The Video System for Imaging to the Bottom of Deep Pipe

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Abstract. Based on the CCD imaging device, a video system is presented to imaging the bottom of deep pipe. By laser beam irradiation, the bottom of deep pipe is detected by CCD chip , which is small view field and large focal length. Then, CCD chip conveys the bottom information to the SQ606 processor, by image processing, distinct image is got. At the defects analysis on the bottom of deep pipe, threshold is found out by regional segmentation method, After image segmentation, clear image about the bottom can be got, finally, the imperfection on the bottom is quickly located and precision measuring.

Introduction

In recent years, small-diameter deep pipe have a wide range of applications in infrastructure and petrochemical exploration and many other fields, due to deep tube diameter is relatively small, the length is relatively longer ,when the traditional deep-tube endoscopy detected the bottom, there is efficiency low, undetected high accuracy and low defects. Therefore, using the small field, a large focal length-based CCD technology, combined with digital image processing and software technology, by high-performance CCD chip, a clear picture of the bottom can be obtained passing image denoising.

The basic frame of the imaging system

To implement the bottom detectiong, a clear picture of the bottom of deep tube must be obtained. At firstl, from small-diameter deep tube diameter determines the radial size of an image sensor smaller; Second, the image magnification should be uniform, distortion should be small, the resolution must be high, this is an area of extreme defeats the premise; Finally, CCD chip must have a large focal length, so as to fit to different length detection of deep tube ,which can improve the versatility of the system.

The video technology contains the prominent features such as compact light weight and high resolution, high sensitivity in low light. Very well suited to deep-tube small aperture, high-quality testing requirements of the special requirements of the resolution. Therefore, CCD technology is usedto obtain images, system components are shown in Figure 1.

In the video system, CCD chip and laser light source are made up to the photoelectric measuring head , CCD sensor tube through the optical system gets the bottom of the deep image data, the data passed to an external SQ606 processor, the processor image information will be collected in real-time display, and according to the relevant algorithms calculation, flaws at the bottom of deep pipe can be got.

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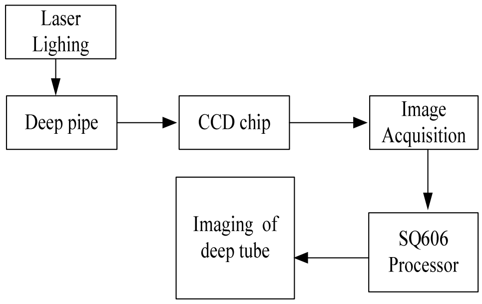

Figure I the diagram Figure of the video system

Hardware design

Hardwave system includes CCD chip, laser light source, image acquisition element and SQ606 processor systems.

Laser light source

To achieve the bottom image of the deep tube detection, not enough illumination is must overcome , when deep pipe is longer, aggregation of the beam have the premise of certain requirements, the system uses four pieces of the power of 5 mW He-Ne lasers, the lasers have the following characteristics:

1. the working material which is helium-neon gas mixture, high color and good uniformity, is the good coherent light source, the output power and wavelength can be stability controlled.

2.Laser is nearly straight line, which has great directional. The laser shot out in an angle of only a few radian.

3.The laser contains many advantages: simple structure, small volume, light in weight, long life.

Video system

CCD and the drive module are shown in Figure 2. Optical measuring head uses a color CCD, due to size constraints, the video signal of the driver, amplification and long-distance transmission circuits (10m) is separated with the CCD body ,by CCD drive of the external TMS320DSC series and controller ,the driver is completed, the input voltage is DC 9V/500mA, drive and control signal cable is 12-core shielded cable special ,for getting a good video signal output.

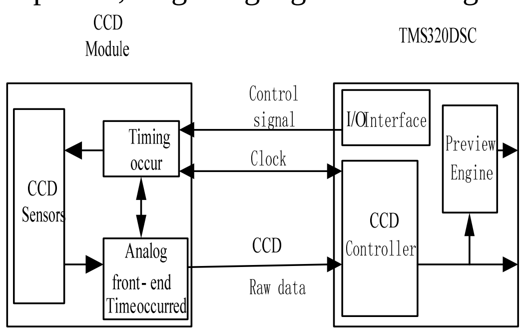

Figure 2 CCD module of the video system

Image Acquisition

Useing a digital CCTV processor ——SQ606, whichi is one fo the Digital Surveillance Processors provided by the Service & Quality (SQ) Technology (Taiwan). For the SQ606 processor real-time display or transmission of the memory real-time storage Input video signal, passing A / D converter, scaling, cropping and other processing. The SQ606 suports real-time video display on Tv screen in either NESC or PAL format. Moreover, this processor is equipped with a motion detection function. When there is any moving object detected, the images will be auto-recoded and saved. For storege media, the processor supports up to 16MB SDRAM,flash memory,and SD card. In addition to the featured H/W and F/W fuctions, the C++ programming platform is able to simplify the development on firmware platform and speed up the overall development schedule.

Image Processing

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After regulating the experimental system, the experimental images will be collected by CCD image capture software, using the SQ606 processor program to read the image information, then, gamma correction, filtering, and a series of binary image processing is took, and ultimately get the required Image of the bottom. Image processing part of the process is shown:

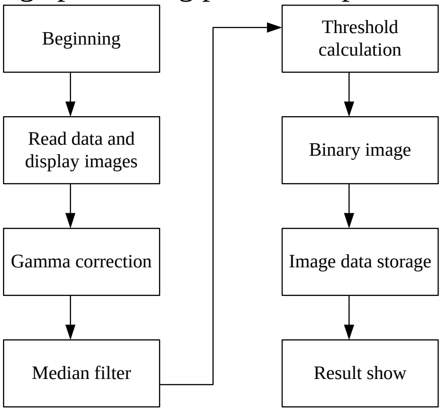

Figure 3 Overall structure

Gamma correction

In the imaging process, light in the scanning system and the light photoelectric conversion system is weak, and insufficient stability of the system can cause that the image is uneven, such as parts of the image is bright, but some parts of the is dark. Gamma correction is to modify the image pixels in the image acquisition system, R, G, B of each pixel multiplied by a constant number, which causes imaging of the entire image uniformly.

Image Filtering

Because noise of CCD and the impact of intermediate processing circuitry, the random noise is inevitably introduced, based on the experimental data, the noise is generally high frequency signal, which can be suppressed by filtering method.

Median filter is a nonlinear fuzzy image processing method, the gray value of all the pixels are sorted according to the order, while we select the gray value in the middle as the filter processing. By experimental observation, the value of the noise suppression filter can be a good, smooth images. As two-dimensional median filter window shapes, we can select linear, square, cross, circle and so on. Square and round are suit for the outline of the window for long objects, a steeple cross suits angle of the window object image. Therefore, this system takes a two-dimensional square filtering window.

Threshold calculation and image binarization

After processing the image display,for analysis image content better, using statistical pattern recognition in image segmentation. We take a regional approach to cut apart the image segmentation, it is particularly effective for the division of the objects and background scenes with strong contrast

3.3.1 Threshold Calculation

Considering all the threshold calculation, we use class discriminant analysis of Otsu's to find out threshold. Better separation characteristics are obtained by the threshold binary images, the specific process is as follows:

1, the calculation of the input image histogram

2, calculate the mean gray Ave= $\sum_{i=0}^{255}(i-1)Phs(i)$

3, calculate the mean gray level classes Acer (k) and the class histogram W (k)

Ave(k)= $\sum_{i=0}^{k}(i+1)Phs(i)$

W(k)= $\sum_{i=1}^{k}Phs(i)$

4, the calculation of separation index

Q(k)=

$\{ \left[Ave \times W(k) - Acer(k) \right]^2 \}/[W(k)*(1-W(k))]\}$

5, find the maximum value of Q

Best threshold: T = k-1

3.3.2 Binary image

Binary image is only with two gray-scale images. Grayscale histogram uses threshold gray image which can be achieved binarization. The threshold image binarization processing method:

f(i,j)=1; f(i,j)<T

f(i,j)=0; f(i,j)⩾T

With f (i, j) = 1 part of that object, with f (i, j) = 0 part of that background

Eventually the processed images will be imported into a SQ606 processor, by analyzing the problems of image, we can directly control the bottom of the deep flaws that exist.

Conclusion

The system is simple, easy to use, while relations and the operational processes that the device can be connected to each other can not be changed, non-destructive testing about the deep bottom of the tube can be took. Experiments show that the detection system has better image resolution and real-time, which can be applied to different caliber and length of the deep tube.

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