Efficient Material Handling in Automotive Manufacturing Applications

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Pick-and-place robotics has been a common sight in the automotive industry for some time. It is capable of auto racking, bin picking, positioning parts for assembly, and other repetitive tasks that help automate production sequences and reduce costs. A simple algorithm is built into most robot controllers allowing part picking based on a grid. Users simply teach the pick position of one part in the corner of the bin and enter data such as the X and Y coordinates between the parts and the number of parts in the grid. This works great if the parts are well machined and have sharp, distinct geometric features, or if the parts in the bin don’t change position. But when parts are presented that are randomly placed in a cell and are constantly shifting and realigning, simple pick-and-place robotics are no longer effective.

These tasks require very efficient laser sensor technologies along with high-performance hardware to allow the application of computer intensive algorithms so that even complex mathematical methods can be implemented. They require a solution focused on a system approach with a modular technology rather than solving individual tasks. The solution might be found in a robotic bin picking system where a vision-enabled robot can locate, grasp, and remove single parts from a bin of jumbled or randomly placed parts.

Machine Vision Systems
Machine vision technology has played a significant role in facilitating these advancements. It enables inspection and robotic guidance tasks to be performed at various levels of complexity, depending on the application.

Machine vision systems have gained a strong foothold in the automotive industry. Vision systems can be found in virtually every segment of the automotive assembly

process: error-proofing, process control, part tracking and inspection, assembly operations, and guiding robots to perform welding assemblies, inspections, painting, and part handling. Effective bin picking systems that can identify a single part in a bin of randomly positioned parts—that frequently change position when parts are removed—are now providing solutions on automotive factory floors.

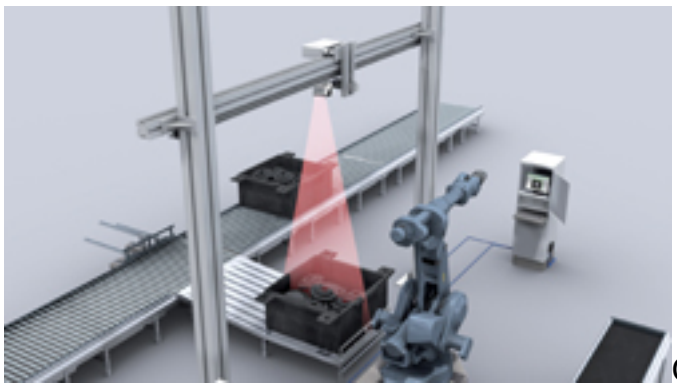
Removing Untreated Brake Disks with a Laser-Based Vision System

Unlike autoracking where parts are presented to the robot one at a time, bin picking untreated brake disks is much more complex. The vision system must find each single disc in a bin of randomly grouped parts that constantly shift and realign each time the bin is jostled or a disc is removed from the bin. The number of part orientations makes it difficult for the robot to “see” the features of a part in order to grasp it. Additional challenges include:

• The bins are often shaped differently due to damage
• The bins may also be different colors
• Fill level of the bins varies
• The appearance of each disk varies (varying amounts of dirt and rust)
• Undefined objects in the bin that must be recognized to avoid collision.

The solution is a laser-scanning-based vision system that enables different sensors (triangulation or light runtime) to be combined to generate an extremely accurate 3-D surface map of the brake discs for robot guidance. The laser profiles are then digitized and used to generate a 3-D map of the part.

To remove the brake discs, a 3-D evaluation using laser sensor systems provides information to control the robotic arm. A height image is generated by measuring the runtime of the light to control the robot grippers.

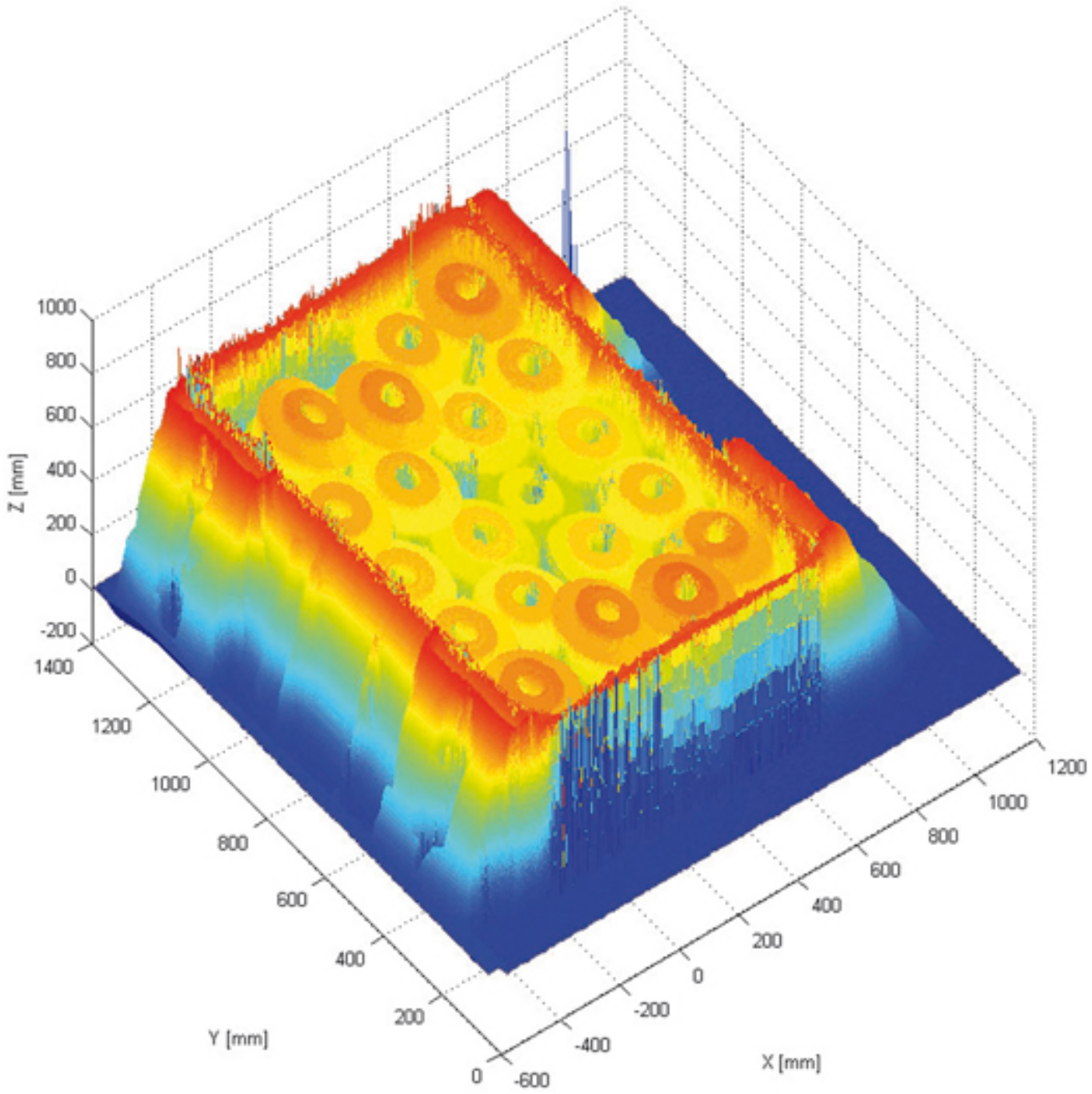


Once a bin is set in a cell, a time-of-flight laser sweeps across the parts. After the initial scan, the system gathers the data from the laser, and in a matter of seconds, forms an “image” of the top layer of the parts in the bin. The image information is sent to the control unit, which allows the robot to pick the center of the part that is closest to the top of the bin based on algorithms. The robot is now able to precisely select the product from the bin and transfer it to the next stage of production.

During removal of the part it is possible for the remaining disks to slip around. As a result, the laser measurement is repeated after every cycle. The laser in this application also provides data to the robot on the shape of the bin and if there are objects that do not belong in the bin. Objects that do not belong in the bin are also acquired in 3-D during these measurements. If something is not recognized, a message is immediately sent to the controller to facilitate operator intervention. Because of the accuracy requirement, a solution using a magnetic gripper could not be considered.

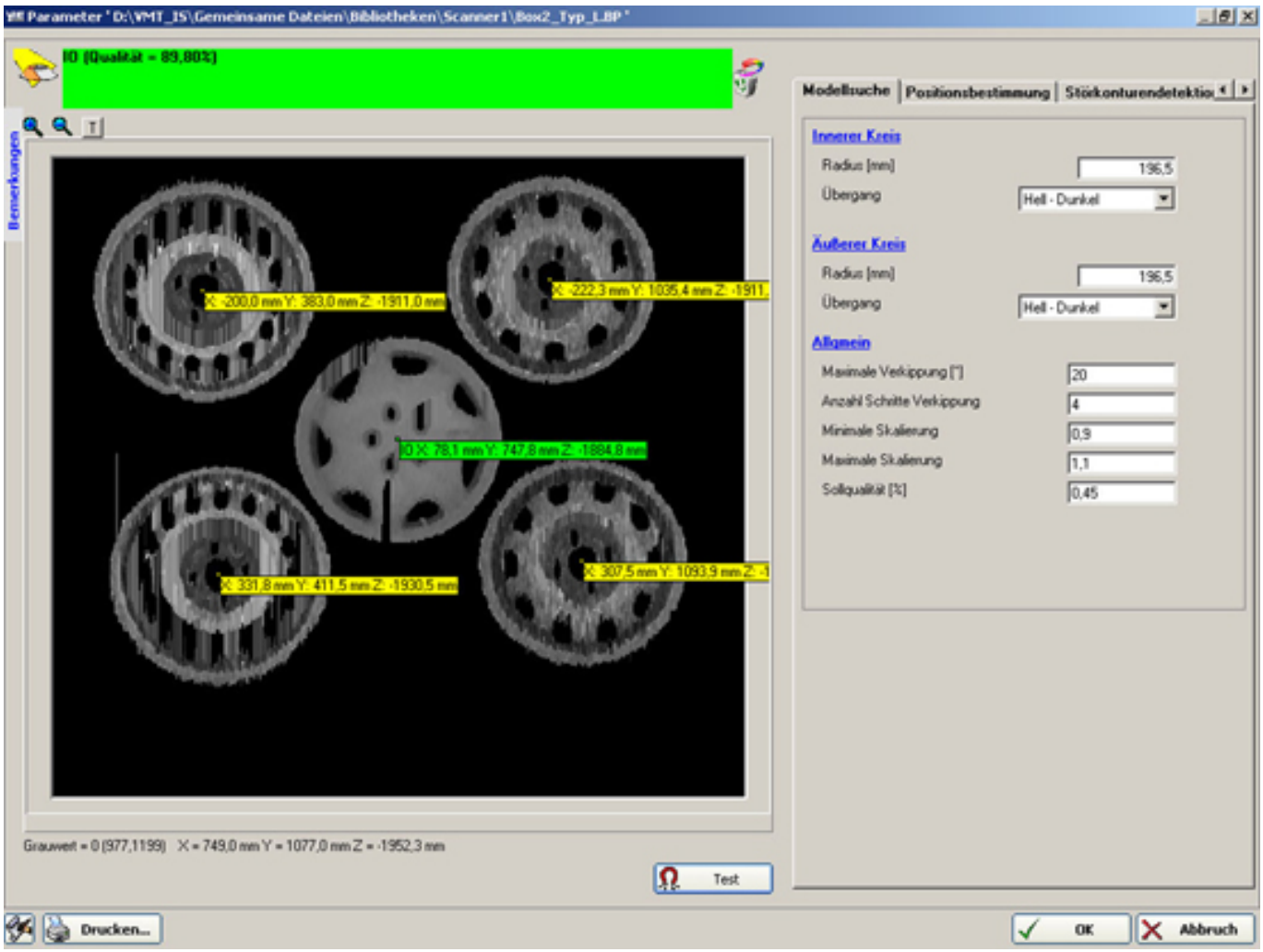
Depalletizing Unsorted Tire Rims

A laser-scanning-based vision system is especially useful in depalletizing a variety of unsorted tire rims with a robot and facilitating their flow to the next stage of production. Different types of tire rims, present on a pallet in several layers, are recognized using the same process described in the preceding application. Position corrections are then determined for the robot or the handling unit.



Additional Benefits

This kind of sensor technology not only provides significant freedom from harsh external light interference for the testing process, it also supplies the requisite speed and fulfills the requirements for accuracy. Additional information is also available for determining the stack height and presence of foreign objects, for example. This is often not available when using traditional image processing.



A System Approach

In both applications, specially developed processes and tools are available from a variety of vendors. These are suitable for the complex tasks of each unique application. Additionally, the availability of high-performance hardware allows the use of computer intensive algorithms, so that even complex mathematical methods can be implemented.

To date, however, existing systems have focused on solving only individual tasks. Any change in the task specifications or environmental conditions (ambient light, new containers, varying part characteristics such as geometry or color) usually requires extensive interventions, modifications, and expansions in order to adjust the new task setting to the task-specific sensor system. VMT, part of the Pepperl+Fuchs Group, offers a system approach using a modular strategy. VMT provides a platform of available solutions that can be expanded for the requirements of each new application or combined with other functions available in the VMT system, depending on the complexity of the project

VMT delivers a multi-functional program package with varied image processing algorithms for the execution of a wide range of tasks. The system provides a complete documentation of all evaluations, an online log for fast checking of all the results of the previous measurements, and a visualization and archiving of the error images that occur.

System operation and setup is achieved entirely without programming with the graphical interface. The interface is completely uniform for all applications including robot visual guidance, completeness testing, and plain text reading. The user languages (thirteen in total) can be switched online at any time and are open for expansion.

A laser-scanning-based vision system provides a solution that is safer, reduces costs, increases capacity, and allows companies to reach higher levels of efficiency and productivity when parts are unknown and the position within the container is random. It is rapidly becoming an essential part of the automotive manufacturing process.

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