

Automated Video System for Measurement Instruments Test and Calibration

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Abstract-This paper describes a new solution for metrological calibration of the instruments. This solution consists of realizing an automated video system, for data video-acquisition, image processing and digital command, used for various equipments, so that the tests and the calibration can be automatically made.

I. Introduction

Calibration determines the error associated with a measurement, and, if possible, reduces that error. This means that calibration is more than just adjusting the measurement capability of a device. Instead, the calibration process includes three parts:

- verifying that the measurement capability of the measurement device is within specifications;
- adjusting the device to reduce its measurement error;
- verifying the new measurement capability of the device to ensure that is operating within specifications.

International committees have created calibration guidelines to ensure procedural consistency and calibration acceptance among companies and countries.

Calibration improves the measurement accuracy and ensures that the product meets its required specifications. Calibration also provides a number of other benefits, such as: increased production yields, overall measurement consistency, standardization of quality. To maintain the measurement quality, the measurement device must be calibrated at set intervals.

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Instrument calibration is the act of determining the uncertainty associated with the instrument's measurement. If possible, the instrument is adjusted to reduce the overall uncertainty associated with the measurement.

The ability of a measurement device to accurately measure a physical quantity changes with a number of factors. Time in service, temperature, humidity, environmental exposure, and abuse can all affect your measurement accuracy. Calibration quantifies this change in measurement accuracy and, when required, adjusts the device's measurement capability to decrease error.

II. Amperemeter and voltmeter calibration

A. Manual calibration

After the metrological calibration of the measuring device the operator establishes if the device satisfies or not the construction and operation conditions.

Referring at the voltmeter, its technical construction conditions are established through a visual control. To realize the proper calibration we usually need a voltage stabilized source (continuous or alternative of adequate frequency), capable to generate a voltage with at least 10% bigger than the maximum measurement limit of the voltmeter which follows to be calibrated, and a power bigger than the sum between the power consumed by the device under verification and the power consumed by the used standard, when the maximum measurement voltage is applied to them; a block to adjust the voltage source,

from zero to the maximum value, in small steps, so that the voltage variation can be considered continuously (sometimes the block is an integrated part of the voltage source) and a calibrator. Instead of these, it may be used a standard voltage generator, voltage calibrator, with metrological characteristics adequated to the voltmeter/amperemeter verification.

First, the device's indicator is set in zero. Then the device under calibration is connected in the circuit. To determine the error in each mark of the voltmeter the voltage is adjusted till the indicator stops in the mark's corresponding position. By increasing the voltage it read a value at the calibrator and another one by decreasing the voltage. The error will be:

$$E(\%) = 100 * (U_i - U_{ak}) / U_{max}$$

U_i =the voltage indicated by the voltmeter at the verified mark;

U_{ak} =the value read at the calibrator for the corresponding mark;

U_{max} =the maximum value of the measuring range.

The amperemeter's calibration is similarly to the voltmeter.

B. Automated calibration

The most basic requirement of a calibration is proof of traceability. Traceability is defined as an unbroken chain of comparisons, all having stated uncertainties, between your measurement and some national or international standard. Because standards maintained by national and international bodies are well quantified and maintained, the ability to demonstrate an unbroken chain of comparisons between your measurements and these standards provides advantages such as:

- ability to trace your measurement uncertainty back to a known and accepted standard;
- acceptance of your instrument's measurement capabilities between countries;
- ability to determine the maximum uncertainty associated with your measurements.

Manual calibration can be time-consuming and costly. The proposed system automates the verification and adjustment of the products. The goal of system calibration is to quantify and compensate for the total measurement error in the system. Cable losses, conditioning and sensor errors may induce measurement error. By applying known inputs to the system and reviewing the resulting measurement, you develop a model that represents the error in your system.

The video-automated system proposed for the measuring devices calibration consists of: a video camera and a video card (used to acquire the informations proceeded from the device's display under calibration/verification); a computer, used to process the image, extract the informations and to drive the calibrating equipments through specialized interfaces (figure 1).

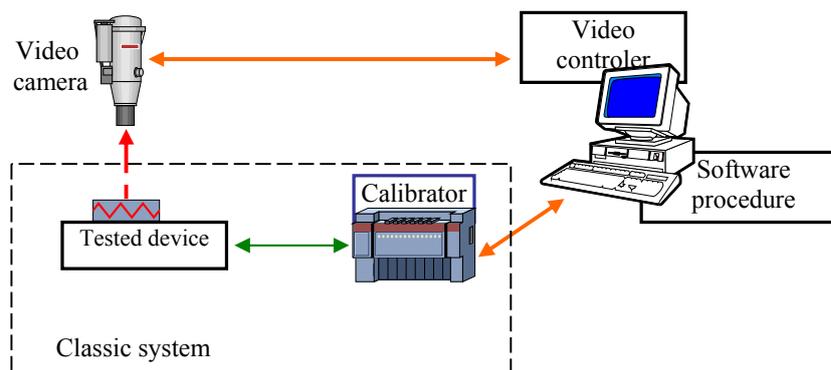


Figure 1. The architecture of the automated system

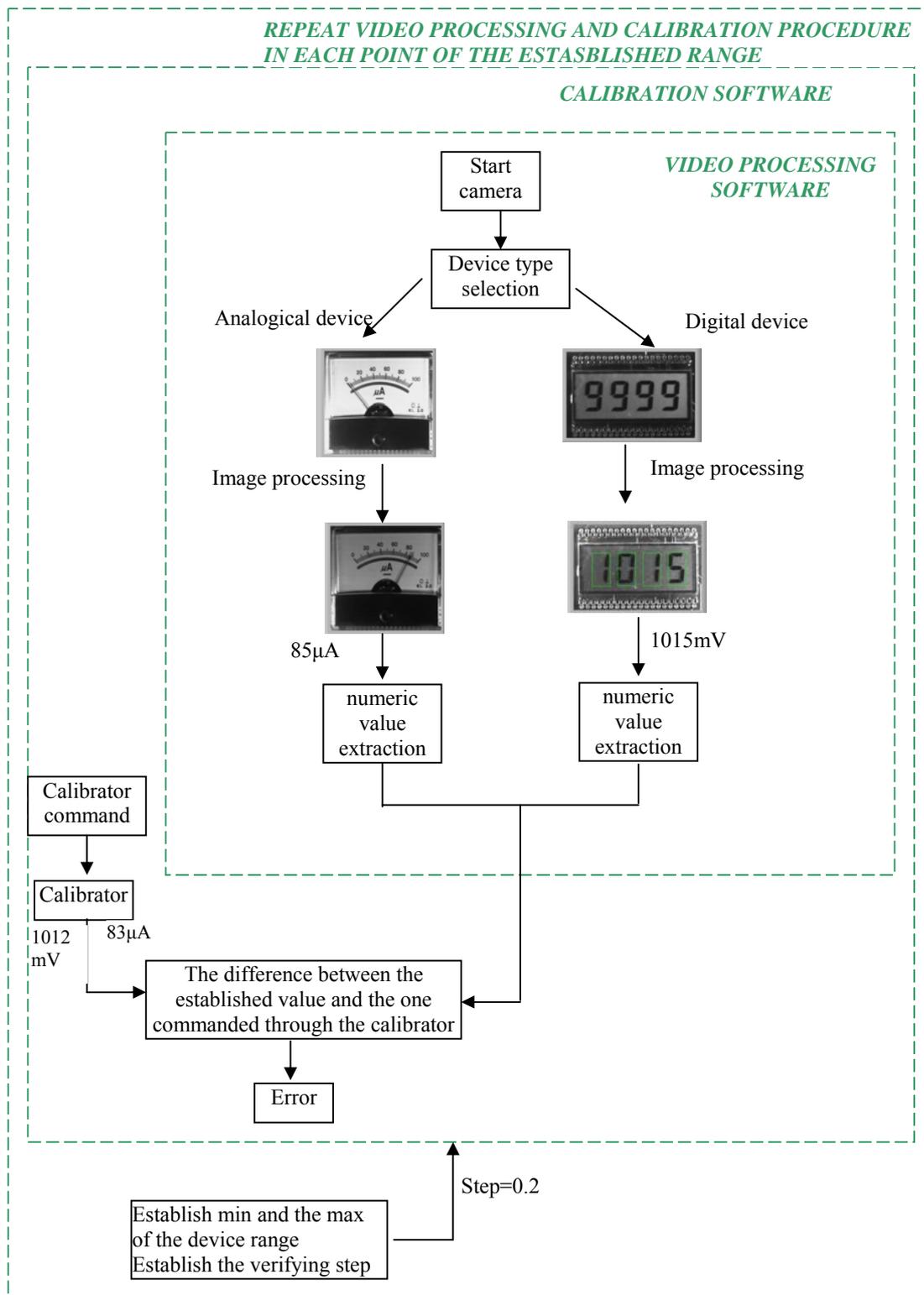


Figure 2. The block diagram of the automated system used in instruments calibration

This system follows the values variation of the investigated measurements of the device under calibration depending on the values commanded to the calibrator. The new method is according to SR EN ISO/CEI 17025:2005, because it is a method developed in laboratory.

When an analogical device is under calibration, the system will reduce the parallax error by processing the images of the needle and of its reflexion in the quadrant's mirror. It also considerably reduces the dividing fraction of the deviation perceived by the human operator.

The block diagram of the calibration process using the automated video system is presented in figure 2.

When the camera starts it acquires an image and the computer, using the algorithm presented above, establishes the device's type (analogical or digital), as shown in figure 2. Suppose the device under verification is analogical. The calibrator is commanded to generate for example 83 μ A. In the same time the camera acquires an image from the analogical device. By processing the acquired image the system establishes the maximum and the minimum of the device's scale and the needle's position. The next step consists in establishing the numerical value identified from the acquired image. Then a difference between this value and the one commanded by calibrator is made and in the end the error is calculated. To calculate the error in each point of the scale, a step is chosen (for example 0.2) and the procedure is repeated for each point.

Conclusions

The system assures the technological progress and the increase of the regional challenge. It reduces the calibration time and the dividing fraction that a human operator can perceive. This work is addressed to a large number of beneficiaries because it concerns all the unities which produce equipments with applicability in the electrotechnical industry.

The goal of calibration using an automated system is to quantify and improve the measurement accuracy of the measuring instruments. The benefits of maintaining properly calibrated equipment include:

- Reduced measurement errors;
- Consistency between measurements;
- Increases in production yields;
- Assurance you are making accurate measurements.

Selective bibliography

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