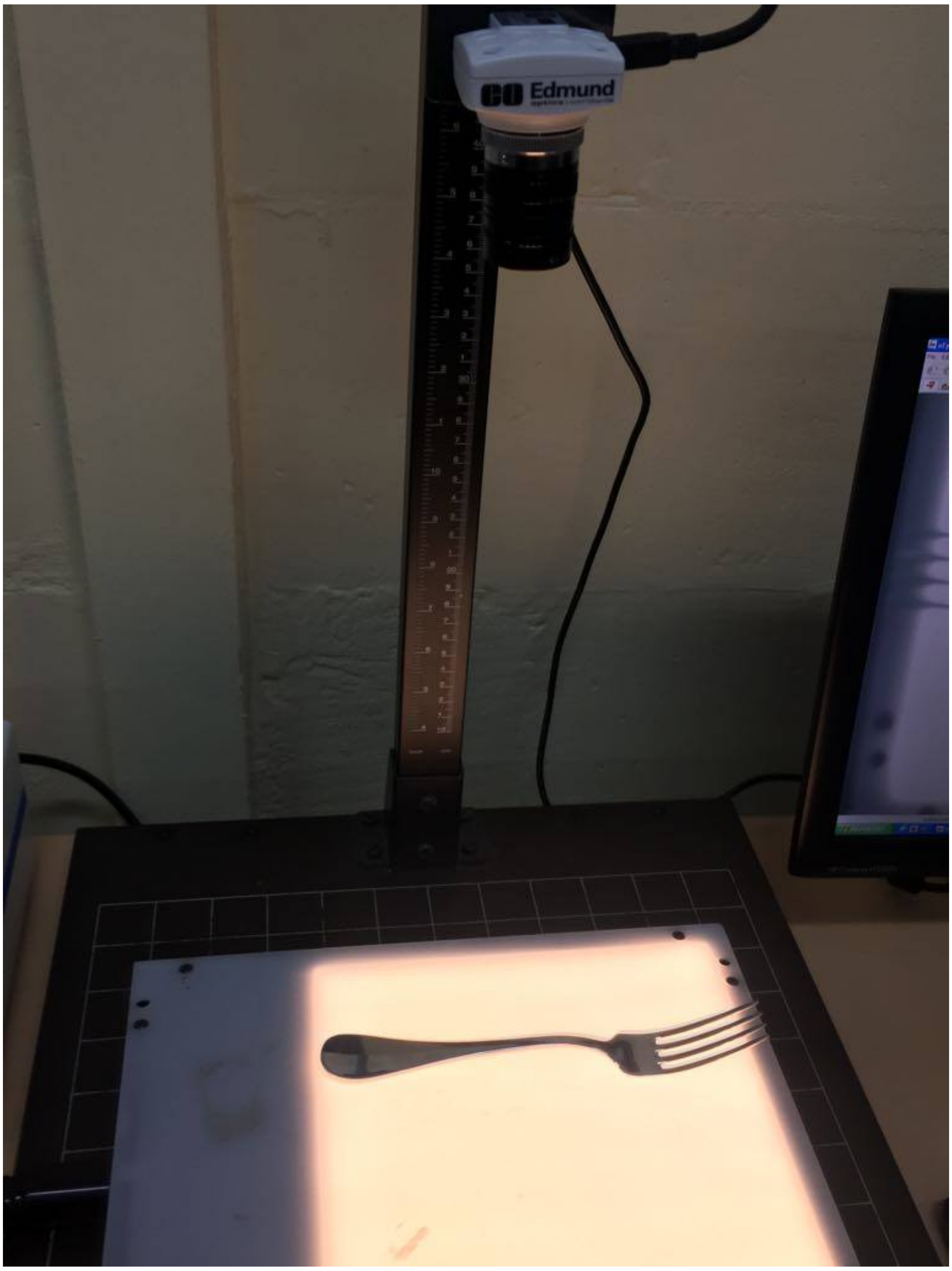
Sensors And Digitization

Lab 3 - Lens & Lighting



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Chapter 1

Introduction

1.1 Background Of Study

This is a report based on a laboratory course we had in our course module sensors and digitization. We performed tasks based on lens and lighting. Many research papers have defined a lens to a value that composes a getter and setter function to produce a bidirectional view into a data structure. Lenses are a very general concept and they can be applied to almost any kind of value that encapsulates data. The term lens can be applied to a piece of glass or transparent plastic, usually circular in shape that has two surfaces that are ground and polished in a specific manner designed to produce either a convergence or divergence of light. The two most common types of lenses are the concave and the convex lenses.

Light is of crucial importance in machine vision. The goal of lighting in machine vision is to obtain a robust application by enhancing the features to be inspected and by assuring high repeatability in image quality. Essentially, light is made up of wave-particles called photons. Visible light falls in the Electromagnetic Spectrum, between approximately 400 and 700 nanometers (1 nanometer=one billionth of a meter). White light consists of all visible colors combined. The color of visible light changes in respect to its wavelength. Red, being the longest wavelength and violet, the shortest.

1.2 Objectives

The goal of this laboratory course is for us to study the influence and characteristics of multiple lenses and lighting systems on an image acquired by a camera.

We will first study the camera available for the laboratory and give its key features. We will then run specific test with the camera and the lenses given to capture images with and without an extension ring and also compute Spatial resolution .

We also to implement our own experimental setup using our chosen lens and lighting configuration to perform Silhouette analysis and also defect detection on a shiny surface.

Chapter 2

Hardware and Software Specifications

2.1 Hardware Specifications

These where the hardware components in which we use during the laboratory course:

- PC Computer
- Industrial Lenses
- Extension Rings
- Lighting Devices
- LE (Lite Edition) EO USB 2.0

2.1.1 PC Computer

Our PC computer with a monitor, keyboard, mouse with a basic windows operating system which had the software which will be used to perform the tasks installed on it. This will be useful in monitoring and controls of the activities during the practical session.

Figure 2.1: PC Computer

2.1.2 Industrial lenses

We will be using 11 lenses with different measurement made up of the following specifications during this laboratory course.

Figure 2.2: Industrial Lenses

Detial of Lenses

- 1 x 8mm, 1:1.3
- 3 x 16mm, 1:14 (triplicates)
- 2 x 25mm, 1:1.3 (duplicates)
- 1 x 25mm, 1:1.6
- 2 x 35mm, 1:1.4 (duplicates)
- 2 x 50mm, 1:1.28 (duplicates)

2.1.3 Ligthing Devices

We will be using various types of lighting system in this practical work. We will use each with the main aim of the silhouette of a specific image. Below are the various types of lighting system we will use.

Figure 2.3: Lighting Devices

2.1.4 LE (Lite Edition) EO USB 2.0

The LE (Lite Edition) EO USB 2.0 cameras offer an even more compact, economical design in a high impact ABS plastic housing. Each camera features a 41mm x 41mm x 25.4mm housing and weighs only 32g.

Features :

- Ultra-Compact Housing
- Progressive Scan
- Adjustable Frame Rate via Binning, Sub-sampling or AOI
- Powerful Easy to Use Software Interface

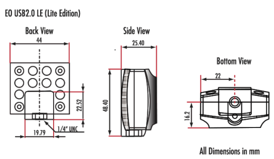

Figure 2.4: Camera Dimensions

Figure 2.5: LE(ite Edition) EO USB 2.0

Specifications :

- Manufacturer : EO
- Video Output : USB 2.0
- Mount : C-Mount

Chapter 3

Lens

3.1 Choosing the right lens

The goal of this part is to get the best image using the appropriated lens. To do that we mount the selected lens on the camera and start the software before grabbing images.

3.1.1 Manipulation

We did experiment in 6 lens in order to decreasing the focal length. Each lens we took 3 pictures to show 3 calibration, 1 for maximum aperture (more light), 1 for minimum aperture (less light), 1 for best quality picture. All has been taken with the best focus setting (focus ring adjusting) and constant distance of 500 mm between camera and the object.
The focus ring determine how sharp an image could be produce. It?s indicate Depth of Field which is the field that the subject is sharp in this field and blurred (out of focus) when it?s out of this range. The Aperture determine how wide a lens could open to let light come inside the camera. Therefore it affects the brightness of images. It also change the depth of field by shrinking / expanding its range. The focal length determine the view/perspective of the image, how zoomed it is. The higher focal length lens the more the image will be zoomed.

	Lens	Focus distance	Maximum aperture	Minimum Aperture
1	1:2.8 50mm	0.53	2.8	16
2	1:1.4 35mm	0.8	1.4	16
3	1:1.6 25mm	1.5	1.6	16
4	1:1.3 25mm	1.5	1.3	16
5	1:1.4 16mm	0.5	1.4	16
6	1:1.3 8mm		1.3	16

Figure 3.1: Parameters

3.1.2 Results

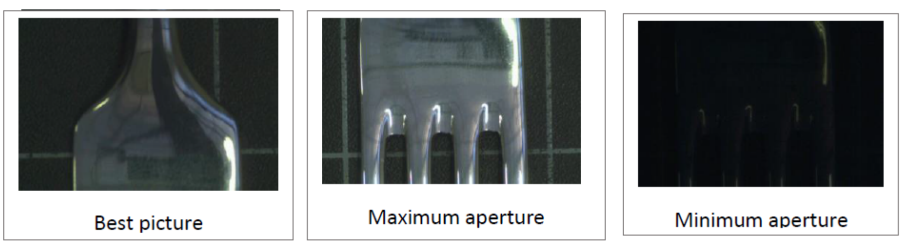

Figure 3.2: Lens 1

Figure 3.3: Lens2

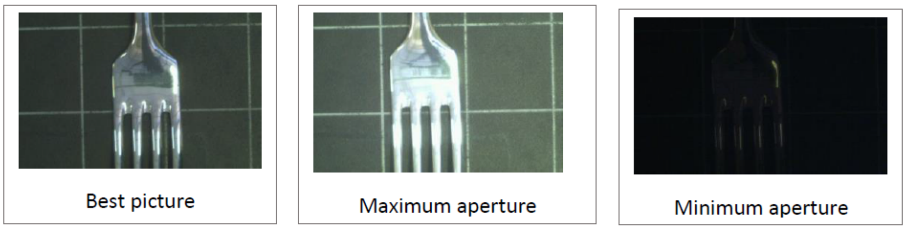

Figure 3.4: Lens3

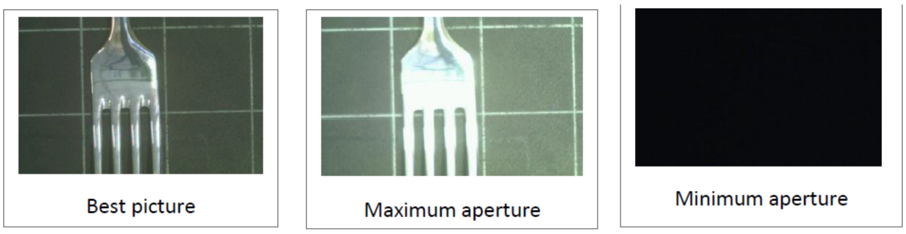

Figure 3.5: Lens4

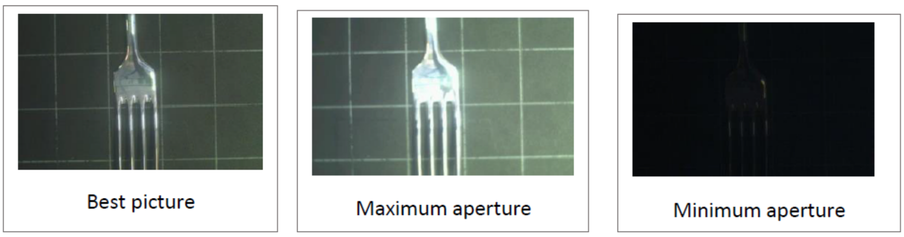

Figure 3.6: Lens5

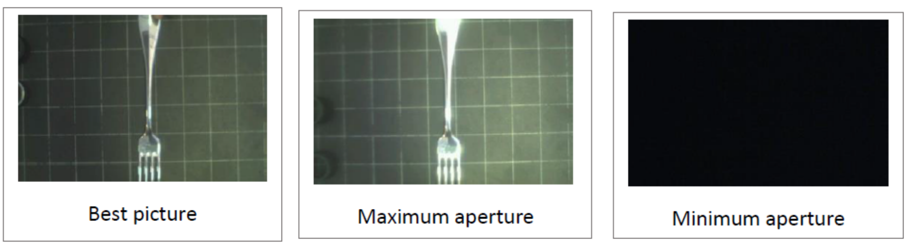

Figure 3.7: Lens6

The best image where the fork is entirely seen is given by the lens 6.

Chapter 4

Spatial Resolution

Spatial resolution is a term that refers to the number of pixels utilized in construction of a digital image. Images having higher spatial resolution are composed with a greater number of pixels than those of lower spatial resolution.

The measure of how closely lines can be resolved in an image is called spatial resolution, and it depends on properties of the system creating the image, not just the pixel resolution in pixels per inch (ppi). For practical purposes the clarity of the image is decided by its spatial resolution, not the number of pixels in an image. In effect, spatial resolution refers to the number of independent pixel values per unit length.

4.1 Experiment

We performed a spatial resolution on the image in which we chose as the best . We used the properties of the software to compute spatial resolution. We manipulated the pixel clock bar. The initial image had a pixel clock at 24 so we perform three instances in which we then gave reports on.

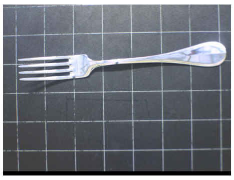

Figure 4.1: Image at pixel clock 5

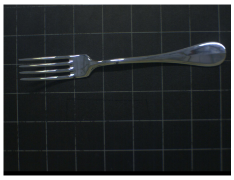

Figure 4.2: Image at pixel clock 30

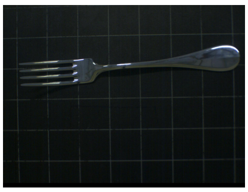

Figure 4.3: Image at pixel clock 43

Observation: When operating the pixel clock bar as the slider is moved to the right, the spatial frequency of the digital image is linearly reduced. The spatial frequencies utilized range from 175 x 175 pixels (30,625 total pixels) down to 7 x 7 pixels (49 total pixels) to provide a wide latitude of possible resolutions within the frequency domain. As the slider is moved to the right (reducing the number of pixels in the digital image), specimen details are sampled at increasingly lower spatial frequencies and image detail is lost. At the lower spatial frequencies, pixel blocking occurs (often referred to as pixelation) and masks most of the image features.

4.2 Extension rings

In this part we mount different extension rings to the lens keeping the distance from the fork at 50mm.

Figure 4.4: Extension ring 20mm added

Figure 4.5: Extension ring 30mm added

We can observe that by adding a extension ring from 5mm, we can't see the object anymore. so we have to modify the distance between the lens and the object to be able to get an image of the object.

Chapter 5

Lightning

5.1 Silhouette Analysis

In this case we will study the influence of the light to the object in order to observe the contour. To do that, we put the fork on different lightning and modify the lens(18 mm) parameters in order to get the best contour. We will use 3 different lightening as shown the figures below.

Figure 5.1: Light 1

Figure 5.2: Light 2

Figure 5.3: Light 3

Results The main difference of 4 lighting systems is the intensity and the direction of the light source. The best lighting system to produce best silhouette of the fork is the lighting system in figure 5.6. The intensity is moderate in order to keep the fork stand out completely and still keep the sharped edges.

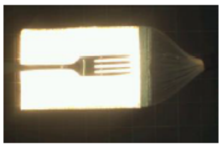

Figure 5.4: Light 1

Figure 5.5: Light 2

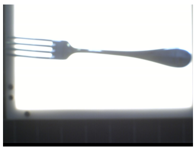

Figure 5.6: Light 3

5.2 Defect Detection on Shiny Surface

This final part is to detect the scratches and holes seen in the fork. For that we use a lens with a focal distance at 25mm to observe more details

Figure 5.7: Image at pixel clock 5

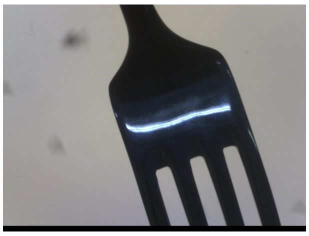

Figure 5.8: Image at pixel clock 30

Figure 5.9: Image at pixel clock 5

Figure 5.10: Image at pixel clock 30

5.3 Surface Inspection

One of the particular use of the lightning is also to perform detection of a surface. For our lab course, we particularly performed coins detections using a 1 an 5 cents coins. In order do keep the distance between the lens and the coins in 50mm we change the previous lens to another one with a focal distance at 50mm and get as result the figure below.

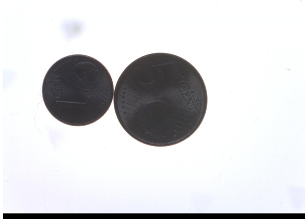

Figure 5.11: Coin detection

Chapter 6

Conclusion

We performed the tasks given and gained more knowledge during this course. We were able to have better understanding with lights and lens. We used it in various setups and achieved remarkable findings.

Lens and lighting has a major impact in many sectors of developments. Be it in industries or say health sectors. advance lens are used to attain necessary informations or details in which could not been seen normally. Lens and lights works hand in hand with each other and has made life much more easier in various disciplines.

We will not just stop here but also research and acquire more knowledge with our future studies.

References

1. **Lecture Notes on Sensors and Digitization**
2. **Spatial Resolution**
   http://micro.magnet.fsu.edu/primer/java/digitalimaging/processing/spatialresolution/