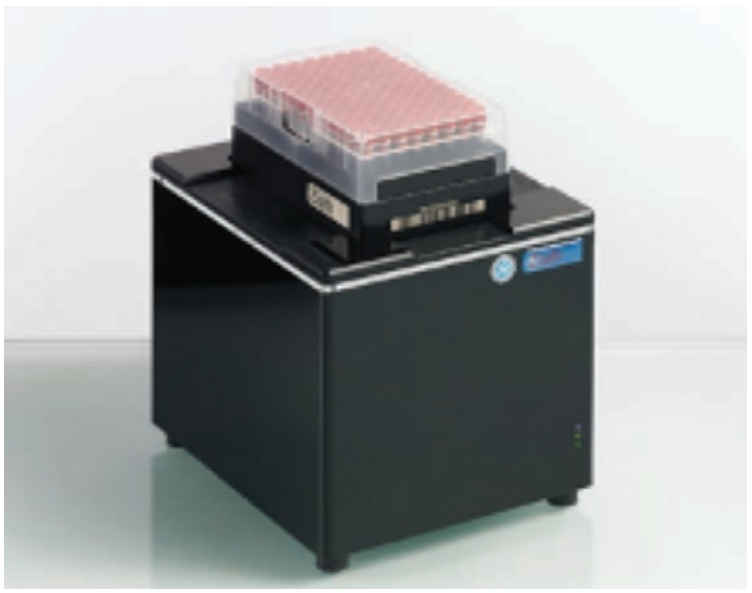

Figure 3: Cube scanner with red screw capped tubes in rack.

Flat-bed or camera based?

Some liquid handlers can accommodate higher instruments, but this is unusual. Those automation platforms which use discrete sizeable 'carriers' rather than a solid level deck, have difficulty accommodating anything that is bigger than one carrier position. If a solid-deck design is in use, then a lower-profile scanner is the best option. For some applications, older legacy designs based on flat-bed scanners have been preferred, but the basic functional units are now becoming obsolete and the scanners built around them are harder to source. Camera-based designs are much faster, have no moving parts to wear out and can read the vast majority of tube types on the market. With designs such as the Ziath Express, the control functions are in a separate box which can be stowed beneath or behind the robot, leaving only the optical unit to be accommodated on the deck; an obvious advantage. Even Ziath's one-box solution, the Mirage, will fit on most decks, benefitting from a clever optical design that helps keep the overall form low.

Ease of Integration

When selecting a scanner for integration with your robot it is important to determine in advance what support is available from your chosen manufacturer. In most cases, you will need an API (Application Programming Interface) in order to control the scanner from the robot. The drivers for this may be available directly from the manufacturer of the robot, but if they do not already exist, getting them written for a particular scanner/robot combination can be expensive. Established manufacturers such as Ziath will have APIs available for most of the popular laboratory automation systems. In addition, Ziath offers a 'command line' interface in their software that obviates the need for a driver completely. It can also help to have CAD drawings available as .STP files that allow you to accurately plan the layout of your robotic cell. CAD drawings for the Ziath camera-based scanners are available from their website, highlighting the small footprint and low height of the Express for integration applications.

Conclusion

Choosing the right type of barcode rack reader for your robot is a complex decision which requires careful planning. It is certainly an easy and reliable way to keep track of the many samples passing through your workflow, but mistakes can be costly in this case. Poorly specified readers may not fit the robot or may not accommodate the racks you want to use and, in some cases, may not communicate correctly with the robot control software. In that case, having a wide range of data export formats, such as XLS, XML, JSON, Text and Image can help. The message here is to consult widely with manufacturer's published information and the sales and applications specialists from your chosen vendors to ensure a seamless integration of robot and reader.