The Discussion on Data Processing of Measurement

Ling REN, Guangsheng ZHANG, Chunhong SHI,
Lin SUN, Yunpeng REN, Hong CHEN
Metrology Department, Shaanxi Applied Physics-Chemistry Institute, Xi'an, 710061, China

Keywords: Measurement; Measurement Control; Data Processing

Abstract: Data processing of measurement were discussed in this paper, including the processing of measurement error, assessment and presentation of measurement uncertainty and processing and reporting of measurement results. The importance of measurement data processing in the measurement control system was clarified.

1. Introduction

The ultimate goal of measurement was revealing the relationship between the relevant physical quantities, finding the inherent regularity of things, verifying the correctness of a theory, or preparing the basis for future experiments by obtaining and processing data. Therefore the obtained data should be processed correctly. With the wide application of computer technology and the rapid development of optimization techniques, more and more new methods emerged in the measurement error analysis and data processing such as expanded from the normal distribution error to the non-normal distribution error. From obtaining the original data to drawing the conclusion, the data processing was throughout the entire measurement process.

2. Processing of Measurement Error

2.1 System Error

Under specified measurement conditions, the same measured quantity was repeatedly measured. A constant estimate of system error could be found between measurement results obtained and reproducible measurement standard value. When the measurement conditions such as time, temperature, frequency and others changed, measurement results varied according to a defined rule, which was linear or non-linear increase or decrease. From that variable system error was found in the measurement results.

In the following methods the system error could be eliminated or reduced. The system error could be reduced by correcting the measurement results for the known part of the system error. All the factors of system error should be possible to be reduced or eliminated during the experiment. System error could be canceled without affecting the measurement results.

2.2 Experimental Standard Deviation

The random error was the component in accordance with unforeseen changes of the measurement error in repeated measurements. It was the difference between the measurement results and the endless repeated measured average value of the same measured quantity. Since it was impossible to measure infinity times in the actual work, the value of random error could not be obtained. The value of random error reflected the dispersion of the measured values, which was measurement repeatability. Repeatability was characterized by the experimental standard deviation, which was the estimated value of the standard deviation obtained from limited measurement data. Experimental standard deviation was a quantity characterizing the dispersion of the measured values. When the reproducibility was poor, the arithmetic mean value obtained by increasing the number of measurements could be taken as the measurement result, in order to reduce the random

measurement error.

2.3 Identification and Elimination of Abnormal Value

Abnormal value was also known as outlier. In a number of measurement results obtained from repeated measurements to the same measured quantity, it was a individual value out of the statistical law and far from the other values. It came from different populations, and belonged to unexpected or accidental measurement error. It was also known as "gross error". The cause of abnormal value might be vibration, shock, power supply change, electromagnetic interference and other unexpected conditions change, human error in reading or recording, the internal fault of the instrument, etc. If there were abnormal value in a series of measured values, it was bound to affect the measurement results. At this time, if the value was eliminated, the result was more in line with the objective situation. In some cases, the dispersion of a set of measured values objectively reflected the random fluctuation characteristic of the actual measurement. If some normal data far from the others was eliminated, the so-called dispersion of results was small. But that was false actually. It was because that in the same conditions the original normal dispersion of the measurement results would be revealed in the future. So it was necessary to correctly judge and remove abnormal value. In the process of measurement, the abnormal values whose cause was known such as wrong record, wrong reading, a sudden jump or vibration and other abnormal conditions, should be found at any time and removed. That was the physical discrimination method. Sometimes a value was just suspected. When which was the abnormal value was not determined, statistical discrimination method could be used to distinguish.

3. Measurement Repeatability Assessment

The repeatability of the measurement standard referred to the ability to provide similar values in the same measurement condition, when the same measurement was repeated. The measurement conditions include: the same measurement procedure; the same observer; under the same condition, using the same measurement standards, in the same place; in a short period of time repeated measurements. The repeatability of the measurement standard usually expressed as the standard deviation of the experiment.

The repeatability of the measurement results is the consistency in the results obtained by repeated measurements under the condition of repeated measurements. The repeatability of the measurement results was the component of the uncertainty of the estimated value for measured quantity. It was live measurement result and a comprehensive reflection of the various random factors affecting the measurement results, which included all measurement standards, supporting equipment, environmental conditions and other factors, as well as the random change of actual measured quantity. The dispersion of measurement results was also effected by the measured object, especially when the measured object was non-material measurement instrument. Therefore, the dispersion of the measurement results is usually larger than that caused by the measurement standard itself.

References

[1] Nation Technic Intendance Office, Metrology Management, Deng Zheng, Liang Chunyu, Beijing: China Metrology Press, 1997.

[2] Wang zhengke, Internet Technology, Beijing: Tsinghua University Press, 1998.