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Design Concepts and Process Analysis for Transmuter Fuel Manufacturing: Quarterly Progress Report #6

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Design Concepts and Process Analysis for Transmuter Fuel Manufacturing

QUARTERLY PROGRESS REPORT #6

UNLV AFCI University Participation Program

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Project Milestones

- Completed a systematic study seeking to arrive at an optimized plant configuration, using value engineering techniques in January 2006.
- Vision-based robot serving and automated plant safety monitoring is currently in progress.

1. Concepts for Vision-Based Robot Control

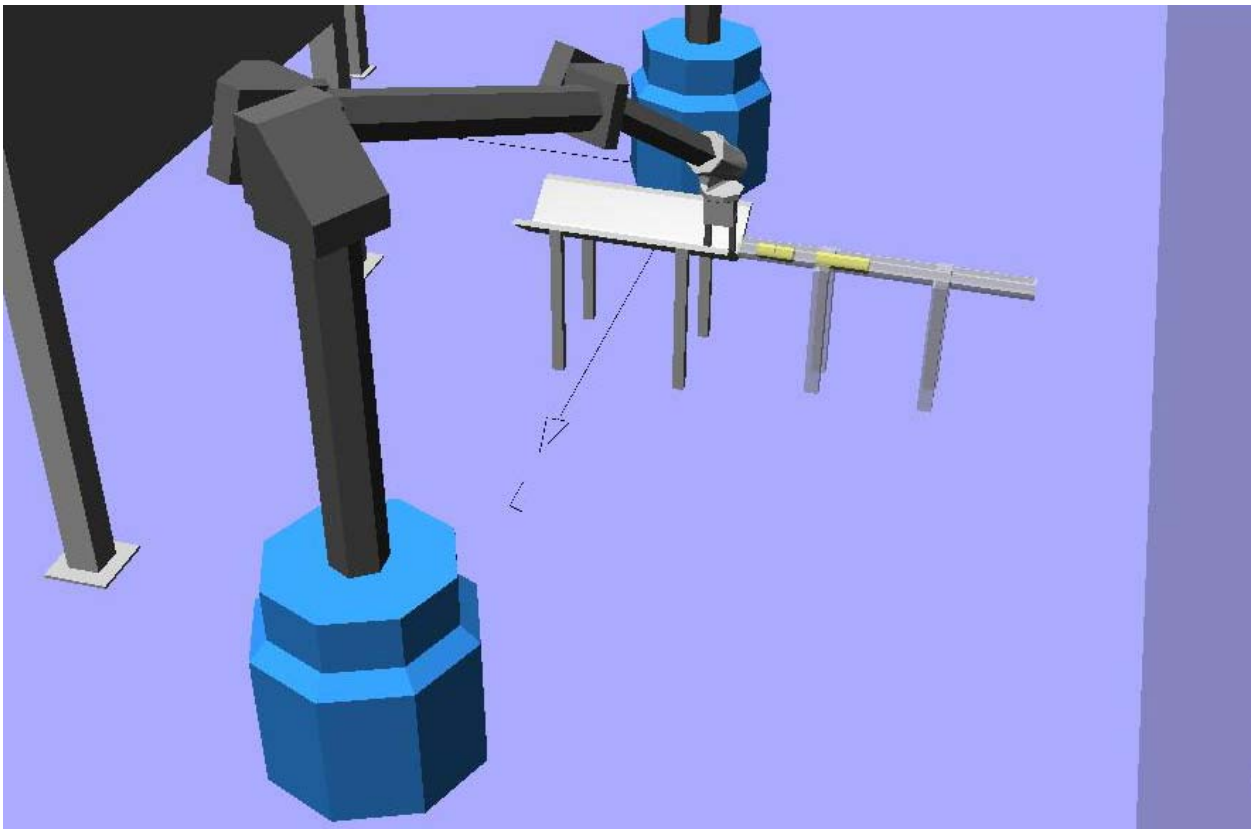

Figure 1: Example of Vision-Based Robot Servoing: Robot inserting Pellet into Cladding Tube.

A calibrated camera within its field of vision can guide the end effector accurately to its destination, and monitor the execution of the robot task at hand. Fig. 1 shows the example of pellet insertion into a cladding tube. While other sensors can be used to guide the robot, cameras are the most versatile. Cameras also can be positioned outside the hot cell, and thus reduce exposure and contamination risks.

Fig. 2 shows the robot motion control concept. The reference or controlled variable is generally a six-dimensional vector with 3 Cartesian location coordinates, and 3 angles defining the end effector orientation

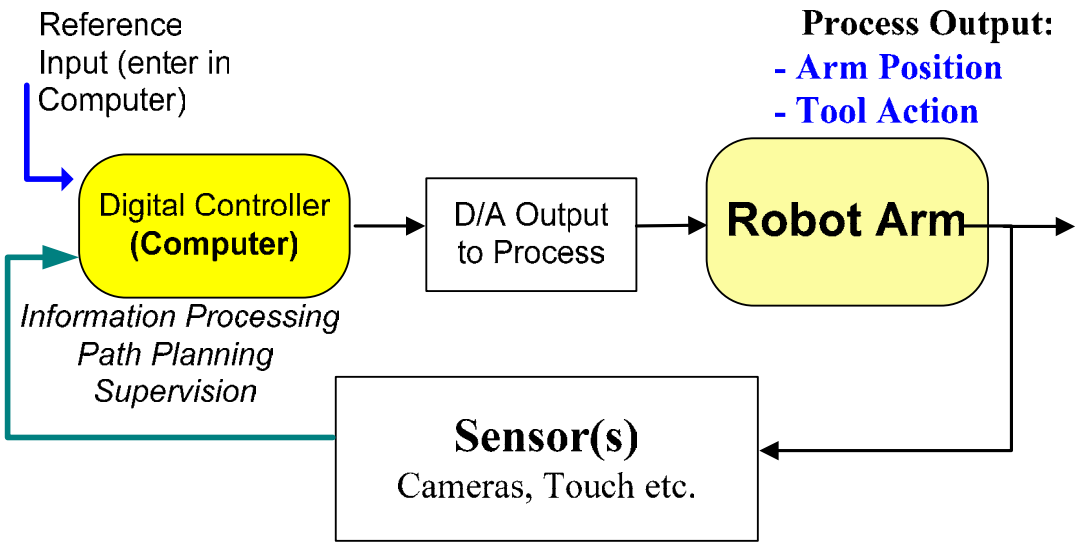

Fig. 2 Robot Controller Concept

2. Work performed

The camera system and image recognition software were configured and tested.
The image acquisition and processing is done with Matlab software tools. A remotely controllable Panasonic color camera is connected to the controller PC through a frame grabber.

The first step is image recognition. According to the requirements of the project The greatest point of interest is cylindrical objects, i.e. fuel pellets. The pellet(s) present in the image are identified, and their spatial location and orientation is determined. Fig. 3 shows an example of pellet identification in Matlab. Undesired image elements are removed as seen in Fig. 4 and Fig. 5.
The software for real time image acquisition and processing, and for camera control, is now operational.

Cylinder Recognition Procedure

For the recognition of the shape of a cylinder we examine first the contour of the shape, and then the shape with all its points inside.

A contour consistent with a cylinder is identified if
1. 2 lines are parallel and are the same length
2. Each end of the contour is a half-ellipse

A true cylinder must meet additional criteria:
1. One of the 2 ends is a complete ellipse
2. The other end is a half ellipse that has the same characteristics as the ellipse.

3. Work Plan for April to June 2006

- Calibrate Camera, and determine accuracy of location and orientation measurements of identified parts.
- Test camera system in noisy environments for the vision system's ability to discern pellets form other objects present.
- Develop Matlab code and document results

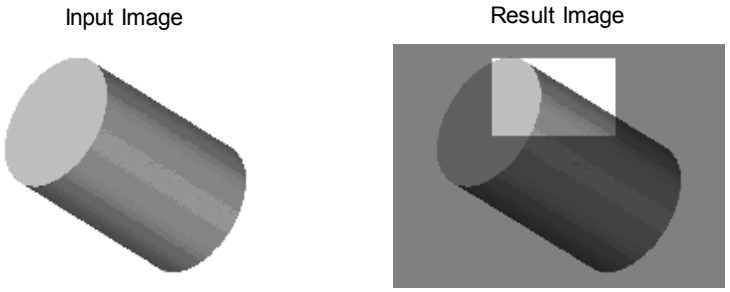

Fig. 3 Example of Pellet identification in Matlab

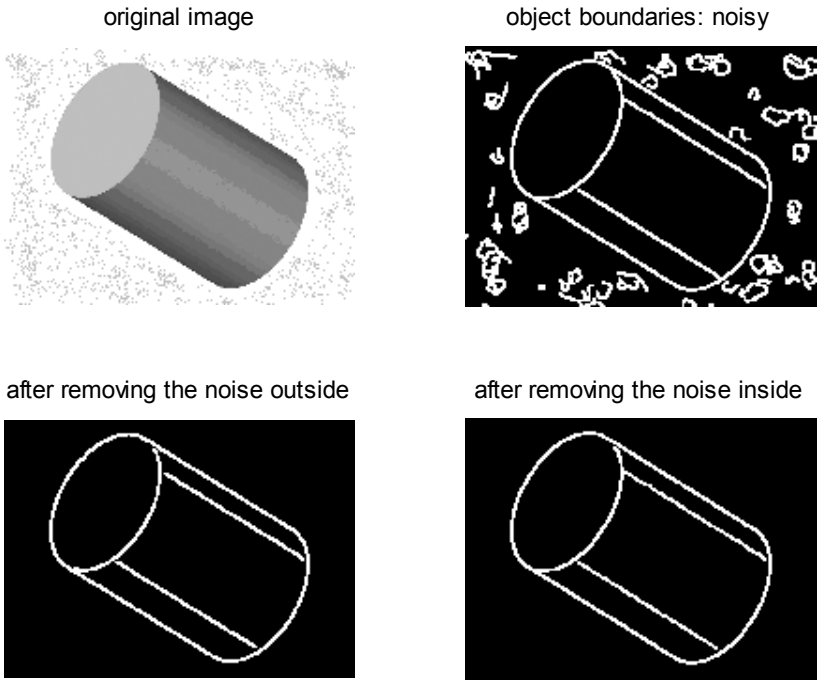

Fig. 4 Example of Image Processing in Matlab, part 1

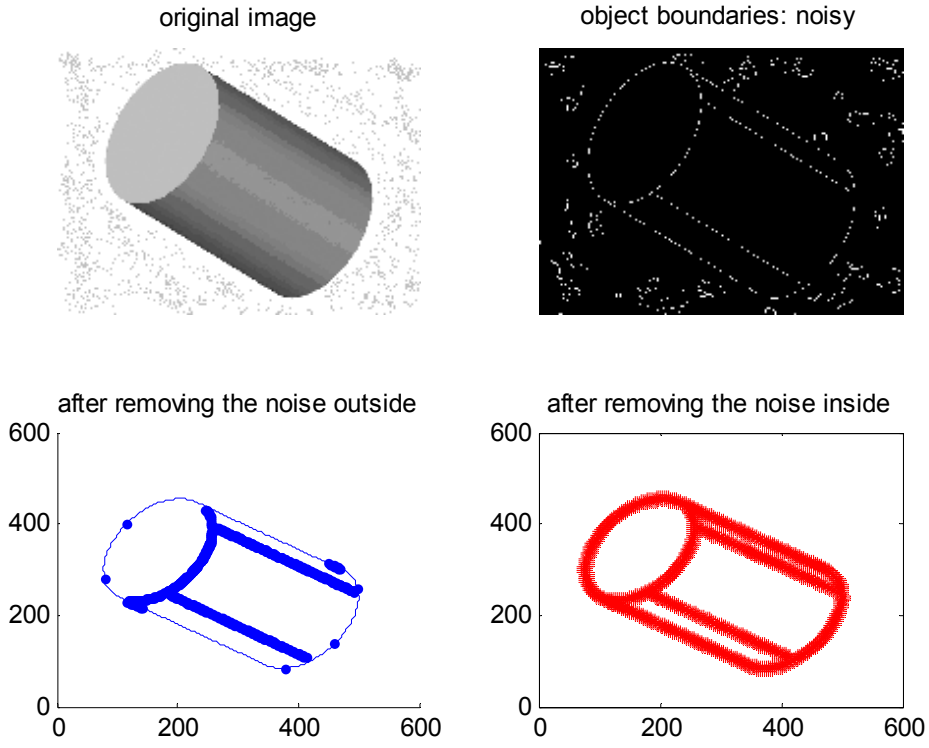

Fig. 5 Example of Further Image Processing in Matlab