Review Paper on Automated System for Instruments Calibration

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Abstract: *The present paper views a system for checking and calibrating measuring instruments. The system is based on calibrating instruments and generates certificates. The system actually provides the required sensitivity, tractability and accuracy of the instrument of the operating platform. The system required different methods like mean value, variance, Standard uncertainty, and the standard deviation for finding false positive, false negative, true positive, true negative errors for finding calibration accuracy of a particular object. This system is use for improve the accuracy of the existing system. Calibration of your measuring instruments has two factors. It checks the accuracy of the instrument and it determines the traceability of the measurement instruments. The qualities of the system were confirmed by the results obtained from the experiments done. Result provides important information to give the instrument's owner confidence that the device was calibrate correctly and to help show proof of the calibration.*

Index Terms: *Calibration, error detection, machine learning, Data mining, dynamic accuracy.*

I. INTRODUCTION

The accuracy of all measuring instruments degrades over time. This is typically caused by normal wear and tear. However, changes in accuracy can also be caused by electric or mechanical shock or a hazardous manufacturing environment (e.x., oils, metal chips etc.). Depending on the type of the instrument and the environment in which it is being use, it may degrade very quickly or over a long period of time. The calibration improves the accuracy of the measuring instruments. Accurate measuring devices improve product quality.

In the existing system of calibration of the instrument is performing manually. In existing system, there is a problem with the accuracy of the instruments. In this context the following activities play an important role: developing the required equipment that ensures the transfer of the unit values from the reference to the operating instruments, and estimating and correcting the measurement errors. These activities are mainly typical of those areas of meteorology where the existing reference base is not sufficiently to provide the complete spectrum of physical quantities. For instance, in the field of dynamic measurements the existing referential elements are very insufficient to cover all areas of measurement of quantities that change within them.

The proposed system aims to be useful in calibration lab, Industrial companies, and mechanical lab. Based on Accuracy of measuring instrument during calibration and generate the report which is provided by the calibration expert, which captured error and calibrate the instrument on the basis of error using data and show proof of the calibration in the form of certificate.

II. LITERATURE REVIEW

The system described in [1] views a model of a system for checking and calibrating measuring instruments operating on moving objects, in particular on ships. The system is a stand simulator based on a six-degree-of-freedom Stewart platform. In this system the mathematical model, based on the inverse kinematics problem of parallel mechanisms, is universal enough to be used in the development of other systems for calibrating devices operating on various moving objects such as automobiles, aircrafts, etc. The referential qualities of the system are ensured by a specifically developed output device which is calibrated by means of references for length. The qualities of the system are confirmed by the results obtained from the experiments done.

Therefore, some important problems in the area of metrology can be solved with the help of the automated system presented in this paper.

The paper [4] considers an algorithm for increasing the accuracy of measuring system operating on moving objects. The algorithm is based on the Kalman filter. It goal to provide a high measurement accuracy for the whole range of change of the measured quantity and the interference effects, as well as to eliminate the influence of a number of interference sources, each of which is of secondary importance but their total impact can cause a considerable distortion of the measuring signal.This problem could be solved by using adaptive algorithm integrated in the metrological chain of measuring systems .A Characteristic feature of instrument measuring parameter of moving objects is their operation in dynamic conditions [4]. But the Variation of their values can be caused by process variation.

The measuring system, proposed in [13] this article, ensures high accuracy of measurement of the ship's heel and trims both in static and dynamic operating mode. The metrological circuit of the system is based on a gyro-free design of the vertical unlike most systems built on this principle. The simplified design of the system's mechanical module guarantees a minimal instrumental error of the measuring system, which appears of great importance for ensuring the accuracy of measurement, especially in static mode. Its principle of operation is based on eliminating the dynamic error due to the deviation of the vertical in the inertial space in real time. The mechano electro-mechanical systems (MEMS) are used. When a Kalman filter is connected to the system, the measurement accuracy in dynamic mode is increased because the filter reduces not only the secondary fluctuations caused by external actions, defined by, but also the influence of the main interference presented in this article. Also this system having some disadvantages design includes very much complex procedures, time consuming and components are costly.

III. BASIC CONSIDERATIONS

The metrological theory related to dynamic measurement aims to achieve traceability at the accuracy level required by today 's science [3]. In this respect the following main tasks emerge:

- Transferring the value of the measuring unit from the reference to operating instruments under the conditions of metrological traceability.
- Standardizing and defining the dynamic characteristics of the measuring devices;
- Estimating and correcting the dynamic error.

For example,

The analysis of the errors should be based on a number of starting principles which can be summarized as follows:

A. **Principal equation**.

The measurement error δΣ, according to VIM, is the difference between the measurement result *Q* and the standard value of the quantity under measurement *Qrv*, i.e. [11]

$$(t)\ Q\ (t)\ Q\ (t)\ rv = -\ \Sigma\ \delta. \qquad \ldots\ldots\ (1)$$

VIM provides guidelines that "uncertainty" is the preferred term to use for describing the specification of an instrument.

B. Measurement mode.

The three quantities in (1) are mixed by the concept of dynamic measurement mode. From a mathematical view point the formulation of the operating mode is the first step of developing the dynamic error models since the time component *t* is introduced by it [3].

(i) Mean Value:

$$\overline{X} = \frac{X_1 + X_2 + X_3 \ldots X_N}{N}$$

Where
$\overline{X}$ = the mean
X_1 = the first value
X_2 = the second value
X_3 = the third value
X_N = the last value
N = the number of valuse

Mean value can be calculated by total of N numbers in data set whose values are given by a group of X-values i.e.X_1, X_2, X_3, …., Xn. then the mean is represented by $\overline{X}$ (measured values).can be found using above formula.

(ii)Variance:

$$s^2 = \frac{\sum (x - \bar{x})^2}{n-1}$$

The variance is a measure of how far each value in the data set is from the mean value. Here is how it is defined:

1. Subtract the mean from each value in the data. This gives you a result of the distance of each value from the mean.
2. Square each of these distances and add all of the squares together.
3. Divide the addition of the squares by the number of values in the data set.

(iii) Standard Deviation:

$$\mathrm{SD} = \sqrt{\frac{\sum |x - \bar{x}|^2}{n}}$$

The standard deviation (σ) is simply the square root of the variance. Where $\sum$ is sum, x is a term in data set, $\overline{X}$ is a sample mean value and n is a sample size.

The standard deviation is a statistic that measures the dissolution of a dataset relative to its mean and is calculated as the square root of the variance. It is calculated as the square root of variance by determining the variation between each data relative to the mean.

(iv) Standard Uncertainty:

$$S_{\bar{x}} = \frac{SD}{\sqrt{N}}$$

To calculate Standard uncertainty of your measurements, first you'll need to find the standard deviation (σ) and the square root of number of measurement values (N).

C. Specific nature of "Uncertainty"

The Uncertainty is the amount of possible error rather than "accuracy" is used to describe the capability of the calibration processes and outcomes. A measurement of the accuracy of an instrument is given by its uncertainty. In other words, the known value must have a clearly understood uncertainty to help the instrument owner or user determine if the measurement uncertainty is appropriate for the calibration. In the test and measurement industry, accuracy is often used to describe the capability of an instrument. Often the instrument manufacturer calculated for an accuracy specification to represent the expected range of error that may occur when using the instrument. Uncertainty describes a scope of values in which the true value can be found.

Uncertainty analysis is need for calibration labs conforming to ISO 17025 requirements. Uncertainty analysis is performed to evaluate and identify factors associated with the calibration instruments and process instrument that affect the calibration accuracy.

D. Data Mining.

Data mining is the process of sorting through huge datasets to identify patterns and establish relationships to solve problems through data analysis. Data mining a large variety of data mining systems available. It is necessary to analyze this large amount of data and extract useful information from it.

Data mining system may combine techniques from the following:

- Spatial Data Analysis
- Information Retrieval
- Pattern Recognition
- Image Analysis
- Signal Processing
- Computer Graphics
- Web Technology
- Business

A data mining system can be differentiating according to the following criteria −

- Database Technology
- Statistics
- Machine Learning
- Information Science
- Visualization
- Other Disciplines

There are two forms of data analysis that can be used for extracting models describing important classes or to assume future data trends. These two forms are as follows:

- Classification
- Prediction

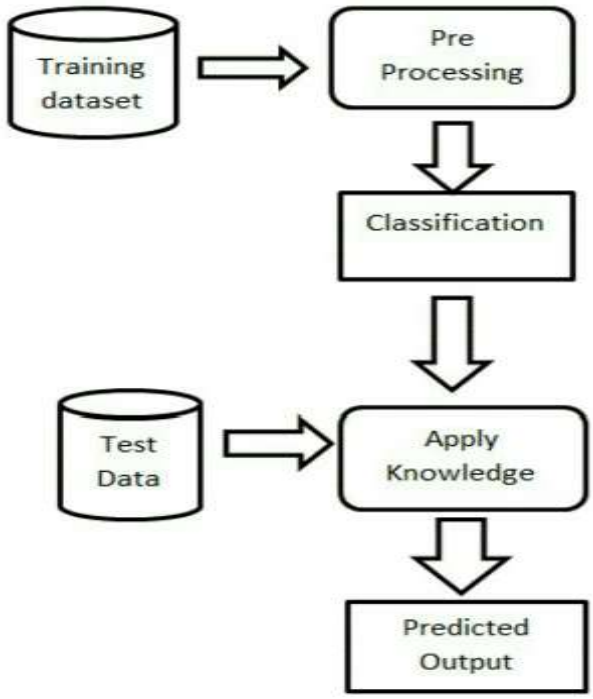

Fig. Data mining.

Classification models predict categorical class labels; and prediction models predict continuous value of functions. Accuracy of device refers to the ability of that device. It predicts the class label correctly and the accuracy of the predictor refers to how well a given predictor can guess the value of predicted attribute for a new data.

SVM is a supervised machine learning model, which is two-classification model. SVM try to find the best compromise between the complexity and the learning ability, in order to get the best generalization ability. Among them, the learning ability refers to the ability to detect any error free samples, and the complexity of the model refers to the learning that the model can get from a specific training sample. SVM represents the data feature vectors in the feature space, the support vector refers to those samples from the training data that are closest to the classified hyper plane. For linear non-separable data, SVM can map the data into a high dimensional space through a kernel function, and then transform the linear non-separable problem into a linear separable problem.

IV. Proposed System

This paper has been created on the basis of the developed automated system for instrument calibration of the mechanical module to improve the current calibration system. The main purpose of this system is to checks the accuracy of the instrument and determines the traceability of the measurement. And generate the report which is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.

The qualities of the system are confirmed by the results obtained from the experiments done and result/certificate calibration laboratory often provides a certificate with the calibration of an instrument. The calibration certificate provides important information to give the instrument's owner confidence that the instrument was calibrated correctly and to help show proof of the calibration. A calibration certificate might include a statement of traceability or a list of the calibration standards

used for the calibration, any data resulting from the calibration, the calibration date, and possibly pass or fail statements for each measurement instrument.

Advantages of Proposed System:

- High Accuracy.
- Guarantees a minimal error of measuring instruments.

V. CONCLUSION

The measuring system proposed in this article, ensures high accuracy of measurement of the instruments. The simplified design of the system's mechanical module guarantees a minimal instrumental error of the measuring system, which appears of great importance for ensuring the accuracy of measurement. The system is used for the more accuracy of the instruments.

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