

APPLICATIONS OF ROBOT VISION IN THE AUTOMOTIVE INDUSTRIES

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ABSTRACT: Robot vision is the technology and methods used to provide imaging-based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance in the industry.

Robotic VISION Technologies provides a vision guided robotic software platform for industrial applications for the automotive, general manufacturing, materials handling, bottling, and inspection markets. On this paper, is presents an overview of a typical solution for robot vision application. In this case, we show a solution for a robot which are picking a component from the rack.

KEYWORDS: 3D robot guidance, camera, recognize objects

1. INTRODUCTION

The Vision System is the standard system for identification and position recognition. It provides information about the position, rotation, and component type that are arranged on a defined plane. Contour extraction-accurate down to the subpixel-provides the highest precision, even in the case of fluctuating features.

Machine Vision gives robots intelligent eyes. Using these eyes, the robot can recognize the position of objects in space and adjust their working steps accordingly.

The system links the information from camera photogrammetrically to produce precise recognition of the object's spatial orientation. Deviation from a given target orientation are precisely calculated in all six degrees of freedom and robots, in particular, those that process large format components, such as the robots in an automobile line, are controlled.

By incorporating simple point and click programming with an easy to understand interface, robotic vision takes the complexity out of robotic guidance. The system was born out of the realization that machine vision is much too complicated. Today's machine vision systems struggle to handle six DOF with a single camera, requiring the use of structured lighting, external calibration aids and/ or multiple cameras. Robotic vision is an evolutionary step change which uses a single camera, outputs six (6) DOF, and requires no external aids. Simplifying the machine vision genre to its simplest form..True Visual Recognition!

Machine Vision for robot guidance provides the robot or handling system with information of where the component to be processed or moved is located spatially.

Today, industrial robots have become a major economic factor in industrial automation. With Robot Vision, the number of application possibilities for these automation components increases exponentially.

Robotic VISION Technologies' lists of industrial vision-guided robotic technologies are applied in various settings, for various part types and industries. Some of the generalized applications are listed below:

- Structured Bin Picking
- Semi-Structured Bin Picking
- Completely Unstructured Random Bin Picking
- Inventory Organization and Management
- Motion Detection
- Moving-line Part Tracking and Handling
- Automotive Materials Handling and Assembly

2. SYSTEM OVERVIEW

The new 3D robot guidance process operates with only one camera, which opens up entirely new perspectives for cost-effective image processing applications in all the important industries. It is now possible, from one single captured image, to precisely define a three-dimensional object based on the measurement of only three criteria in all six degrees of freedom (position and orientation).

By incorporating simple point clicking interface, the system is able to learn and recognize objects in order to guarantee the precise and repeatable location of parts.

Camera and lighting units are mounted on the robot. In fig. 1 is shown a system which are used for robot application.

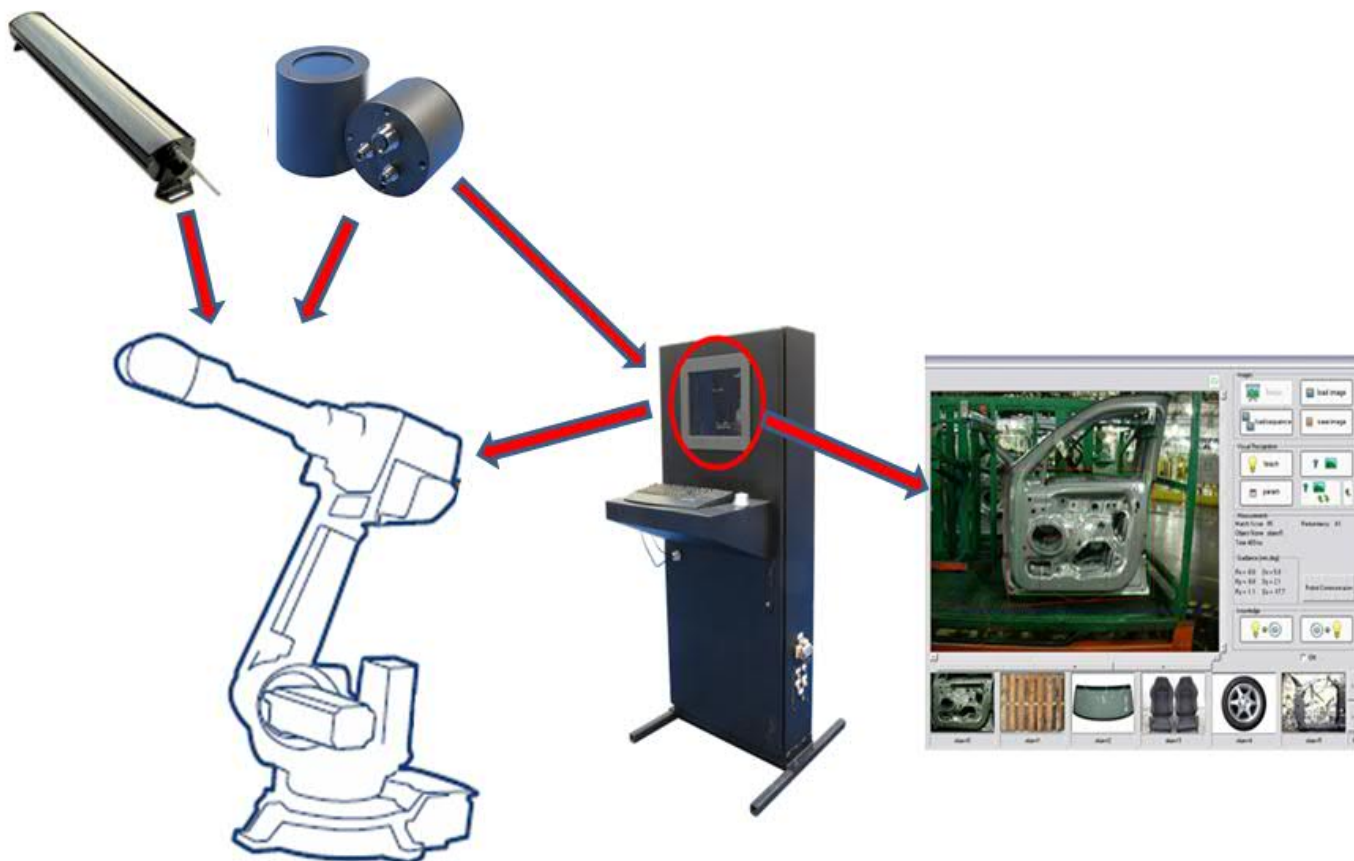


Figure 1. System components

- **Camera**

The camera collects the radiation received from the object in such a way that the radiation's origins can be pinpointed. In the simplest case, this is just an optical lens.

In figure 2 is representing a type of camera which is used for robot vision application.

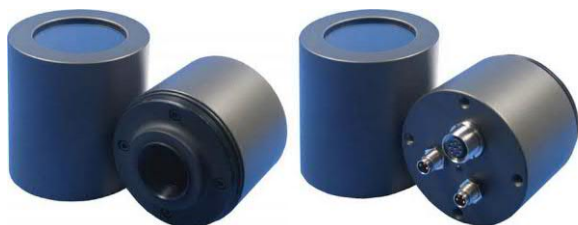


Figure 2. Camera

The visual camera could be mounted on a grippers (Figure 3) which are manipulated a part.

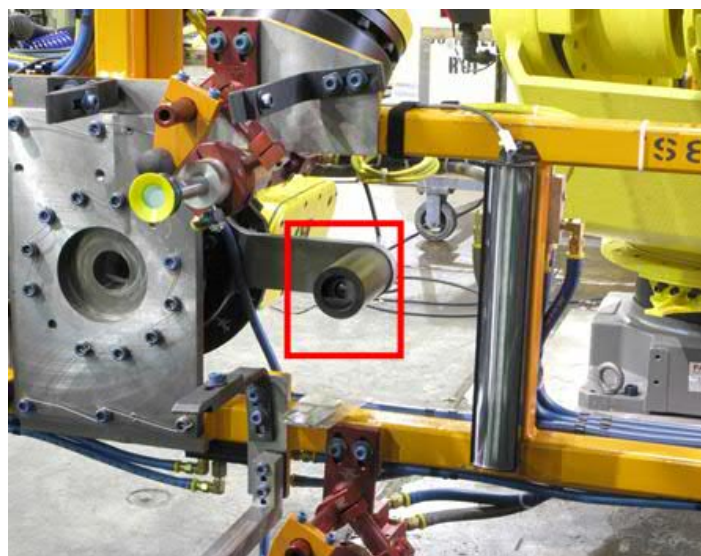


Figure 3. Camera mounted on a gripper

The camera determines a work area that is set depending on various applications (Figure 4).

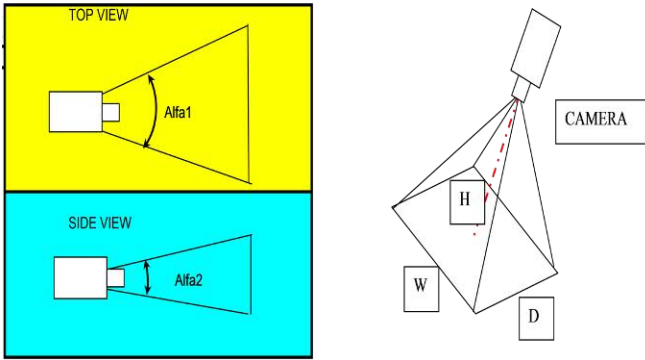


Figure 4. Camera measurement distance

Mono 3D is the economical alternative to procedures and equipment for 3D measurements with one camera. With one camera and one image only, all six degrees of freedom (position and orientation) can be determined precisely for a three-dimensional object using only three features (Figure 5). This can be used, for instance, for de-rack-ing of complex components from transport and storage racks.

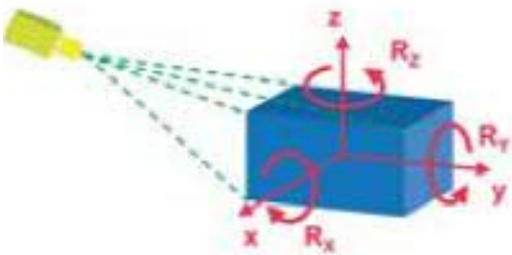


Figure 5. Monocular 3D Robot Vision

- **Computer**

Using a software, the computer (Figure 6) compare the theoretical and real position to guide the robot to find the correct position.



Figure 6. Computer

Computer Vision and Applications, Concise Edition, offers a fresh approach to computer vision by regarding the whole process from image formation to measuring, recognition, or reacting as an integral process. Computer vision is understood as the host of techniques used to acquire, process, analyze, and understand complex, higher-dimensional data from the environment for scientific and technical exploration.

Faults are provided from the recognition system to the robot for easy debug (Figure 7). The program has in his memory a picture for the detection zone.

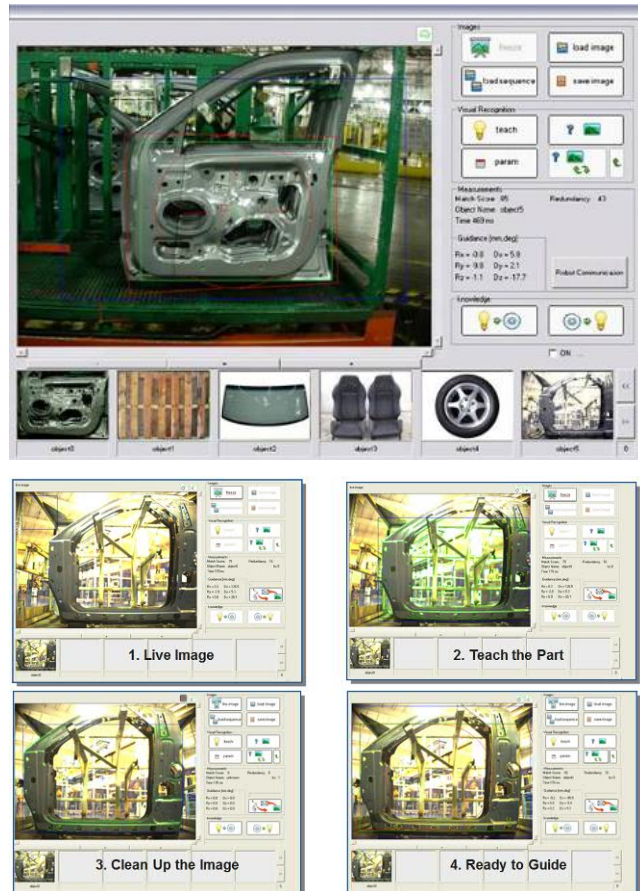


Figure 7. Calibration program

- **Lights**

Lights (figure 8.) are mounted on the robot to obtain a better visibility for the camera. Depending on the application could be mounted one or two cameras on the robot.

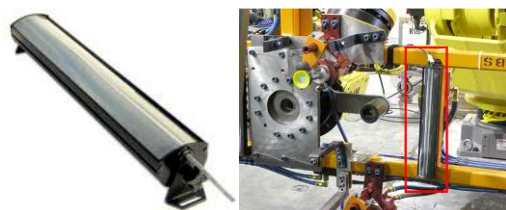


Figure 8. Lights

3. EXAMPLES OF APPLICATION

The visual system, at the end of its cycle, reports to the camera (and consequently the gripper robots) in the same relative position between the workpiece and camera (also called a "measurement position") that has been saved in the programming phase.

Below is an example of a robot which are unloading apart from the rack. The robot must find the best position to visual the hole part from the rack.

The camera should be positioned to cover a larger area of the part which are unloading from the rack (Figure 9).

This sensing area must cover all the part from the rack.

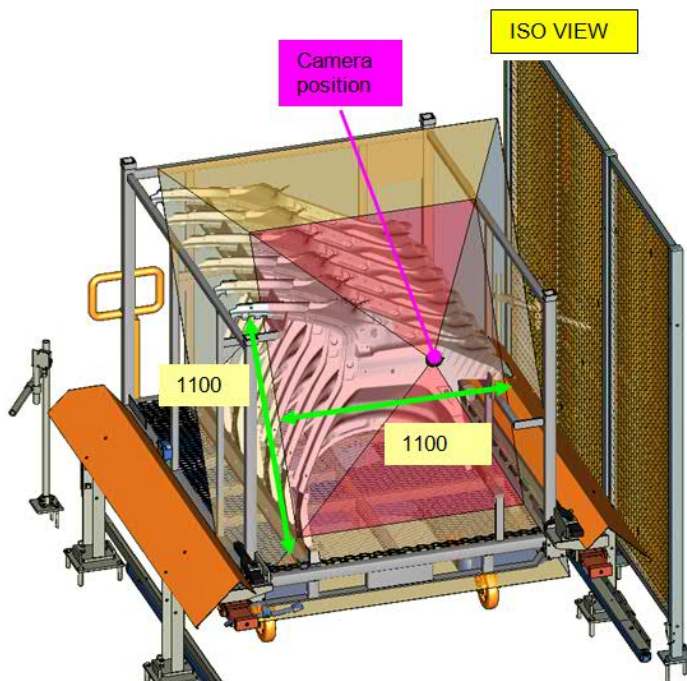


Figure 9. Camera position

The robot goes into the position to unload the part from the rack (Figure 10).

The volume of vision of the room is modeled as a right pyramid with a rectangular base with its vertex on the camera itself. The base of the pyramid is parallel to the floor of the camera.

The measuring position must be such as to present the piece in front of the camera.

Whether for technical limitations or existing is decide to show only a "representative portion" of the piece, one must take into account that all the residual error is more in the download area far from the camera area.

If possible, need to choose the point of measurement of the weight so that even when it is in the phase of measurement for the last piece of the rack (the last one) of the gripper on the robot is OFF from the zone of interference with the rack.

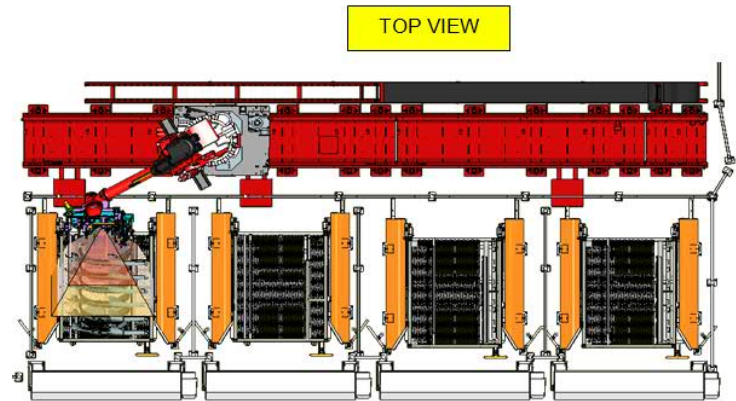


Figure 10. Robot unloading from the rack

Choosing the distance measurement, and then we must ensure that any placement of the piece on the rack, do not lead the gripper (considering it as "mechanically" each) in an area of interference with other equipment in the station or body itself.

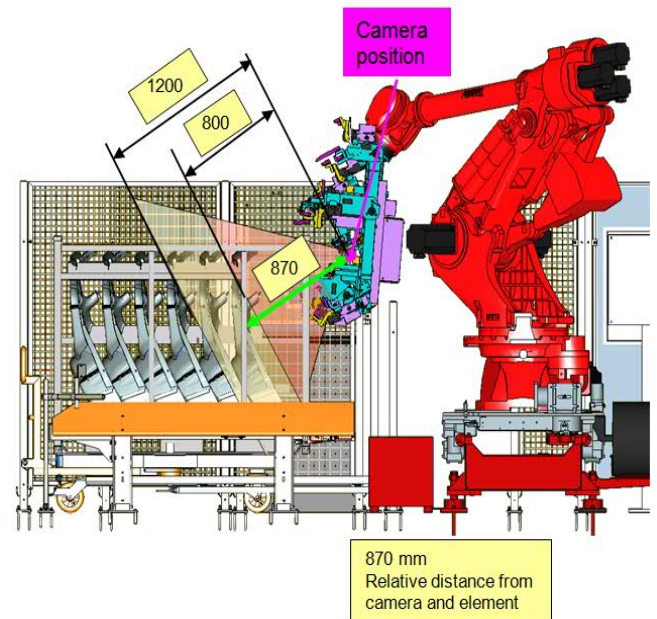


Figure 11. Robot position relative to the part

In general, the tests to do in each should do the following:

1. Retrieve data about the magnitude of the displacement expected of the piece (in mm, the angle of rotation inside and outside of the plane).
2. Assume a measurement position (Ex. Bringing the camera perpendicular to the workpiece and gripper).
3. Check in every condition "limit" positioning of the piece, with room and gripper "mechanically"

bonded" to the piece, is not going to interfere with external obstacles or the rack.
 4. Repeat the checks for each piece inside a container with many elements.
 5. Repeat to check also the pickup location, which is also obviously "glued" on the piece or in general.

The cycle diagram for the robot is represented in Figure 12.

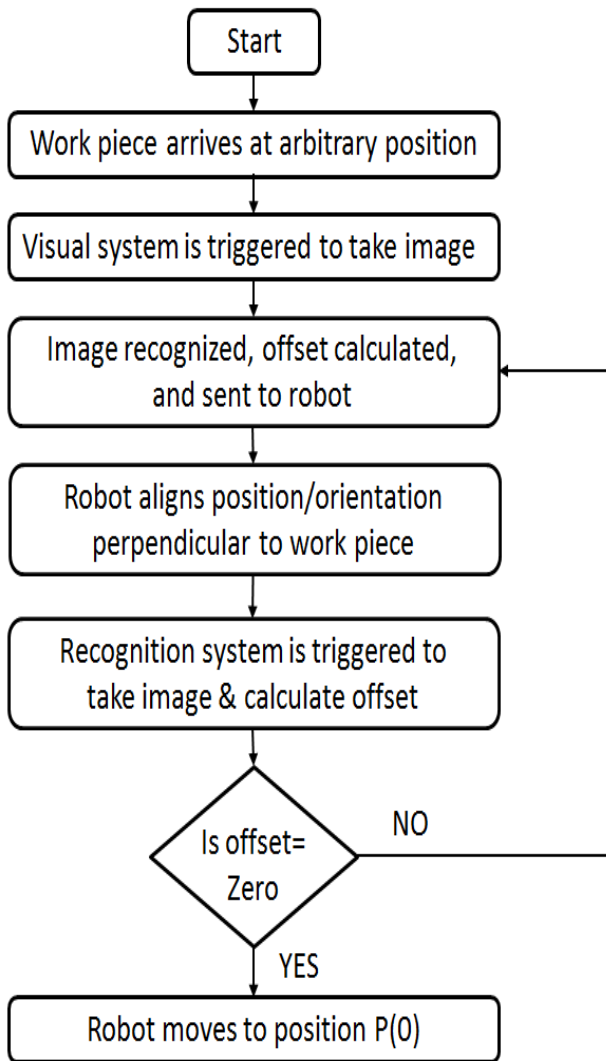


Figure 12. Cycle diagram

4. CONCLUSIONS

Robotic vision is an evolutionary step change which uses a single camera, outputs six (6) DOF, and requires no external aids. Simplifying the machine vision genre to its simplest form....True Visual Recognition!

Below is some advantage of this applications:

- Sensor GigE based
- High flexibility
- Variable operation
- Stationary
- Mobile, on the robot arm
- On-the-fly
- Combination of several systems
- Integration in practically all production and controlling processes
- Simple, time-saving installation
- Low space requirements and ease of integration in confined spaces
- Short cycle times due to fast image processing
- Simplified calibration as well as simple programming - also as a result of the teach-in function

5. ACKNOWLEDGEMENTS

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