Fine Rack Positioning: Vision Technology Enhances Image Capture

TECHNOLOGY BRIEF

The VOS120-FFPL fine rack positioning system for automatic storage and retrieval applications from Pepperl+Fuchs

Automated Storage and Retrieval Systems (ASRS) are at the heart of any fully automated warehousing system. As in all automated solutions, users demand nearly perfect, (i.e., 100%) availability and exceptionally fast operation at the lowest possible price point. While the raw speed of an ASRS along each axis of motion is limited by the selected drives' components, modern sensor technology–the eyes of the ASRS–allows designers to coordinate positioning motion, increasing the effective speed of the ASRS. This type of motion has been common for coarse motion. Coarse motion can be controlled by a number of different solutions from string potentiometers, encoders, long-range sensors with absolute position output, and more recently, precision linear encoders. Fine positioning, i.e., the precision position correction not possible by these previously mentioned technologies, has typically been done one axis at a time. Since fine positioning is done at low speeds, the time penalty is particularly large and, therefore, offers significant room for improvement.

Reliability of the storage and retrieval process can also be enhanced using better sensing technology. It is intuitively clear that storing a pallet of goods at a storage location requires a different tool motion than retrieving the same pallet at a later stage. This is especially true when the loads are high, resulting in appreciable deflection of the retrieval tool (e.g., the forks). When an ASRS approaches an empty storage location, the forks are typically raised by a substantial amount, thus making sure the insertion process is smooth. Next, the pallet is lowered and the forks are retracted. When retrieving the pallet, the forks are inserted in the low position and then raised until the pallet is completely supported. For the smoothest and fastest operation, it is desirable to use a sensor system that can securely detect the two insertion positions independent of load and height above ground. Such a solution automatically compensates for product variances (weight) and storage bin location.

In the past, tool positioning was accomplished by using standard sensors in combination with targets attached to the individual storage bin locations. A common way of detecting the ASRS position is based on using four photoelectric sensors, mounted in a square pattern on the ASRS. Each of the storage locations is equipped with a square reflective metal plate that is just small enough to fit within the beam pattern created by the photoelectric sensors. Besides being time consuming during the build phase, sensor alignment can be a problem, and coordinating xy motion is not possible.

Figure 1 shows such a setup after the tool location has been placed in its final position. The alignment has been selected such that the outputs of all four sensors is ON in this case. It is quite obvious that the precise placement of the target is not only critical but time consuming. Sensor alignment is another possible problem.

Fortunately, a new solution utilizing vision technology addresses those negative aspects and makes ASRS more reliable and faster. The prefabricated support structures used to build large storage bin systems typically come with prestamped holes that eliminate the need for drilling. After the frame is bolted together, there are usually several unused holes. The vision-based system takes advantage of these holes, using them as visual markers for alignment and target position, without the need for reflective metal plates

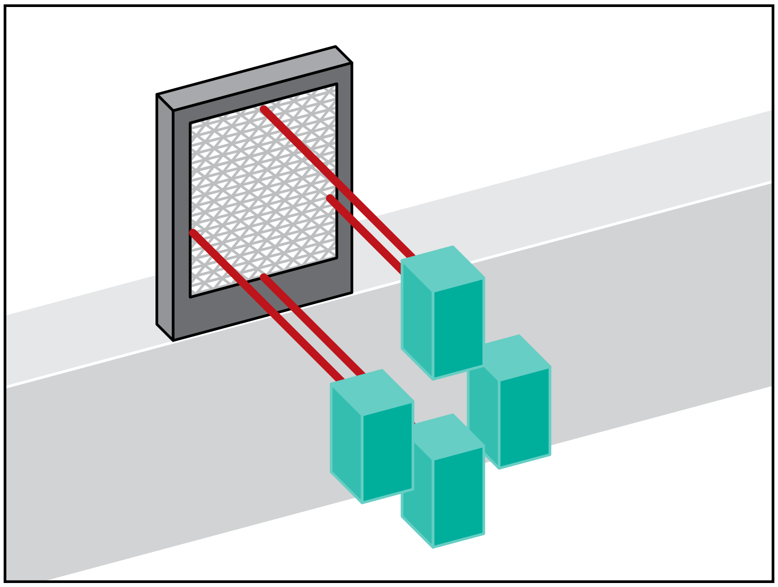

Fig 1: A conventionally constructed fine rack positioning system using four sensors and a reflector. The ASRS has reached its final position if all sensors see the reflector (i.e., the sensor outputs are HIGH). If the ASRS is too far right, the rightmost sensor is OFF, indicating that a correction to the left is needed. Coordinated moves are not possible since the relative offset is unknown; only the final good position can be detected with certainty.

or additional peripheral devices. The labor savings are significant. With no holes to drill and no peripheral equipment to buy, mount, and adjust, manufacturers can build and deliver their system faster and more economically.

Instead of mounting a collection of photoelectric sensors on the ASRS, a single vision-based sensor is attached. This sensor is then taught to find the existing hole and create data specifying the relative offset of the ASRS with respect to the hole. Using this data, programmers can now develop logic that allows the ASRS to approach the desired position along the shortest path possible. Since the position feedback is instantaneous, the programmer can even construct a solution that moves faster when the relative offset is still comparatively high, slowing down as the target position moves closer. Unnecessary overshooting can be omitted elegantly.

When the loads vary, the lifting position of the forks can be adjusted automatically, making collisions between pallets and the storage structure a thing of the past. Similarly, storing and retrieving can reliably use the provided offset from the target hole.

In situations where a more basic, noncoordinated motion solution is desirable, the vision sensor offers four traditional outputs referred to as Y+, Y-, X+, and X-. Each output corresponds to the information "move in that direction." More specifically, if the X+ output is OFF, then the ASRS needs to be moved a bit more in that direction. In this operating mode, the vision sensor replaces the four sensors previously mentioned and removes the problem of precise alignment of both the target placement and sensor array.

In addition to addressing cost and speed concerns of modern ASRS solutions, a vision-based approach

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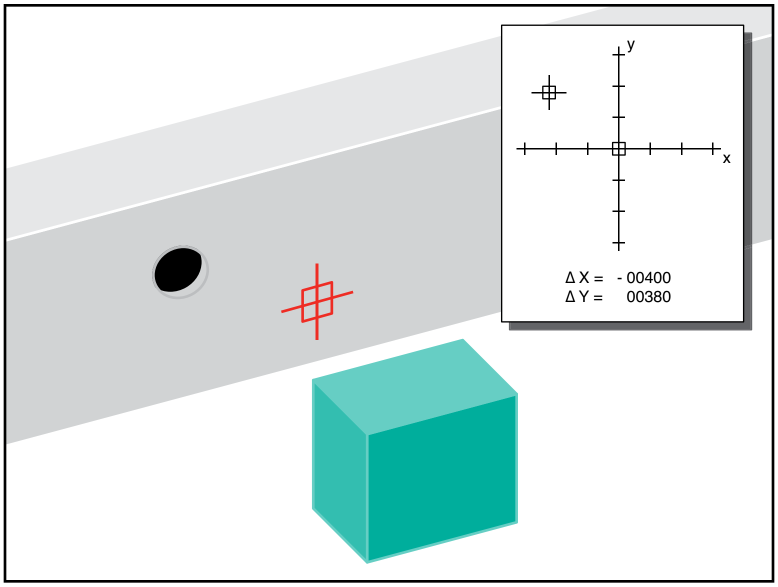

Fig 2: A vision-based solution uses a feature (in this case, a hole in the beam) to calculate a relative offset. These numbers allow the ASRS controller to directly and precisely correct the motion and quickly position the ASRS where necessary. Using the existing hole makes this solution less costly and more reliable, while increasing the speed of the system.

has the added benefit of increasing troubleshooting functionality. For instance, a well-designed product has the ability to store and transmit error images. These can be uploaded for analysis supporting maintenance personnel in their task to determine fault causes and possible solutions. Error images speed up problem resolution in cases where no valid target hole has been detected. This helps in quickly identifying issues like covered target holes or a grossly misaligned sensor.

Utilizing the full functionality of vision-based ASRS alignment sensors for fine positioning has the ability to both reduce the cost of the installation and increase the speed of the storage and retrieval process by means of creating position-dependent coordinated moves. But even in situations where this is not possible (retrofit systems come to mind), a vision-based system is desirable. This is another example where utilizing the power of vision technology solves difficult applications with ease.

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