THE IMPORTANCE OF CALIBRATION ON DIGITAL RADIOSCOPY SYSTEM

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Abstract

Radiography testing is one of the non-destructive testing methods where it is used to detect discontinuities in a material by using x-ray and gamma ray as a sources of radiation. Mobile digital radioscopy system (MDRS) is act as a detector or medium to capture and convert the image in a real time and the image produced can view directly from the computer connected to the MDRS. Calibration is one of the factors that we need to consider in order to get the image and see in a high resolution and good contrast. The advantage of calibration in MDRS is to reduce and avoid from the noise. Calibration is not stable and the imaging system must be calibrated periodically. It is also as an alternative to the radiographic film to reduce and saving cost and time with considerable saving in running cost and processing time.

Abstrak

Ujian radiografi adalah satu kaedah-kaedah ujian tanpa musnah dimana ianya mengesan ketidaksinambungan dalam satu bahan dengan menggunakan x-ray dan sinar gama sebagai satu sumber radiasi. Sistem radioskopi digital bergerak (MDRS) adalah betindak sebagai pengesan atau dan menukar imej dalam satu masa sebenar dan imej yang dihasilkan boleh dilihat secara langsung daripada komputer itu bertalian dengan MDRS. Penentukuran adalah satu faktor-faktor yang kami perlu mempertimbangkan supaya imej dapat terhasil dalam resolusi tinggi dan kontras yang baik. Kelebihan penentukuran dalam MDRS ialah untuk mengurangkan dan mengelak daripada gangguan pada imej. Penentukuran tidak stabil dan sistem pengimejan mesti diukur secara berkala. Ia juga sebagai satu alternatif bagi filem radiografi untuk mengurangkan dan menjimatkan belanja dan masa dalam kos pengendalian dan masa pemprosesan.

Keywords/katakunci: Digital radioscopy system, calibration

INTRODUCTION

Non-destructive testing is a method to do the test and examine in an object and to check whether there is a discontinuities in an object. In this paper we will discuss more about the radiographic testing. The accepting and rejecting an object depends on the types of defects and the size of defects and it is referred to the ASME V standard. Radiography testing is a method where it is used the radiation source. There are two types of radiation sources used in radiography technique. The object is placed between the source of radiation and a piece of film. The object will stop some of the radiation. Thicker and more dense will stop more if the radiation.

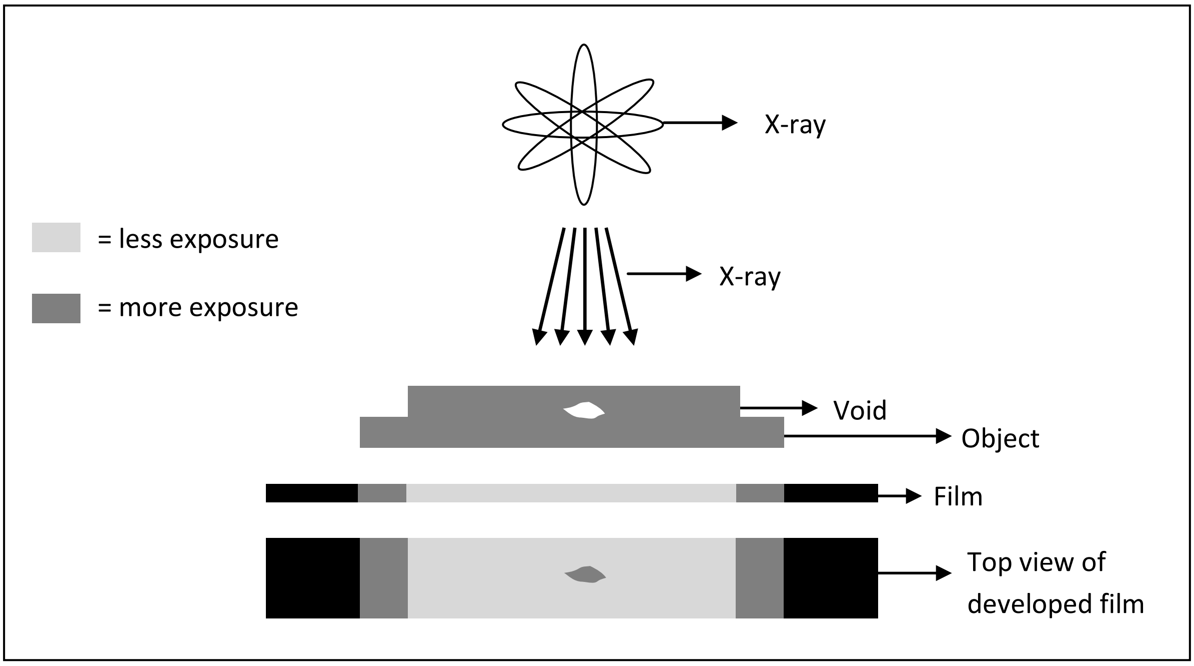


Figure 1: Schematic diagram of radiographic testing (RT)

The above figure shows us the schematic diagram of the radiographic testing. There are three main things we need to have in order to make the test in radiography. There are radiation source, object, and film.

The old technique we used in radiography testing is conventional radiography where it was used a piece of film as a medium to capture and store an image. After the film was exposed to radiation, the film has to develop first in dark room before the image can view and make an interpretation.

DIGITAL RADIOGRAPHY

The old technique is using the film as a medium to capture and store image. By using Digital radiography it will save the image into the digital image. This technique is easily and become friendly to operator when the inspection running. There are advantages while using the digital radiography such as it can reduce the exposure time,

MOBILE DIGITAL RADIOSCOPY SYSTEM (MDRS)

The MDRS is built up with a scientific monochrome camera (Charge Couple Device, CCD), fluorescence screen, first surface mirror and a lead glass. It is use to obtain digital radiographic image. The camera is protected with lead. The monochrome camera is coupled with a lens and the objective is focused on the fluorescence screen. This system is real time digital radiography and the image can viewed as a real time. The viewable image is 17mm x 14mm. The MDRS has been qualified in accordance EN13068 (Standard for general principles of radioscopic testing of metallic materials by X- and gamma rays. For radiographic inspection, the MDRS is useful for inspecting steel plates ranging from 5mm to 19mm thickness. The MDRS can also be use as a detector for stationary inspection of castings and small diameter pipe.

Figure 1: Mobile digital radioscopic system (MDRS)

SIGNAL TO NOISE RATIO (SNR) MEASUREMENT

Noise is a main factor to decrease the image quality. Its influences on the images could confuse the operators and make it more difficult to distinguish the defects. Noise is usually from x-ray photon fluctuation and A/D conversion, also from the digital hardware characteristic like reading out noise and so on. Noise level is measured by the SNR. SNR is the quotient of mean value I_{mean} of the linearised signal intensity and standard deviation σ of the noise at this signal intensity. It could be calculated by the formula

$$SNR = \frac{I\ mean}{\sigma} \qquad (1)$$

The value of SNR depends on the radiation dose and the imaging system properties.

The signal intensity I_{mean} *and standard deviation σ* shall be computed from a region without shading or artifacts. Sample SNR value will be taken in different regions of the image area under test to ensure that SNR value is stable and believable. The size of ROI (Region of Interest) used to measure the mean intensity and the noise shall be at least 20 by 55 pixels and it belongs to an area ROI. A kind of data processing technique for assuring reliable signal to noise measurement could be used as below. This can be achieved using a commonly available image processing tool. That means the signal and noise could be calculated from a data set of 1100 values or more per exposed area. The data set is subdivided into 55 groups or more with 20 values per group. For each group with index I, the value I_{mean} is calculated as mean of the unfiltered group values and the value σ is calculated from the same group values. An increased number of groups yield a better uncertainty of the result. The final result I_{mean} is obtained by the median of all I_{mean} values. The final σ value is obtained by the median of all values.

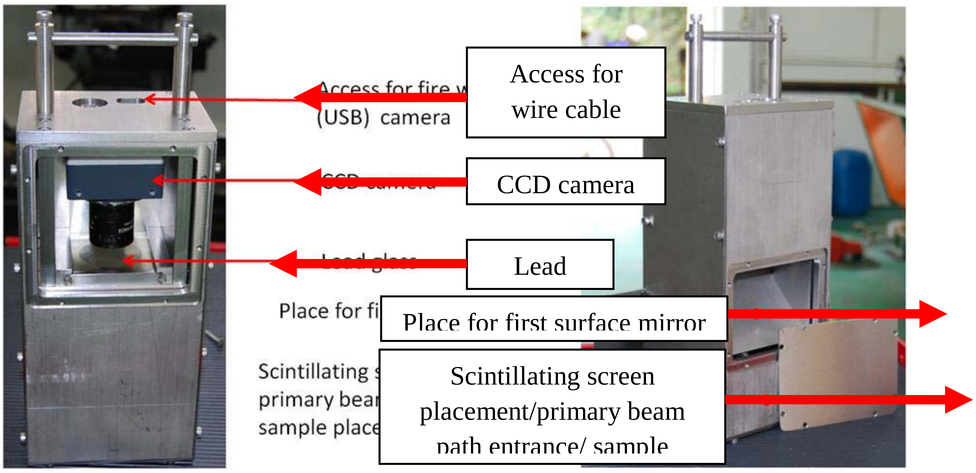


Figure 3: Complete set up of MDRS

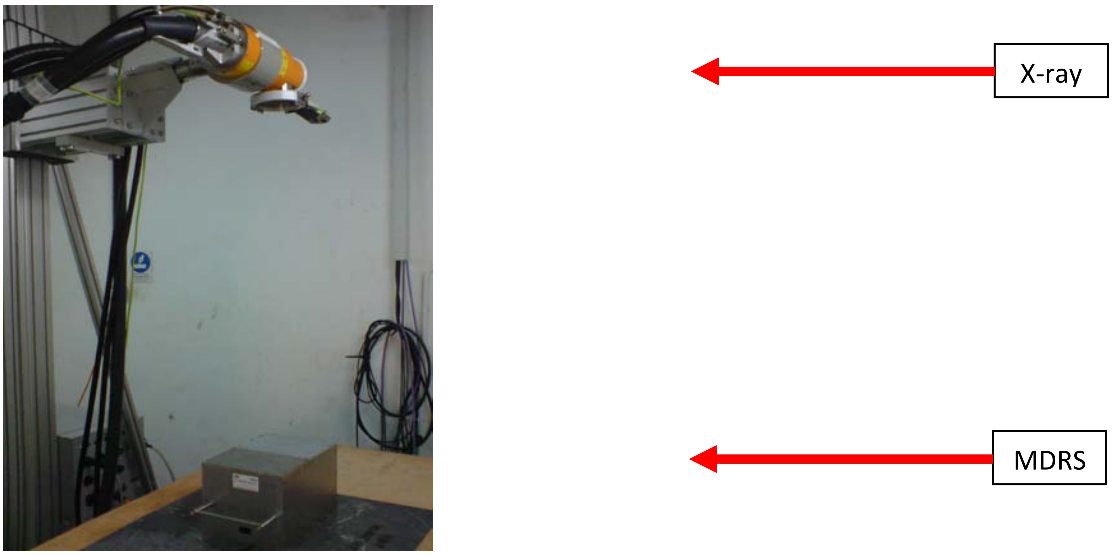


Figure 4: Experimental set up of MDRS

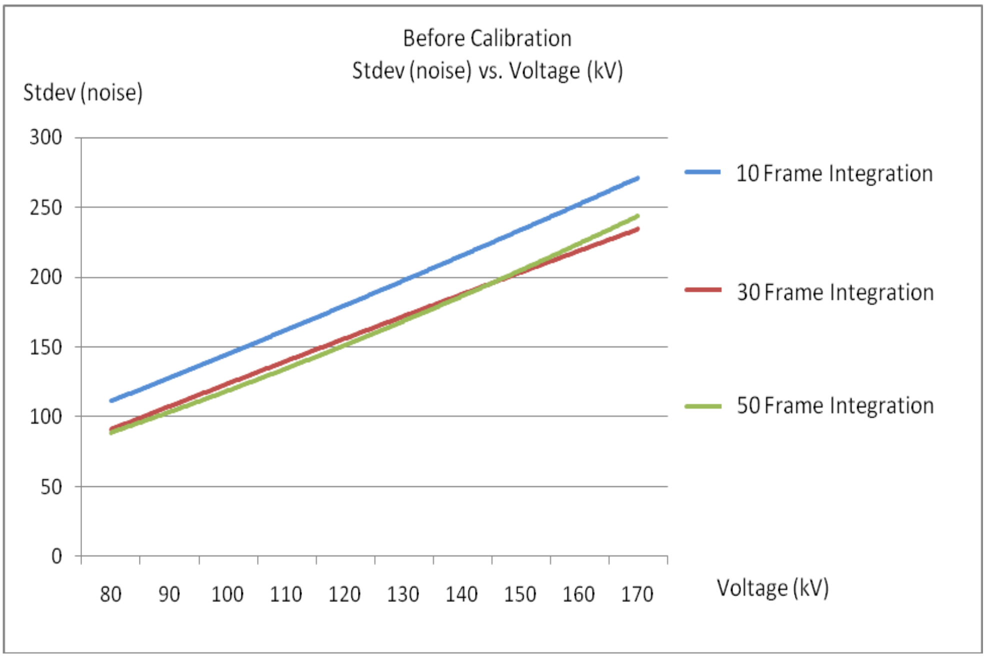
RESULT

10 Frame integration						
Voltage	Before calibration			After calibration		
kV	Mean (Signal)	Stdev (Noise)	Mean/Stdev (SNR)	Mean (Signal)	Stdev (Noise)	Mean/Stdev (SNR)
80	7685	109.8	69.99	6092	0	NaN
90	10062	127.8	78.74	7961	0	NaN
100	12678	143.2	88.53	9984	0	NaN
110	15405	168.8	91.27	12134	0	NaN
120	18188	181.6	100.2	14336	0	NaN
130	21058	196.2	107.4	16614	0	NaN
140	24003	214.4	112	18841	0	NaN
150	26806	231.2	116	21120	0	NaN
160	29694	248.6	119.3	23500	0	NaN
170	32471	276	117.7	25728	0	NaN

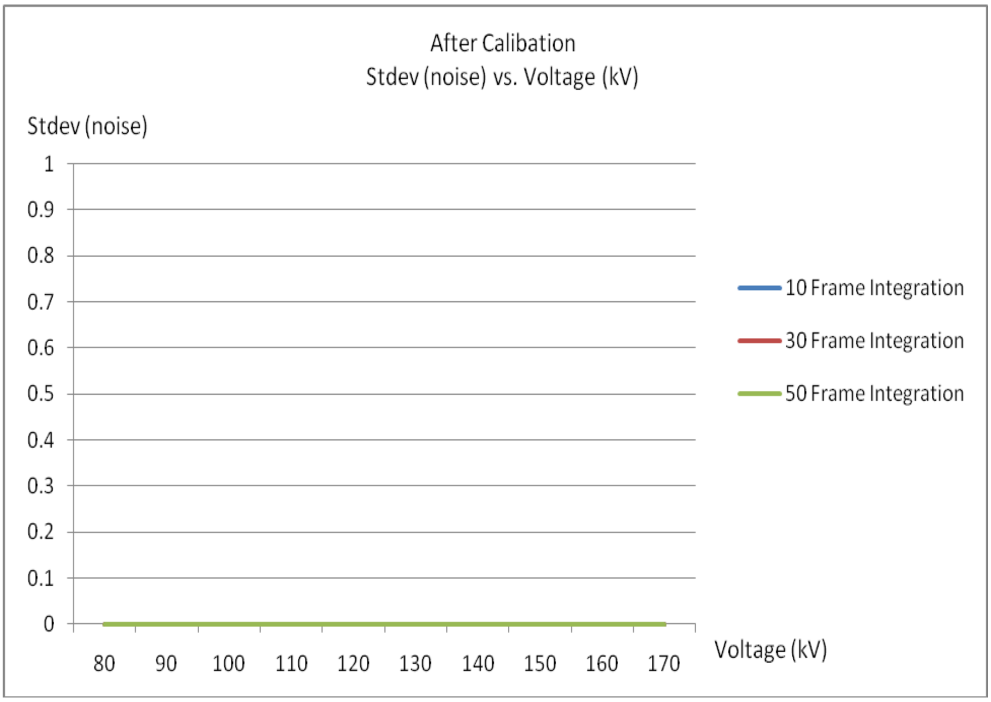
30 Frame integration						
Voltage	Before calibration			After calibration		
kV	Mean (Signal)	Stdev (Noise)	Mean/Stdev (SNR)	Mean (Signal)	Stdev (Noise)	Mean/Stdev (SNR)
80	7668	89.33	85.83	6075	0	NaN
90	10054	106.6	94.3	7944	0	NaN
100	12671	125.7	100.8	9975	0	NaN
110	15378	143.4	107.3	12117	0	NaN
120	18164	158.5	114.6	14318	0	NaN
130	21018	168.4	124.8	16588	0	NaN
140	24030	185.9	129.3	18875	0	NaN
150	26874	204.8	131.2	21179	0	NaN
160	29633	214.9	137.9	23483	0	NaN
170	32427	238.1	136.2	25745	0	NaN

50 Frame integration						
Voltage	Before calibration			After calibration		
kV	Mean (Signal)	Stdev (Noise)	Mean/Stdev (SNR)	Mean (Signal)	Stdev (Noise)	Mean/Stdev (SNR)
80	7656	86.84	88.17	6067	0	NaN
90	10045	102.1	98.34	7941	0	NaN
100	12658	120.1	105.4	9968	0	NaN
110	15372	140.2	109.6	12113	0	NaN
120	18155	155.3	116.9	14315	0	NaN
130	21018	163.2	128.8	16583	0	NaN
140	24011	185	129.8	18862	0	NaN
150	26819	202.4	132.5	21130	0	NaN
160	29654	223.3	132.8	23475	0	NaN
170	32503	247.4	131.4	25763	0	NaN

Table 1: Different frame integration with different voltage



Graph 1: MDRS Noise value before calibration



Graph 2: MDRS Noise value after calibration

Discussion

Noise is defined as an unwanted signal that interferes with the measurement or processing of information while for the processing noise is the noise that results from the digital/analog processing of signals. In order to reduce the noise and to avoid the noise, calibration is needed in this situation. To do calibration, we tested MDRS with different voltages, currents and frames integration. From the Table 1 it shows us the different frames integration with different voltages. As a result from the graph 1 is for the result before the calibration, Noise versus voltages values for 10, 30 and 50 frame integration. The linear line from the graph shows the higher the value of voltage the higher the noise and the higher the frame integration the lower for noise value.

Conclusion

Calibration is an important part before the real work can progress. As a conclusion, to reduce the noise the higher the number of frame integration the better it is.

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