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Influence of Image pixels and Image contrasts in computing 2D geometrical properties using MATLAB

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Abstract. A traditional way of measuring an object is cumbersome since the same methods were astounded by expending the MATLAB program that acts as a dynamic methodology to utilize this technology in a more operational and supple way to measure the apparatuses in 2- Dimensional manner by the easiest mode of using MATLAB toolbox. In general, these measuring methodologies are prepared manually through gauges and gauging devices which leads to the instrumental errors as well as human miscalculations. As a result, utilizing this toolbox trailing process provides enhanced consequences with an adequate assortment of insignificant percentage of manual error. The main objective of the study is to have constant standoff distance between the object and camera for different configurations and reveal the secrets about image pixels and contrast behind the images by comparing between and among the same digital images of different configurations of specimens.

INTRODUCTION

Conservative dimension measurement process established on the measuring gauges and measurement devices with manmade blunder and ecological disruption with narrow calculating/analysis setting. The conformist approaches are also liable on the peripheral features bounded comparable to temperature, pressure, fluid, vibration and etc.

Strength of any quantifiable material depends on the 2- Dimensional possessions to resist in contrast to fracture failure or strain variation mechanism. The study on 2-Dimensional properties of metals and non-metals are conceded out to examine the strength and other mechanical and metallurgical properties of materials.

This entire investigation is based on 2 phase of materials which is about the digital image dispensation by use of the MATLAB program by comparing it is Image scale factors. Primary objective of our study is to maintain constant standoff distance for all test on various objects. First phase of our investigation is to examine the influence of pixels in color image, gray image and binary image by the virtue of Image Scale Factor (ISF). Second phase of our study is to understand the influence of image contrast between the images which is from the results of phase one by the virtue of Image Scale Factor (ISF). Obviously, the study is carried parallel to understand the MATLAB codes to process images and capture all of the images with the high resolution camera to create high resolution image with adequate circumstantial light source to augment the precision of the images. Lastly, the images were processed through MATLAB codes in suitable database and measure the fundamental 2-Dimension properties comprising width and length using the measuring tool of MATLAB programs' tool box. As common, the validating process is completed at the end and fraction of difference where distinguished. In addition, exploration about the applications and it is compared with traditional method.

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To carry out the test to we have selected two standard specimens and one manually prepared specimen. Here we notion as specimen-A (50mm sine gauge), and Specimen-B (100mm sine gauge) & Specimen-C (200 x 50mm Al specimen) to display the disparity occurs before and after by captivating several images. Error eradication during complete process of Digital Image Processing Technique are very much significant though allowing for some inaccuracies are not taken as a serious issue.

LITERATURE REVIEW

In the current year innumerable research exploration on Measurement of Strain [1] is frequently used on one of the non-destructive procedure known as Image Processing [2]. However, 2-D measurement systems has its own advantages and shortcomings. Primarily the learning of image processing on the Aluminium cantilever beam was studied with gummed black square arrangement. A Regular DSLR camera and a laptop for software design determination is used. Image analysis methods based on Open CV are used to examine comparative movements of the indicators on the test specimen. Image processing was done by Open Source Computer Vision is a huge collection of programming utilities chiefly designed at real-time computer vision. This Open CV was premeditated for its computational competence and with a robust focus on real-time submissions. Dev C++ program was used to advance the codes for the image processing technique like thresholding the image (output-1), image filtration, and centroid discovery (output-2) along with strain measurement by bubble species. The deflection in Y direction that is strain is calculated mapping with both images pixel values. Finally, theoretical and experimental deflection were compared and it is within +-10% error [3].

Similar way, the above work was extended by the author by introducing MATLAB. Here measurement of strain from tensile test was carried out using MATLAB environment and Normalized cross correlation was used to find displacement. Image processing technique was explained in detail with enough pictures reference [8]. Author suggested to use MATLAB image processing tool box instead of more complex formula. Also preferring to square of pixels must be compared with target image by correlation instead of single pixel which produce less computation but unreliable accuracy. Finally concluding that DIC method is an alternative way for calculating Poisson's ratio [4].

Next, Image Processing and Image Quality Assessment with experimental results were discussed [5]. This paper provides an overview of some possible usage of the software described in the Part I. It contains the real examples of image quality improvement, distortion simulations, objective and subjective quality assessment and other ways of image processing that can be obtained by the individual applications.

This paper completes the description of the MATLAB-based applications for image processing and image quality assessment developed at MMTG, FEE, CTU in Prague started in the first part with the description of their function. In this part some concrete examples of use were shown and every application was practically presented.

This above three distinctive work is the motive force for this paper.

EXPERIMENTAL WORK

The 2-Dimensional Digital Image Correspondence encompasses the subsequent three successive steps

Specimen and investigational groundwork

In this article, the creation of two dissimilar design mark on each of three specimens-A (50mm sine gauge), B (100mm sine gauge) & C (200x50mm Al specimen). And the high perseverance digital camera CANON 6D mark 2, lens 50mm, f/1.4 is placed with its optical axis standard to the sample surface. Formerly the factual experimentation and seizing of investigational digital image is required to do pilot examination for discovering the digital camera in suitable position and alignment to evade image misrepresentation, patching and for better clarity image. The greater resolution digital camera CANON 6D mark 2, lens 50mm, f/1.4 is located with its optical axis standard to the surface of sample.

Constant Standoff specification of experimental setup is as follows:

1. From the ground to the camera 120cm apart.
2. From camera to sine gauge bar is50cm.

The Subsequent stage of the experimentation is to record the digital image with good focus and sufficient brightness of the planer face of the sample.

There are numerous deviances on digital image that can be detected amongst the image reserved by digital camera and the authentic surroundings. Some are ecological distortion and some are alignment alteration. Hence image standardization is counteractive accomplishment to recompense for major distortion.

In the foremost phase the camera is being regulated by patterning datum point or network of points for the known value or known detachment, resulting Image Scale Factor (ISF) is calibrated by matching the reserved image pixel detachment with actual distance. The first digital image with white background or bright surroundings prior to the distortion or start of investigation is referred as “start image”.

Data accusation

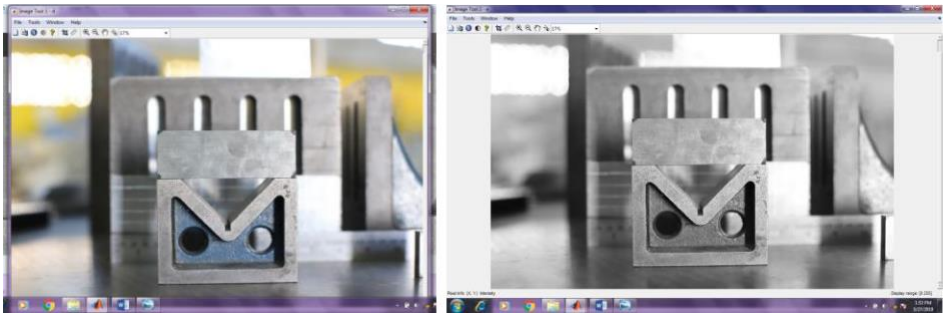
Throughout data accusation process, the extent of digital image essentially be in smart size to advance the process time.

Image resizing

In the present experiment, size of the images was taken by digital camera CANON 6D is 6000 x 4000 pixels is very bulk to display and edit. So as a preliminary step to all the digital images are resizing and converting them from RGB to Gray scale by the succeeding MATLAB instructions.

```
a=imread('barb.jpg');
b=rgb2gray(a);

c=b(1400:2400,2100:4400)
imwrite(c, 'crb.jpg');
imshow(c);
```

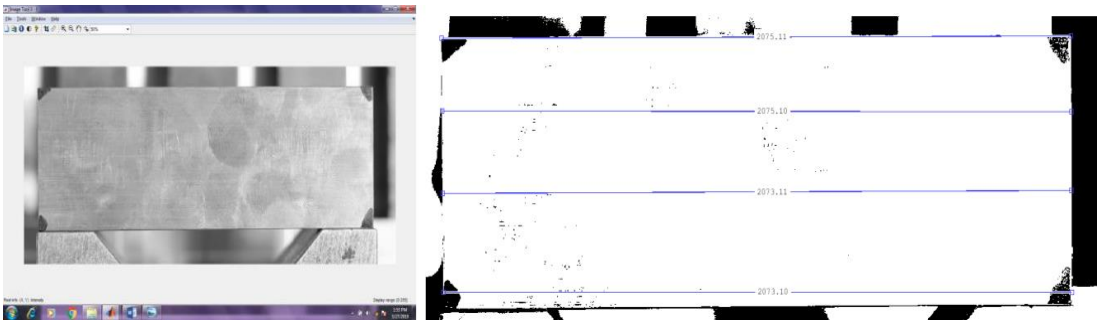


(a) (b)

FIGURE 1. (a) RGB image, (b) RGB to gray image

Image Cropping

Abridged size of image is adequate to disclose the statistics. So, threshold process or transforming gray scale to binary is not necessary, and the area of attention from the un-deformed image was gathered and mentioned as datum or Region of Interest (ROI) spot by the following MATLAB command



(a) (b)

FIGURE 2. (a) Region of Interest (ROI) in gray, (b) ROI in black and white

Data collection

Data collection is the process starts to calibrate the distance sandwiched between the pixels striking at each sample. Then, the observed values are organized for evaluation to conclude estimation process that is completed by numerical operations.

The development of observing a connection or relationship amid two pixels is marked on each sample [6].

Scale factor

The definite distance between A & B / Dignified pixel distance amongst A & B

The Definite distance (length or width) of sine gauge bar in mm (Gauge measurement)

Test No 1: *100 x 35mm sine gauge*

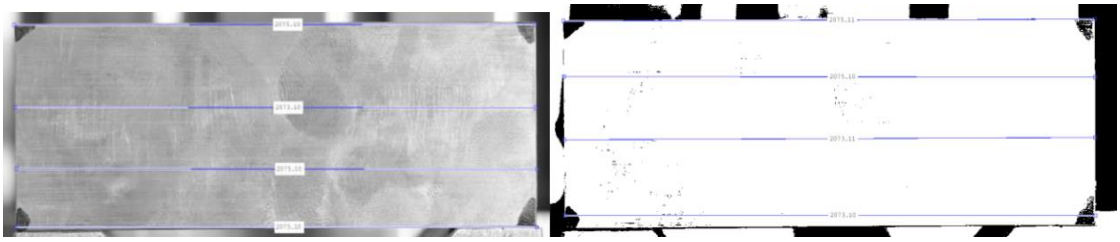
Scale factor

Definite distance between / pixel distance between A & B

The Authentic dimensions of specimen is 100mm length and 35mm width. (Gauge measurement)

Using MATLAB the calibrated pixel distance is as follows

Measurement in horizontal direction



(a) (b)

FIGURE 3. 100 x 35mm sine gauge (a) in Gray, (b) in black & white with horizontal measurements

TABLE 1. Horizontal measurements of 100 x 35mm sine gauge

Image	**Track 1 (Pix)**	**Track 2(Pix)**	**Track 3(Pix)**	**Track 4(Pix)**	**Avg (Pix)**
Gray	2075.11	2075.10	2073.11	2073.10	2074.10
B/W	2075.10	2073.10	2075.10	2075.10	2074.6
			Final average		2074.35

Distance between each pixel is given by

2074.3525 pixels = 100mm

1 pixel =?

100 / 2074.3525 = 0.04821mm

Individually, the pixel value on image is 0.04821mm (say 0.05mm) called the Image Scale Factor (ISF), and a very vital factor is the linear distance between the camera and specimen should endure the same as any relative movement of this distance can leads to distortion of the image size of sample.

Measurement in Vertical direction

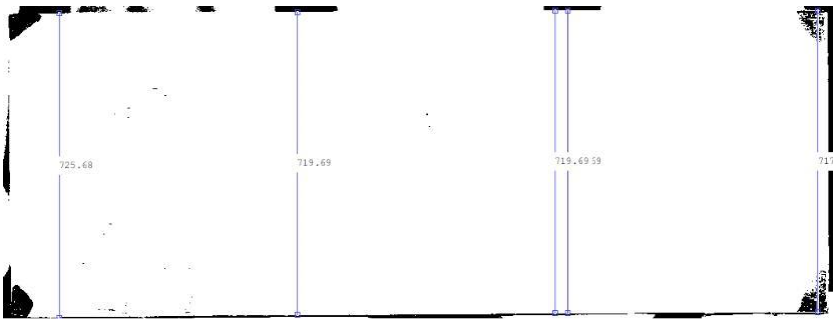


FIGURE 4. 100 x 35mm sine gauge with vertical measurements

TABLE 2. Vertical measurements of 100 x 35mm sine gauge

Track 1 (Pix)	Track 2 (Pix)	Track 3 (Pix)	Avg (Pix)
725.68	719.59	717.59	
	Average		720.953

Distance between pixels:

720.95 pixels = 35mm

1 pixel =?

35 / 720.95 = 0.0485mm

Each pixel value on image is 0.0485mm (say 0.05mm) called image scale factor (ISF).

Test No 2*: 50 x 35mm sine gauge*

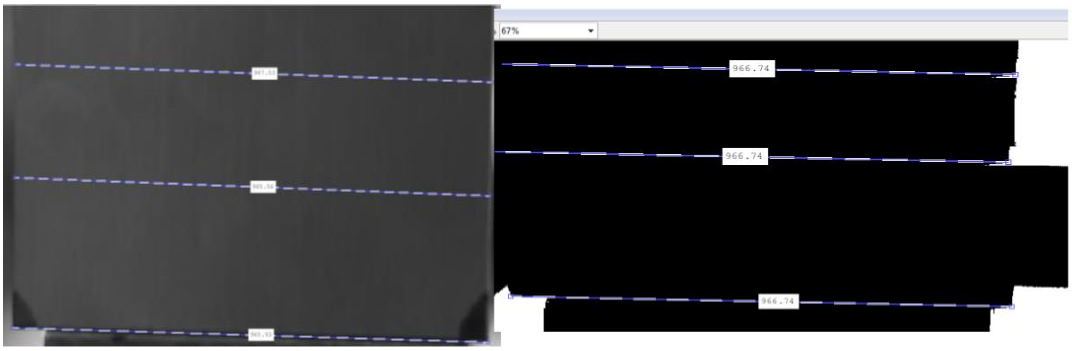
Scale factor

Actual distance between / pixel distance between A & B

The Actual dimensions of specimen is 50mm length and 35mm width. (Gauge measurement)

Using MATLAB the measured pixel distance is as follows

Measurement in horizontal direction



(a) (b)

FIGURE 5. 50 x 35mm sine gauge (a) in Gray, (b) in black & white with horizontal measurements

TABLE 3. Horizontal measurements of 50 x 35mm sine gauge

Image	Track 1 (Pix)	Track 2(Pix)	Track 3(Pix)	Avg (Pix)
Gray	967.53	965.56	965.93	966.93
B/W	966.74	966.70	966.78	966.73
	Final average			966.54

Distance between each pixel is 966.54 pixels = 50mm

1 pixel =?

50 / 966.54 = 0.0517mm

Each pixel value on image is 0.0517mm (say 0.05mm) called Image Scale Factor (ISF)

Measurement in Vertical direction

FIGURE 6. 50 x 35mm sine gauge with vertical measurements

TABLE 4. Vertical measurements of 50 x 35mm sine gauge

Track 1 (Pix)	Track 2 (Pix)	Track 3 (Pix)	Avg (Pix)
667.24	665.74	667.24	
	Average		666.74

Distance between pixels is 666.74 pixels = 35mm

1 pixel =?

35 / 666.74 = 0.05249mm

Each pixel value on image is 0.0524 (say 0.05mm) called image scale factor (ISF).

Test No 3: 200 x 50mm Aluminium sheet

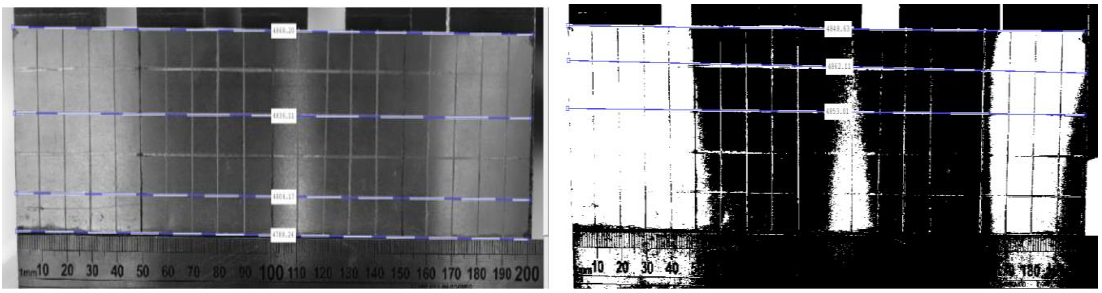
Scale factor

Actual distance between / pixel distance between A & B

The Actual length of AL sheet = 200mm (Gauge measurement)

Using MATLAB the measured pixel distance is as follows

Measurement in horizontal direction



(a) (b)

FIGURE 7. 200 x 50mm Al sheet specimen with cross pattern (a) in Gray, (b) in black & white with horizontal measurements

TABLE 5. Horizontal measurements of 200 x 50mm Al sheet

Image	Track 1 (Pix)	Track 2(Pix)	Track 3(Pix)	Avg (Pix)
Gray	4868.20	4836.11	4804.17	4824.18
B/W	4848.63	4862.11	4853.01	4861.25
		Final average		4842.7

Distance between each pixel is

4842.715 pixels = 200mm

1 pixel =?

200 / 4842.715 = 0.0413mm

Each pixel value on image is 0.0413mm (say 0.04 mm) called image scale factor (ISF).

Measurement in vertical direction

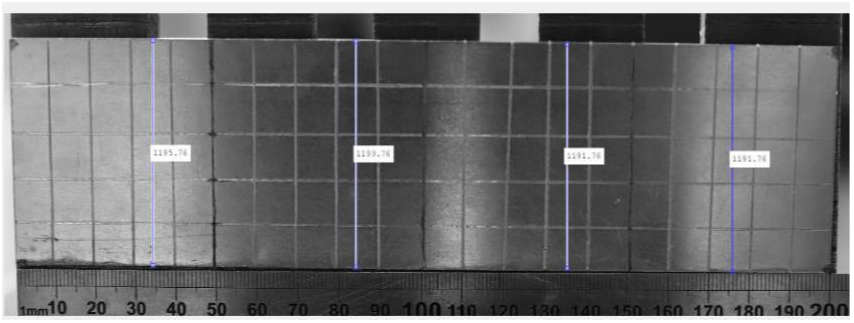


FIGURE 8. 200 x 50mm Al sheet with vertical measurements

TABLE 6. Vertical measurements of 200 x 50mm Al sheet

Track 1 (Pix)	Track 2 (Pix)	Track 3 (Pix)	Avg (Pix)
1195.76	1199.76	1191.76	
	Average		1195.76

Distance between pixels is 1195.76 pixels = 50mm

1 pixel =?

50 / 1195.76 = 0.04181mm

Each pixel value on image is 0.04181 (say 0.05mm) called image scale factor (ISF).

RESULTS AND DISCUSSION

The results and discussion is classified into two ways based on the objective of our study in this paper. Influence of pixels on the gray and binary (black & white) image while in measurement of 2-Geometrical properties by the virtue of image scale factor, secondly based on the specimen image contrast configuration also based on the virtue of image scale factor.

The variation in results due to positioning of camera with the given sample, and the distortion in image is observed by manual pursuing in MATLAB program.

But, even though the variations are microscopic and as well in acceptable range of error i.e. within 20%. Initial discussion is about contrast between gray and colored image using the image scale factor. From table 7 and 8 shows that image scale factors among these are almost same if we compare the respective specimens. Even we can observe the percentage of variation in pixels is tabulated keeping the 50 x 35mm sine gauge as a base element. Obviously, the percentage of variation in 100 x 35mm sine gauge gray vs black & white is almost same, even this is reflected same way in 200 x 50mm Aluminium manually prepared sheet.

TABLE 7. Average measurements from 2D Gray image

Specifications	Average 2D Gray image (Pixels)	Image scale factor (mm)	Percentage of variation in ISF
50 x 35mm sine gauge	966.93	0.051710	0
100 x 35mm sine gauge	2074.10	0.048213	6.76
200 x 50mm Al sheet	4824.18	0.041457	19.83

TABLE 8. Average measurements from 2D black & white image

Specifications	Average 2D black & white image (Pixels)	Image scale factor (mm)	Percentage of variation in ISF
50 x 35mm sine gauge	966.73	0.051721	0
100 x 35mm sine gauge	2074.6	0.048202	6.8
200 x 50mm Al sheet	4861.25	0.041141	20.5

Our study focuses on between gray and black & white only not on color. Generally gray scale image is one-dimension image and It is derived from RGB image [7] has shades of black and white (256 combinations of shades of gray). However, color image (RGB) is three-dimension image. It contains the red color, Green color and Blue color image in separate matrix. Gray image is replica of color image, so either comparing gray or color image with black & white is same in result.

Next discussion in on pixels' variation in each images using image scale factor. Table 9 shows image scale factor of the measurement of each specimen in both horizontal and vertical direction. It shows large variation in 50 x 35mm sine gauge but other two quite similar in difference. So, image pixels play major role in large size specimen than small size. And it lays load way to further studies of small size specimen.

TABLE 9. Measurements of 2D black & white image in both directions

Specifications	Average pixels Vertical	Image scale factor mm	Average pixels Horizontal	Image scale factor Mm	Difference between the orientation X 10^{-4} mm
50 x 35mm sine gauge	666.74	0.052494	966.93	0.051710	7.84
100 x 35mm sine gauge	720.953	0.048547	2074.10	0.048213	3.34
200 x 50mm Al sheet	1195.76	0.041814	4824.18	0.041457	3.57

CONCLUSIONS

The results emphasis that gray or black & white images does not effects the results moreover conversion of this gray image into black & white is only for increasing the processing time and reducing the data storage capacity as well. Either gray or binary image can be used for measurement purpose however color image is not recommended. Because Color image has 3D and process time will be more than Gray and Binary image. Next, Pixels variation in large size components are almost negligible. So this study concludes that this method of measuring technique is most suitable in large size specimen than small size.

This non-contacting 2D digital image processing is consistent method for 2-Dimensional calibration and appropriate for all variety of specimen beyond limitation. In view of the results from the digital image processing through image tool box in MATLAB it is found that this method prerequisites fine tuning in process as well as in MATLAB coding to exclude elapsed time. But the obtained results also reveal the measurement are reliable, in future the same can be prolonged to Digital image correlation (DIC) technique and that can be utilized to find all the mechanical properties involving stress, strain etc. The Digital Image Correlation further can be protracted to tensile, compression even torsion tests to examine the specific mechanical properties.

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