

CASE STUDY

DIMENSIONAL MEASUREMENTS OF NUCLEAR FUEL PELLETS USING A VISION SYSTEM

OVERVIEW

Our client is the biggest nuclear research center in India. The organization was established in 1954. Being the leader in Nuclear Energy supply, the company manufactures zirconium fuel pellets to produce energy by fission and fusion.

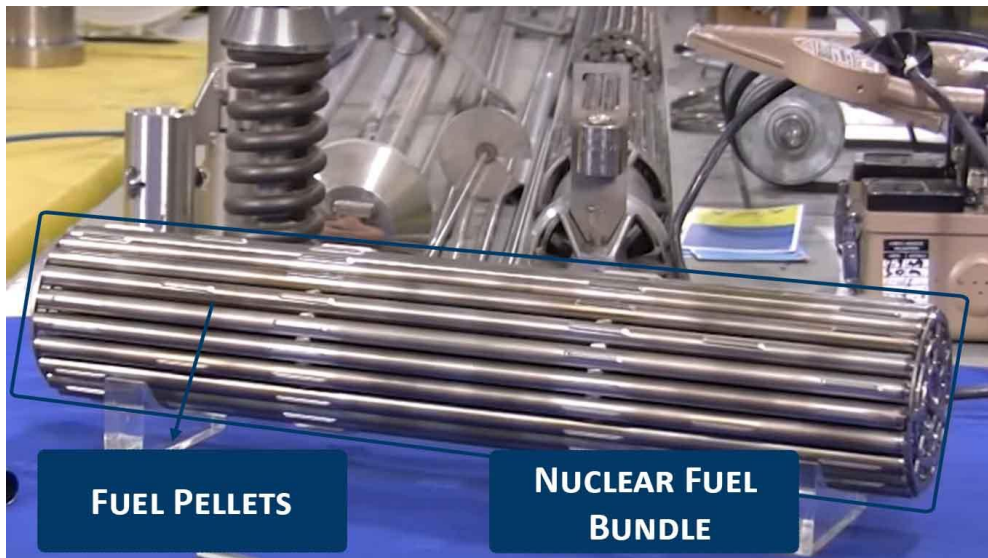


Fig 1.0 - Fuel Pellets Bundled

REQUIREMENTS - The manufactured pellets should have a fixed dimension (length) to bundle them together and fit them into the reactor. To facilitate this, the client required an automated dimensional measuring system with an inspection accuracy of more than 99 percent

APPROACH

Setting Up The System For Perfect Image Acquisition - We developed a vision system for automated dimensional analysis. The system consists of dual-line scan cameras fixed within the same axis.

Challenges with working with Dual Line Scan Cameras.

The cameras are first calibrated for:

1. Tilt - This calibration is done to get one straight image by two-line different line scan camera
2. Pitch - It is the distance between every alternative tile. Pitch calibration ensures the distance b/w two tiles in both images (from camera A and camera B) should be equal.
3. Focus - The focus calibration is required to acquire the explicit images of the objects placed within the working distance. The focus depends on the distance between the camera and the object.
4. Yaw - The optical axis of the camera should always be perpendicular to the calibration target plane (as shown below in fig 1.1). Yaw deviation will increase the working distance and the dimension would not be correctly observed.
5. Overlap - From both camera images, the overlapped length has to be removed to get the correct length of the pellet.

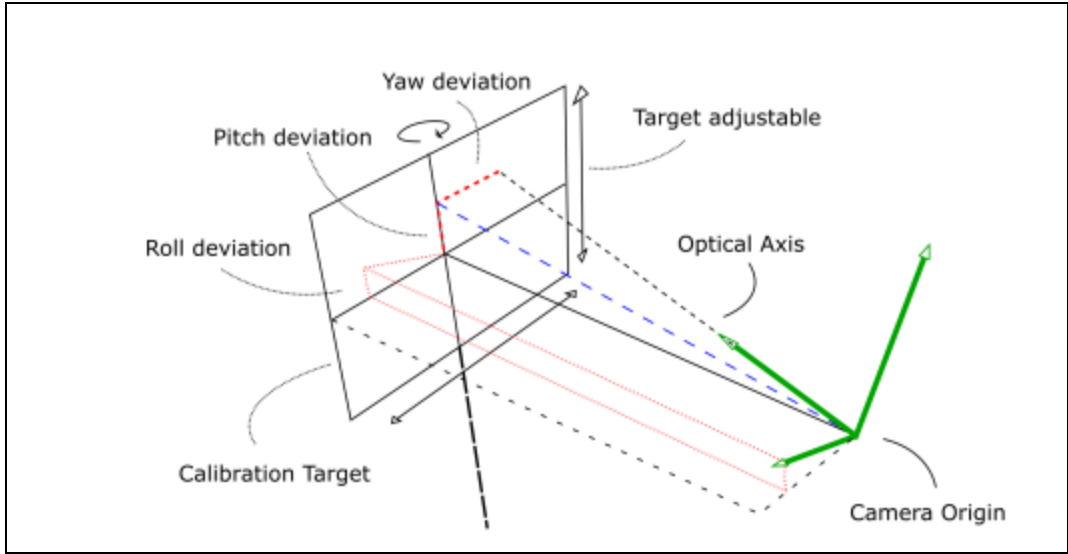
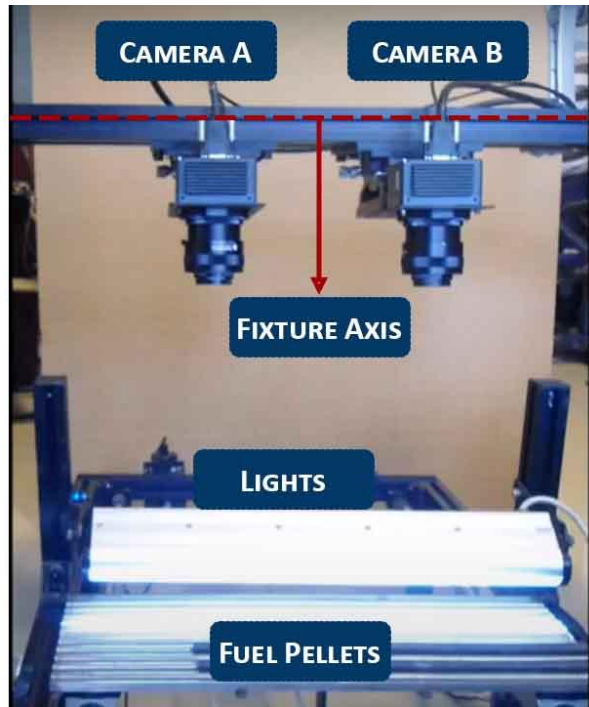


Fig 1.1 - Camera Calibration



Focus Calibration -

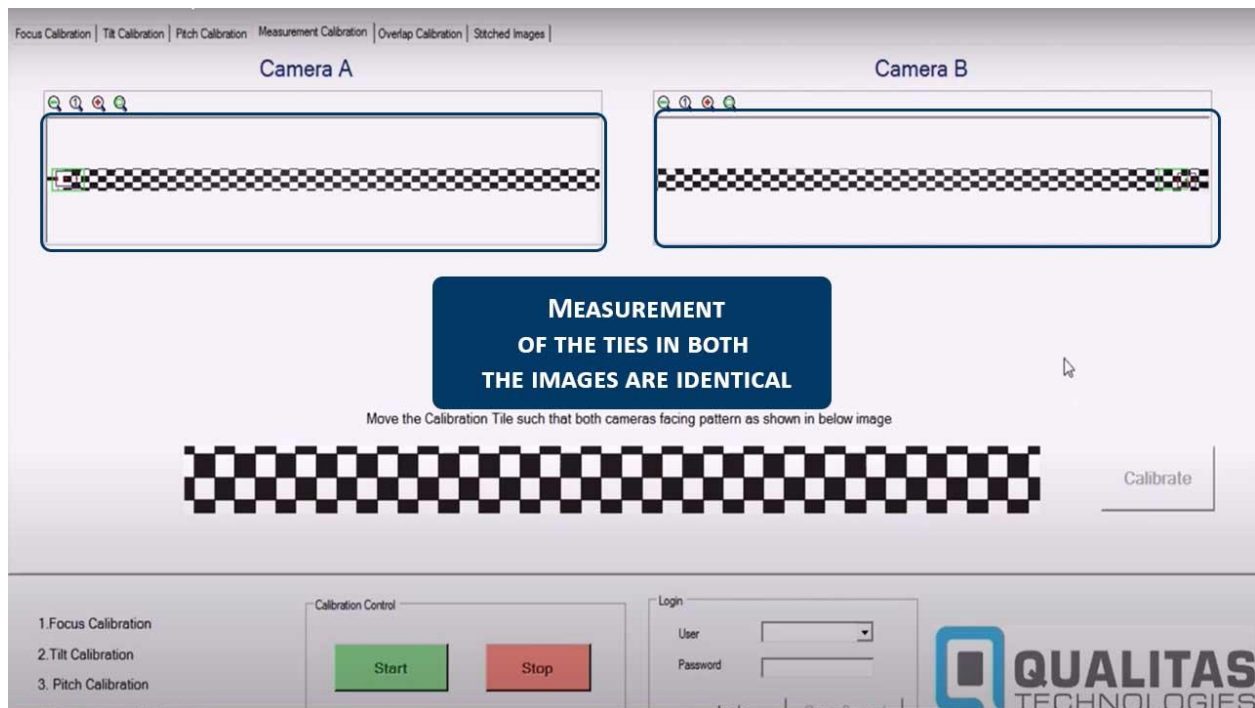
The focus needs to be adjusted until the printed lines within the working distance become perfectly clear.

Tilt Alignment -

With the help of square tile, the tilt alignment can be adjusted to get straight images.

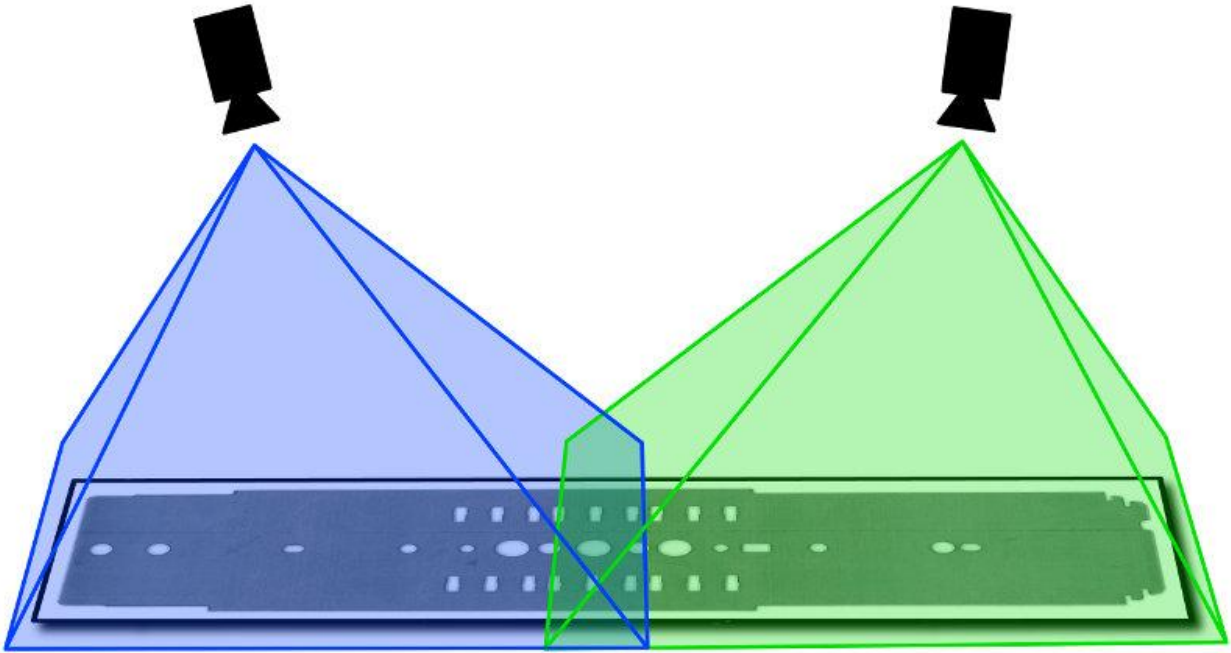
Measurement Calibration -

If the measurements of the tiles are identical in both images (Camera A & B images) this indicates that both the cameras are measurement calibrated.



Overlap Calibration -

Both of the cameras capture the image of the pellets. Let's say camera A captures 'x' mm of the pellet length and camera B captures 'y' mm. At the intersection of both the images, there will be a common length or an overlap that needs to be cropped out, otherwise, it will be counted twice. Let's say the common length is 'c', then we need two images with lengths i.e. 'x+y-c'. These images would then be stitched together to show accurate results (measurements).




CONCLUSION -

The image acquisition was done with the help of a dual-line scan camera. Calibration was done correctly in order to get the right dimensions. Captured images from two different line-scan cameras were processed and the results were displayed on the UI screen. The inspection accuracy was 99 percent.

Pellet Length Measurement

Camera Tiled Image



AQUIRED IMAGE OF FUEL ROD

Pellet No	Pellet Length	Pellet No	Pellet Length	Pellet No	Pellet Length
1	17.186	11	15.688	21	14.192
2	14.847	12	17.224	22	15.722
3	15.804	13	14.828	23	14.181
4	14.815	14	14.813	24	14.152
5	15.164	15	14.821	25	15.670
6	14.708	16	16.217	26	14.089
7	17.714	17	18.421		
8	15.233	18	14.186		
9	17.175	19	15.295		
10	17.277	20	16.717		

LENGTHS OF FUEL PELLETS

Inspection Result

Passed

RESULT

Total Rows Inspected: 2 Rows with Pellets: 1 Rows without Pellets: 1

Reset Counters

Results Log

FileName: 09-07-2013.xls Stop

img Log Start

Results

Total No of Pellets: 26

Total Stack Length (mm): 408.575

Select Stop Row: 1

Inspection Control

Start Inspection Stop Inspection

Password: _____

Log In Change Password

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First Shift 9/7/2013 1:40:16 PM



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