Lab Report-1
Lens & Lighting

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LENS & LIGHTING EXPERIMENT

Aim:

The main objective of the lab is to get familiarized with lenses of the different focal length and lighting configurations. Industry use processing and recognition software is also introduced.

Equipment:

- PC Computer
- Frame Grabber : Edmund Optics mounted Sensor EO-0413C LE
- JAI CV M4+ CL Digital Camera with sensing area 45 x 28 (H x V) (mm)
- 12V power Supply
- Video Cables
- Industrial Lenses
- Extension Rings
- Lighting Devices
- Industrial Parts
-

Software: **IDS uEye** software

Documetation:

- User Manual EO-Edmund Optics
- User Manual IDS uEye Demo-U1122XLEC

Setup:

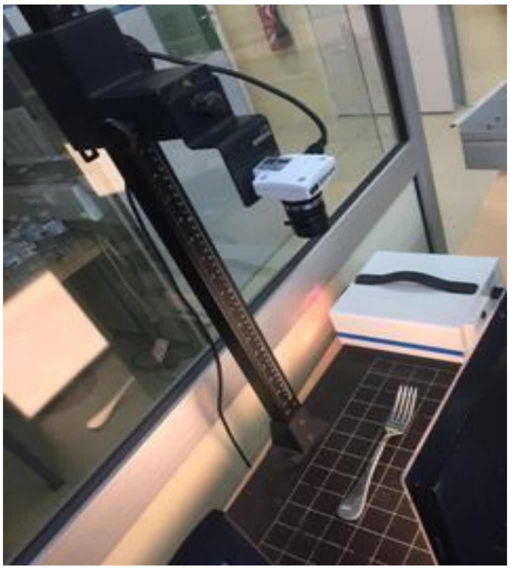


Fig 1 : Working setup

As show in Fig1. camera is mounted at a distance of 500mm away from the object placed on the board and made to focus with different lenses and extension rings. The camera is connected to the PC using the USB2.0 cable. The images are then captured using the **IDS uEye** software.

Experiment:

Part1 : Lens

In the first part of the experiment, we have to observe the fork at a working distance of 500mm in order to perform surface inspection. We first calculated the required focal length following equation from the camera brochure. It should be noted that the **500mm** working distance is the true distance between the lens and the board.

Focal length of width: $$\frac{Working\ distance\ X\ CCD\ Width}{Object\ width + CCD\ Width}$$

$$\frac{500 \text{ x } 4.5}{305+4.5} = 7.269 \text{ mm}$$

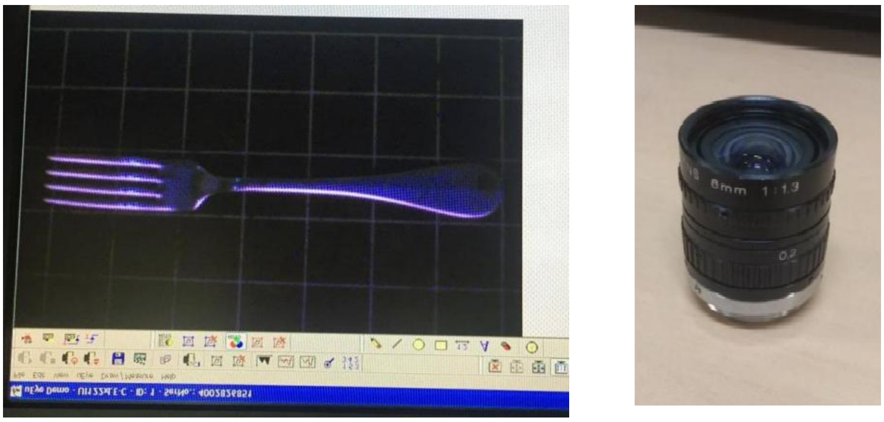
Focal length of height: $$\frac{Working\ distance\ X\ CCD\ Height}{Object\ height + CCD\ Height}$$

$$\frac{500 \text{ x } 2.8}{25 + 2.8} = 50.35 \text{ mm}$$

Part1(a):: Choosing the right lens

It is evident that the image gets enlarged by increasing the focal length of the lens whereas the area of the object captured in the image decreases. With a specified working distance, we needed to choose a specific lens configuration that will allow us to capture the entire fork into the scene. The lens' focal length needs to be lower than the computed focal length of the width; hence we selected the 8mm lens.

The captured fork image is as follows:



Working distance 500 mm & Lens 8mm

The captured image's resolution is **752**x**480**. We can observe from the above image that there are approximately 10 square grids captured in the scene in the height direction, and 6 grids in the width direction.

Spatial resolution: *It is the number of independent pixels values per square inch.*
The computed spatial resolution is approx. 8035 pixels per square inch.

Each grid is 30x30mm in size. We then are able to compute spatial resolutions for width and height

Spatial resolution of width:

$$\frac{752}{30 * 10}$$

= 2.51 pixel /mm

Spatial resolution of height:

$$\frac{480}{30 * 6}$$

= 2.67 pixel /mm

<u>Part 1(b) :: Extension Rings:</u>

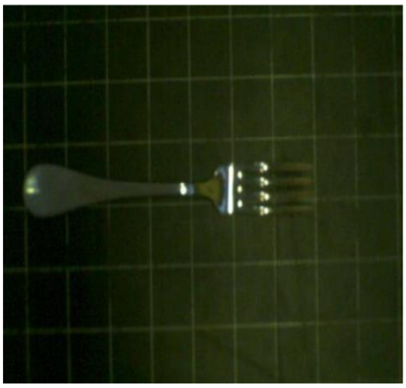
After calculating the spatial resolution, we were provided with the different extension rings and were asked to observe the influence of each of these extension rings on the image acquired. We used extension rings ranging from 10mm, 20mm and 40mm as can be seen in the diagram. The extension ring we selected was 10mm because of the better focal length to grab the images.

An extension ring is an accessory that goes between the camera body and the lens. It is not an optical component, so there is no glass involved. All it does is get the lens further away from the focal plane.

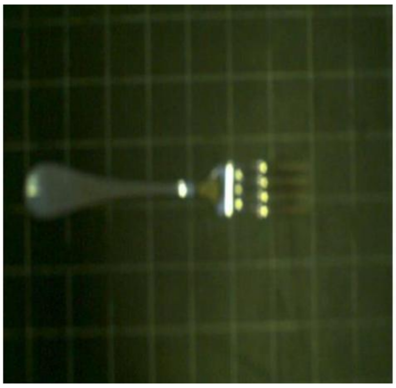
With the extension ring attached one can get closer to its object to be viewed. Diverse combinations of these rings can be used to see which combination provides the finest closeness to an object without deteriorating the quality of an image much.

Considering the limitation of 500mm working distance, extension ring we opted for was of 10mm.With other extension rings image got blurred and overall image quality decreased drastically, which is quite evident from the images attached below:

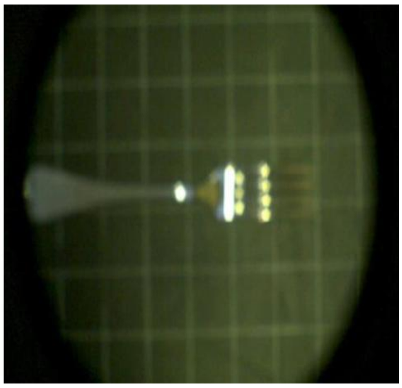
Different images taken from different lens.



10mm extension



20mm extension

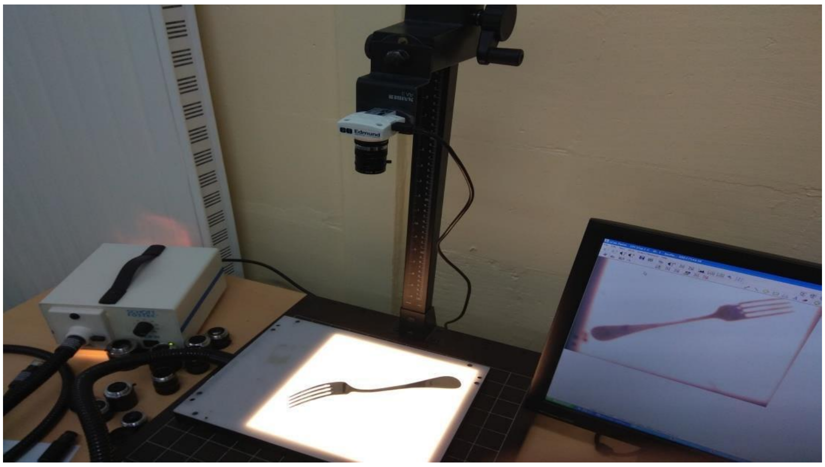


40mm extension

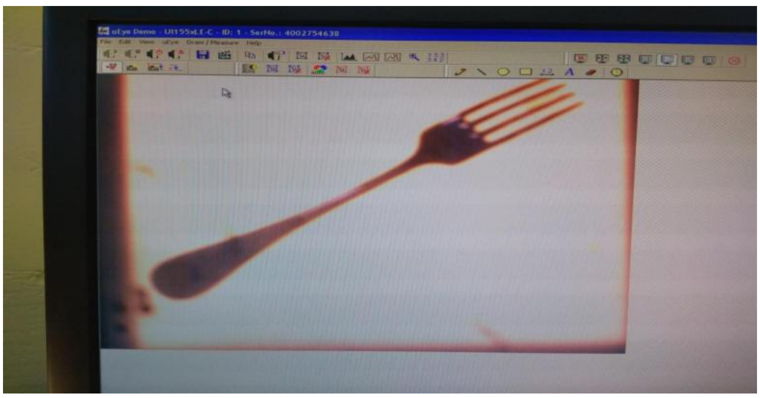
Part 2: Lighting

2(a) Silhouette Analysis:

In this part of the experiment we saw how using the light source effect the quality of the image obtained. We will use lightning source to detect defects and control of the object.



Light source to detect fork's contours



Silhouette Analysis of fork

In this experiment our main goal was to detect the contours of the object. To achieve the desired task we turned on the light source to get the better view of the fork control. It can be clearly seen in figure the fork was laid over the illuminated board to be viewed. From the silhouette analysis we can now easily determine the shape of the fork which can be seen in figure

2(a) Defect Detection on Shiny Surface:

Scratches on the fork

Holes on the fork

Conclusion:

Choosing of lens and lighting configuration to view the scene of fork and to detect the features are resulted.