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DETERMINATION OF THE ACCURACY OF MEASURING USING A CAMERA
STANOVENÍ PŘESNOSTI MĚŘENÍ POMOCI KAMERY

Abstract

The article concerns CVS1450 Compact Video System. This device is connected to a PC via LAN. Another used component is a digital camera BASLER A601f which is connected to the CVS1450 via IEEE 1394 Fire-Wire. The PC is used only for programming and debugging. Several measuring of test-part radius were made on this device. The test-part was placed on a random position in the camera picture. The goal was to determine the accuracy of this device.

Abstrakt

Příspěvek se zabývá aplikací systému CVS1450 (Compact Video System) pro měření rozměrů jednoduchých součástí pro potřeby automatizovaných výrobních linek. Tato autonomní jednotka je připojena k PC pomocí LAN. Další použitý prvek sestavy je digitální kamera BASLER A601f, která je připojena k CVS1450 pomocí IEEE 1394 (Fire-Wire). PC je použito pouze k programování a ladění algoritmu. Na tomto zařízení bylo provedeno několik měření poloměru na testovací součásti. Testovací součást – podložka šroubu, a matice byly náhodně umístěny v obraze kamery. Cílem bylo zjistit přesnost tohoto zařízení. Zjištěné výsledky jsou vyhodnoceny v závěru tohoto textu. Popisovaná sestava se v současné době používá ve výuce na katedře robototechniky.

INTRODUCTION

The article describes a device which is determined to picture analysis. This device consists of products made by companies National Instruments and BASLER. Product of National Instruments is the evaluation device CVS1450 (Compact Vision System). This device contains three IEEE 1394 Fire-Wire ports and one LAN, which is used for connection with PC. This device can also be connected directly to a monitor. Camera (model A601f) from BASLER is used for picture acquisition. This camera is digital and it is connected via IEEE 1394 Fire-Wire port.

Evaluation device CVS1450 is programmed by software, which is product of National Instrument, too. The name of this software is Vision Builder AI 3.0.

The goal was to calibrate the Compact Vision System by a simple calibration to real sizes and to measure radius of a washer. The radius was measured in randomly selected places in camera picture. The goal of this measuring is to determine accuracy of this device when the calibration mentioned above is used.

DESCRIPTION OF WIRING CIRCUIT

The wiring circuit is shown on Fig.1. Digital camera BASLER A601f is connected to evaluation device CVS1450 via IEEE 1394 Fire-Wire. A monitor connected to VGA output displays the picture from camera and measured data. The Compact Vision System is connected to PC via 100 Mbit/s LAN.

PC with necessary software was used for setting and programming. When programming is finished and the program is uploaded to CVS 1450 device, this device is able to work stand-alone.

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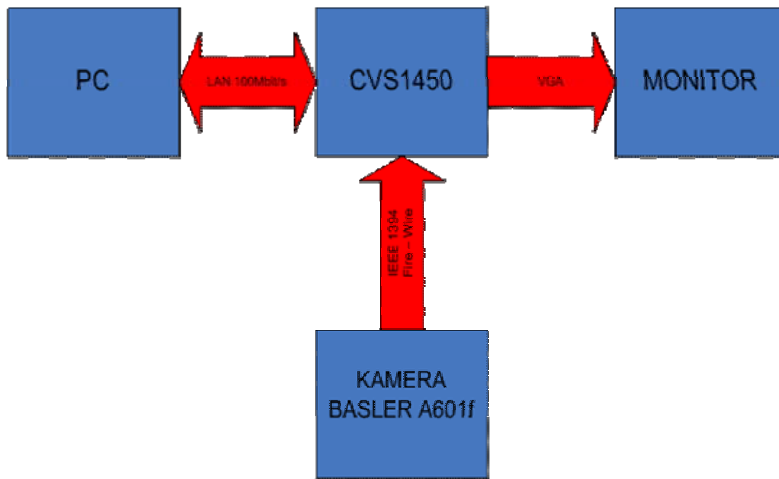


Fig. 1 Wiring circuit

DESCRIPTION OF CONSTRUCTION

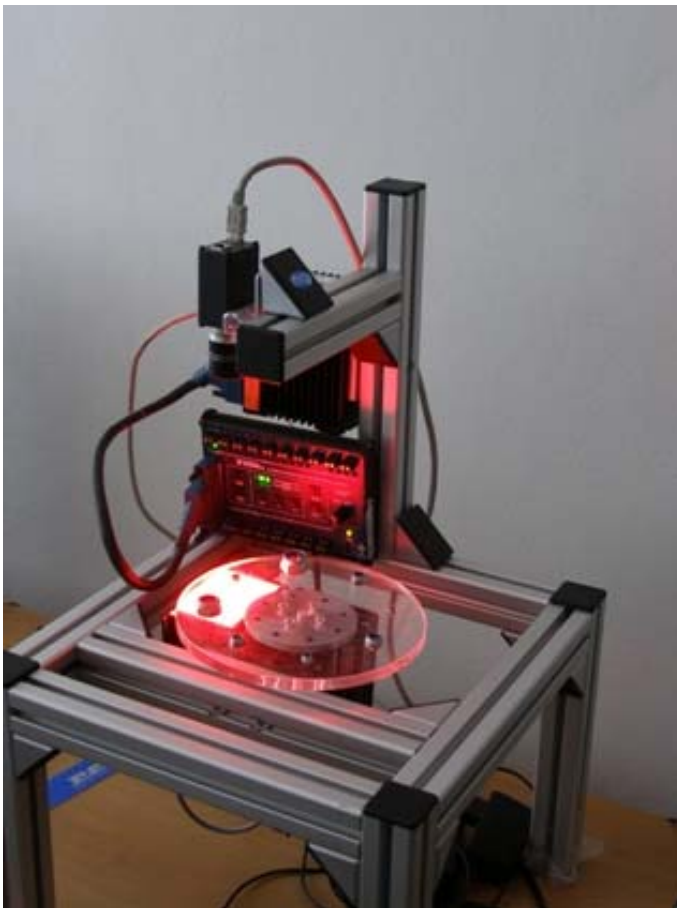


Fig. 2 Photograph of construction

Fig. 2 shows a photograph of the device construction. On this photograph we can see that the supporting structure is made from duralumin profiles. Digital camera BASLER A601f and Compact Vision System CVS1450To are mounted to the supporting structure. Besides the devices mentioned above, also a circular transparent table is mounted to the supporting structure. This table is backlit by monochromatic light. Reason of this arrangement is to get the best visual representation of the analyzed part. The camera is orientated vertically and the table horizontally. An opaque part lies on the transparent table; this way we get a large difference between the luminance of the background and the part itself. This is very good for edge detection.

MEASURING AND EVALUATING OF DATA

The goal was to measure radius of a washer, which is placed on a random place of the camera picture. Calibration of conversion from pixels to real size is executed by *simple calibration*. By simple calibration is meant that there exists a direct proportion between the number of pixels and the real size.

By the measuring were acquired 200 values of radius of the same part. All the values were recorded and a statistic analysis was made from the recorded data, as can be seen on Figure 3. On the horizontal axis of this graph are values of measured radius, on the vertical axis is number of incidence.

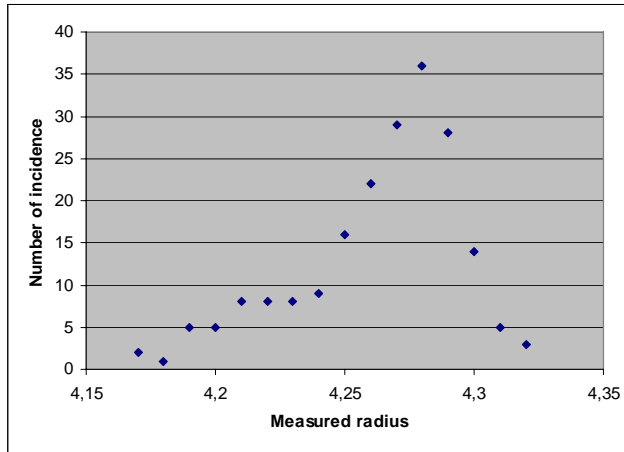


Fig. 3 Number of incidence in dependence on the radius

The measured values were used to compute arithmetic average.

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n x_i = \frac{1}{200} \sum_{i=1}^{200} x_i = \underline{4,26}$$

Then the mean-root-square error is computed.

$$s = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{X})^2} = \sqrt{\frac{1}{200} \sum_{i=1}^{200} (x_i - \bar{X})^2} = \underline{0,03}$$

Finally, the accuracy of measure was computed using the following method: Triple of the mean-root-square error represents the interval where measured value will be on 97.7 %.

s	Mean-root-square error
n	Number of measured values
\bar{X}	Arithmetic average
x_i	i-th measured value

From the calculation above it is clear that the interval will be:

$$\langle x_p - 1.5s; x_p + 1.5s \rangle = \langle 4,215; 4,305 \rangle$$

We can also say that the accuracy of measuring lies in interval $\pm 0,045\text{mm}$ with probability of 97.7 %.

Conclusion

A device for picture analysis, consisting of Compact Visual System CVS1450 made by National Instruments and BASLER A601f camera connected via IEEE 1394 Fire-Wire, was used to make an analysis of accuracy of dimension measuring. The device was programmed by National Instruments Builder AI 3.0 software to perform a simple calibration. 200 values of radius of the same part (a washer) were measured. The next steps were to determine the number of incidence and compute the mean-root-square error. We can say that the accuracy of the device in the configuration mentioned above lies within the interval $\pm 0,045\text{mm}$ with probability of 97.7 %. In the real life, the accuracy may be a little lower, because there are a lot of factors like shadows from other light sources. This shadow in the picture may be detected as an edge. We can reach higher accuracy by using calibration grid.

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