Teleoperate Temperature Calibration via Internet

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Abstract: This paper presents the calibration service for the temperature sensor via the Internet. The purpose of the calibration service is to provide the teleoperate calibration procedure without skillful technician requirement at the client site. Besides the automatic measurement equipment that eases the operation, the developed software emphasizes the reliability of operation, simplifying the measurement data recording and processing, and achieving quality of the temperature measurements.

Keywords: teleoperate, temperature calibration, internet-based system, automatic calibration

1. INTRODUCTION

Since the calamitous financial crash of 1997, the demand of Thailand's industrial upgrading to become more competitive in the international market has arisen causing a strong motivation to be recognized in global standards such as ISO certification [1]. The instrument calibration is one of the most important activities for this improvement. There are many objectives for automation of a precision calibration [2-3], such as the reliability of measurements, repeatability, consistency, measurement error minimization, and human work reduction. Unfortunately, in Thailand the calibration facilities are not spread enough to support such a demand, with the consequence of an enormous workload for the existing calibration laboratories. The main drawback of this situation is a long time interval required for the calibration of an instrument and, in turn, a log out-of-service time of the measurement system based on such an instrument.

To solve this problem, the Internet-based calibration or on-site calibration has been introduced in the literature [4-6]. One should note that this solution offers the further advantage to avoid mechanical stress due to the transportation of the Unit Under Test (UTT), so that a better reliability can be expected. In addition, the implement of remote or teleoperate calibrations using the Internet as a transmission medium is rapidly emerging as a solution to all of the transportation, environmental, downtime, and cost issues with current calibration schemes. Moreover, the benefits emerge in the dissemination of measurement techniques and good practice equally to all laboratories.

This paper aims to present the teleoperate temperature calibration via Internet. There are two basic requirements to implement the proposed calibration, one is hardware requirement and the other is software requirement. For hardware requirement, it is required that every element of a temperature calibration system has the possibility of teleopeate system-by connection via RS232, GPIB-IEEE488, and the Internet system (client and server). In addition, the web cameras at both ends enhance the communication for troubleshooting and collaboration. The calibration software requirements are based on the restricted regarding achievement of demanded performance using Visual Basic programming language. The database and the Web pages are developed using Microsoft Access 2000 and Microsoft Visual Interdev program, respectively.

The experimental results verify that the proposed teleoperate calibration service allows the calibration procedure to be remotely exercised without skillful technician requirement.

2. THE PROPOSED CALIBRATION SERVICE

Fig. 1 and Fig. 2 show the hardware and the software architectures of the proposed calibration service based on the client-server application, respectively. The service allows the calibration procedure to be remotely exercised. Furthermore, the automatic acquisition and real-time processing of the calibration results can be accomplished if the standard and the UTT are equipped with a communication interface.

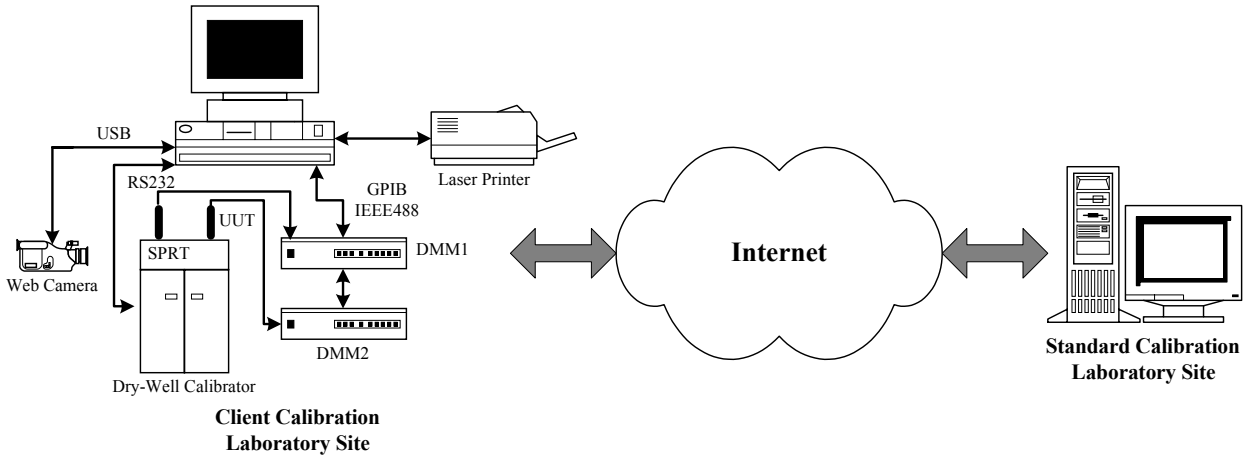

Fig. 1 The hardware architecture of the proposed calibration service

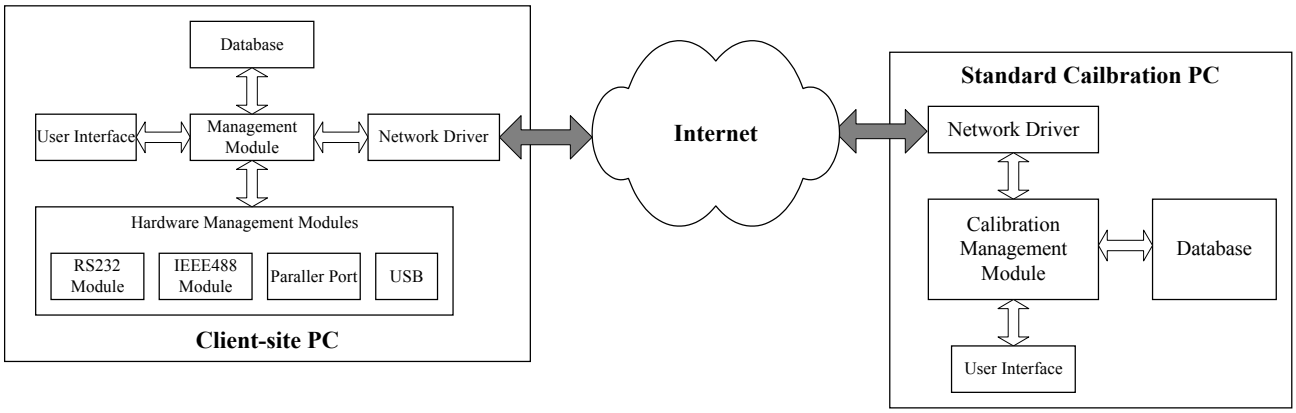

Fig. 2 The software architecture of the client-server application

2.1 Client calibration laboratory site

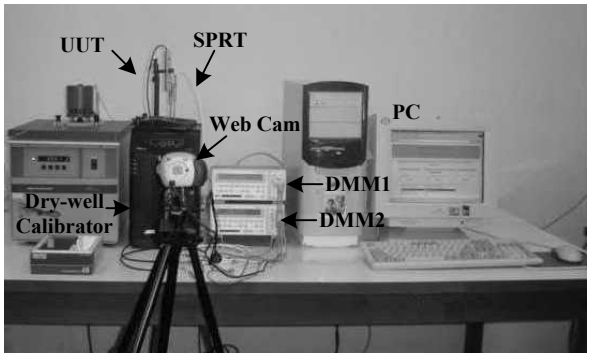

Fig. 3 The required hardware at the client site

At the client site or the UUT site, the required hardware for temperature calibration is shown in Fig. 3. The temperature sensor is to be calibrated using a Chromel-Alumel (K-type) thermocouple as an illustrated UUT in this paper. The temperature range of the calibrator is 35°C-600°C. The central-point of the teleoperate procedures is a personal computer (PC) with the appropriate hardware specification and the developed software, which is able to control the calibration via the Internet. The specification of another apparatuses can be shown as

- The UUT: Hitachi 4261 K-type thermocouple, 20°C-700°C range.
- The Standard Platinum Resistance Thermometer (SPRT): 0°C-400°C range, ± 0.05°C accuracy.
- Dry-well calibrator (constant temperature bath): Hart Sceintific 9122, ± 0.1°C accuracy, 0.01°C resolution.
- Standard digital multimeter (DMM1): Yokogawa 7562, ± 0.009% of reading accuracy for thermocouple.
- Standard digital thermometer (DMM2): Yokogawa 7563, ± 0.006% of reading accuracy for thermocouple.
- Web Camera (Web Cam)
- Laser printer: HP LaserJet 2100. (Optional)

All apparatuses must have a communication interface in order to connect them to the PC when the client application runs. In this situation, the automatic calibration procedures can be implemented. At the client site, the operator is only required to perform the measurement connection between the SPRT and the UUT, hence a non specialized technician can work the calibration procedure.

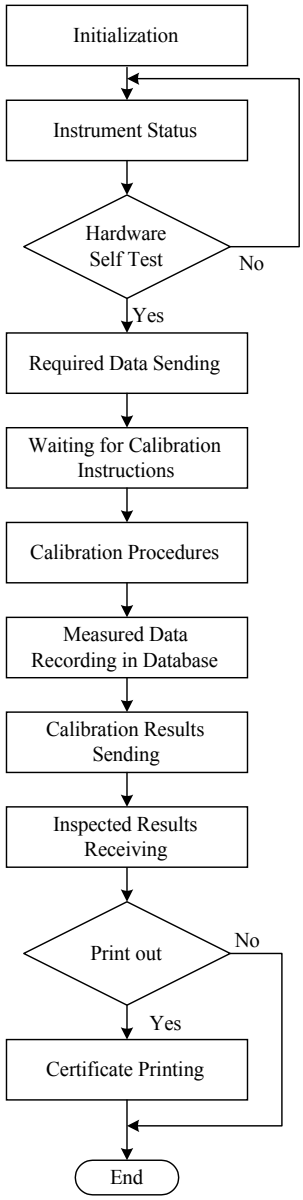

Fig. 4 The flowchart for client application

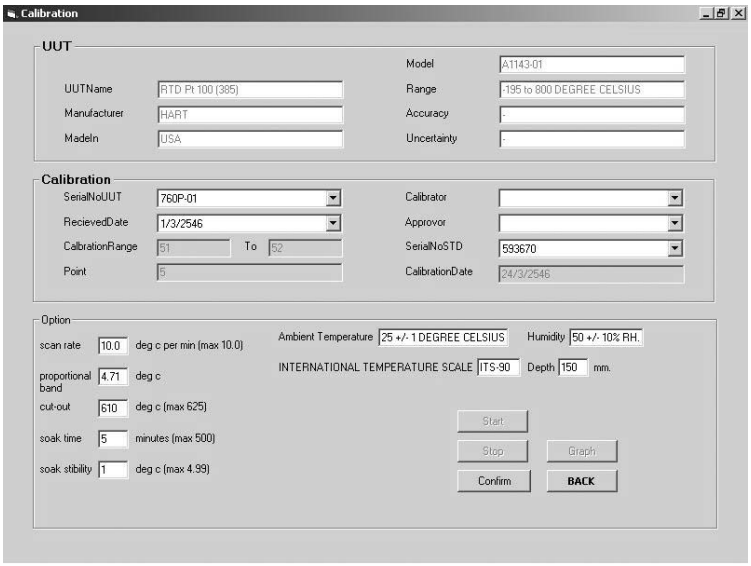

Fig. 5 The initialization setting window of client application

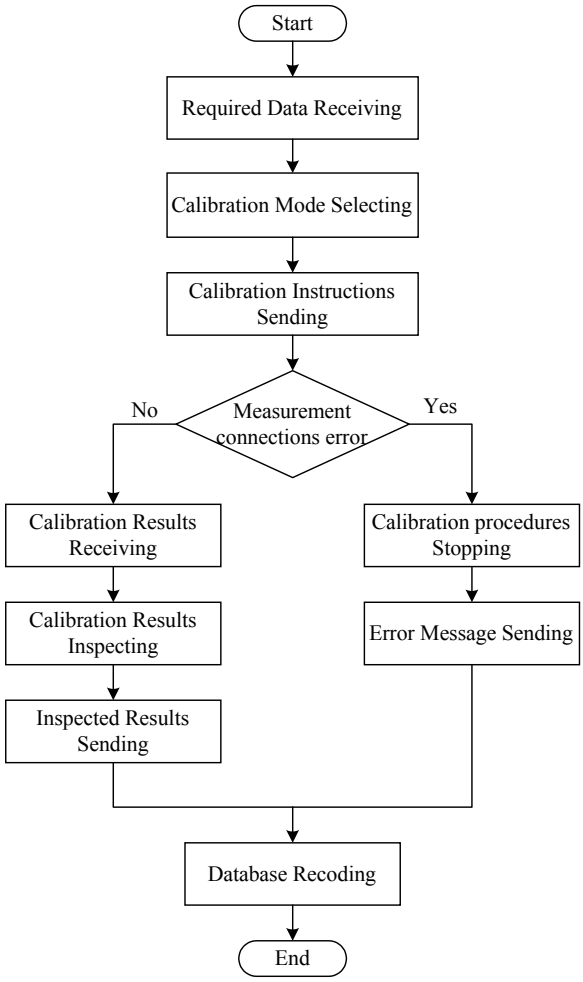

Fig. 6 The flowchart for sever application

The client site PC takes charge of the calibration management based on the control instructions from the standard laboratory site. Fig. 4 shows the flowchart of the developed software using Visual Basic 6.0, MS Access 2000, and Web application programs. During the initialization, the required parameters such as the UUT description, the calibration details, the ambient temperature, and the humidity are required to be set as shown in Fig. 5. The measured data are calculated for the errors and the approved uncertainty in temperature measurement of the UUT. The measured data and the calculated data are recorded in the database and sent to the standard laboratory site. The calibration results must be inspected with the standard calibration before the certificate printing or the temperature transmitter adjustment.

2.2 Standard calibration laboratory site

Fig. 6 shows the flowchart for the sever application. The appropriate standard thermometer and the calibration instructions are selected from the database based on the sending data from the client site as shown in Fig. 7. After all the required parameters are defined, the calibration instructions are submitted to the client site. The calibration results are then transferred back to the standard site for inspecting as shown in Fig. 8. Finally, the inspected results are sent to the client site.

3. EXPERIMENTAL RESULTS

The K-type thermocouple is used as the illustrated UUT in this paper. The number of set point used in the experiment is five, which are 50°C, 100°C, 150°C, 200°C, and 250°C, respectively. Table 1 shows the calibration results based on the use of the proposed service. Fig. 9 shows the window of the calibration results at client site.

Table 1 The experimental results

Set point (°C)	**Measured data** (°C)	**Error** (°C)	**Uncertainty**
50	47.2	2.8	0.121
100	96.24	3.76	0.121
150	143.79	6.11	0.121
200	191.18	8.82	0.121
250	239.13	10.87	0.121

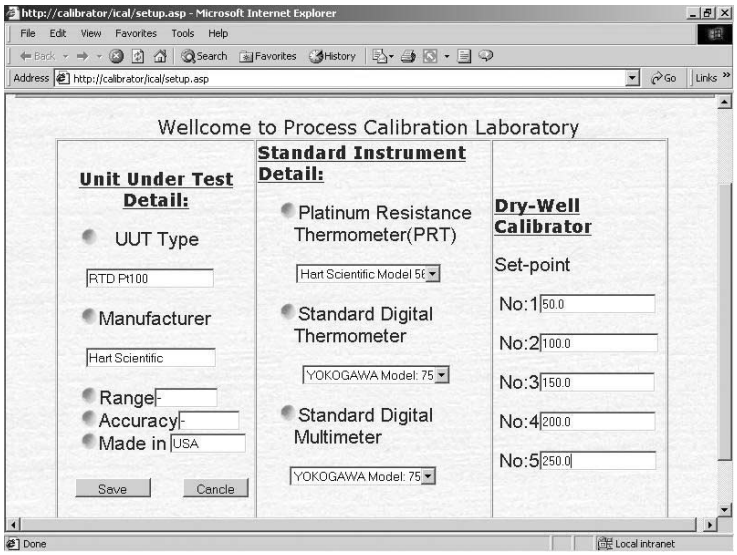

Fig. 7 The window of the calibration procedures setting at standard site.

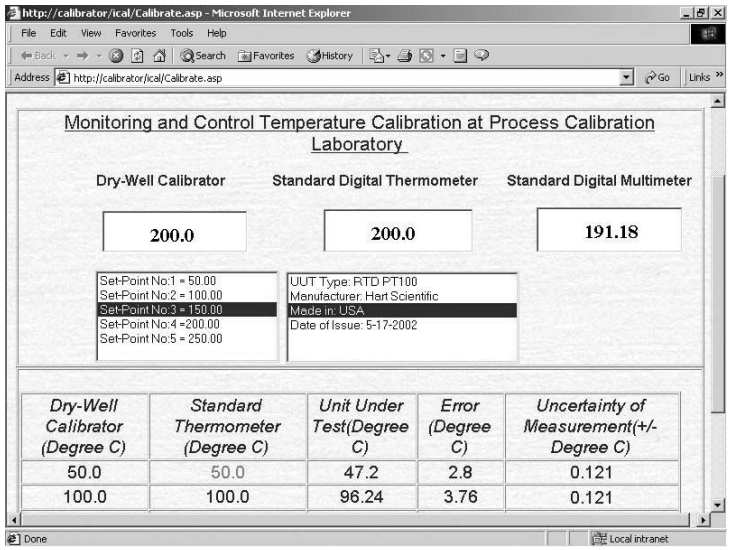

Fig. 8 The calibration results window at standard site.

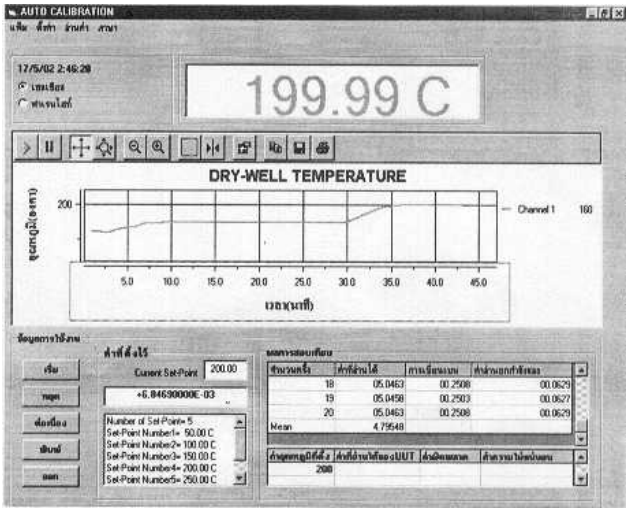

Fig. 9 The calibration results window at client site.

4. CONCLUSION

This paper aims to present the temperature calibration service via the Internet. The proposed service allows the calibration procedure to be remotely exercised. Furthermore, the automatic acquisition and real-time processing of the calibration results can be accomplished if the standard and the UTT are equipped with a communication interface. The experimental results verify that the proposed teleoperate calibration service allows the calibration procedure to be remotely exercised without skillful technician requirement.

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