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Research of Remote Measurement Based on the Robotic Mass Measurement System in NIM

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Summary:
The raw data generated by the current robotic mass measurement system (RMMs) cannot be used as an effective record to meet the requirements of ISO/IEC 17025, manual work on data processing is still needed. Based on the RMMs, in this paper, a fully automated remote calibration system is designed with functions including data automatic processing (e.g., data splitting and recombination, data calculation and analysis, incomplete data processing, automatic generation of original records, and certificate reports) and remote control (e.g., online monitoring and remote calibration).

Keywords: Mass measurement, Remote measurement, Robotic mass comparators, Autonomous measurement system, Automatic certificate generating system.

Background, Motivation, and Objective

Across the world, some mass laboratories in national metrology institutes, NIMs, have been equipped with automatic mass comparators or the robotic mass measurement system (RMMs, for short) instead of manual measurement now [1]. Although the robotic mass measurement system has improved the efficiency of the weighing process, there are still some problems in actual use.

First, the raw data generated by the RMMs, only containing basic information (e.g., measurement time, weighing differences, weighing cycles, etc.), cannot directly generate a valid certificate report with comprehensive information as required in ISO/IEC 17025. Second, since the gap between the forks of the weights carries (about 1.5 mm~2 mm in width), the weight in a small mass value may easily drop off from the carriers during the weights multi-switching process, which leads to the interruption of the measurement task and the generating incomplete data, manual work still needed under the RMMs in this situation. Third, air density measurement is vital for air buoyancy corrections in high-accuracy mass measurements, some automatic mass measurement systems lack air density measurement devices, and others may be equipped with a built-in air density measurement module inside the RMMs (recalibrating each specific sensor individually is hard to realize). Forth, the calibration of the robotic mass comparators performed manually in many NIMs till now, customers need to transport the instruments to a qualified laboratory, and this calibration usually takes 15-20 working days. With a risk of shutdown (the recent pandemic COVID-19, for instance), the work related to this instrument in the customer laboratory will be suspended.

The latest computer communication technologies and IoT technologies enable a variety of applications in mass measurement and calibration fields, thus remote calibration in the mass measurement field has gradually become a necessity [2]. Since many of the available instruments are provided with some communication interfaces (RS-232, RS-495, USB) [3], remote calibration is rapidly developing in recent years, it is possible to create an actual remote functionality of the mass measuring systems, e.g., establishing the connection to national metrology institutes or other mass measurement laboratories to take the remote operation of the measuring instruments without local restriction.

Description of the Remote Measurement System

In this paper, we designed a remote measurement system that enables remote control and online monitoring. To sum up, the remote measurement system possesses the following functions:

a) Realize real-time air density collection and transmission of the environmental parameters and status.

b) Mass measurements data collection, processing, analysis, and calculation.

c) Realize the automatic generation of valid measurement records and certificate reports.

d) Transfer the measurement reports and upload them to the business system of the calibration institute automatically.

e) Realize the remote control of the measuring equipment, receive the instructions from the remote pc, and carry out the real-time monitoring of the measuring devices.

Results

To achieve the functions summarized above, the framework of the remote measurement system for the RMMs is designed in Figure.1.

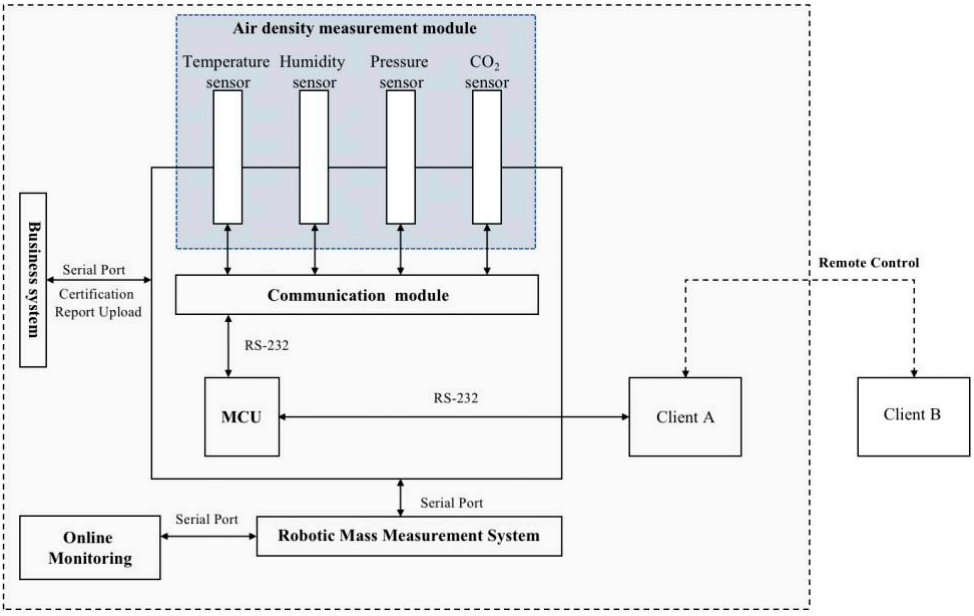

Fig. 1. The Framework of the remote measurement system (MCU represents the built-in microprogrammed control unit, Client A represents the PC installed inside the mass measurement laboratory, Client B represents any PC in a remote laboratory)

The remote measurement system mainly consists of two parts, one is the data processing and another is the remote control. The real-time ambient condition data can be collected by the sensors (e.g., Temperature sensor, Humidity sensor, Pressure sensor, and CO_2 sensor) through the 232 interface. Measurements data can be processed centrally through the built-in Microprogrammed Control Unit (MCU) to generate the raw record. The internet-connect to the business system, where a lot of information is saved (e.g., weights manufacturer, name of certificate unit, certificate report type, etc.), is established. Thus, the specific certificate report template can be downloaded, and the certificate report generated by the data processing module we designed can be directly uploaded. As for the remote control, we established the remote measurement based on the Client/Server (C/S) solution using the remote desktop protocol (RDP). Under the C/S architecture, measurement data computing task is logically distributed as the client and service side, which makes it possible to interoperate through network communication technology.

Based on the problems existing in data processing and original report and certificate generation of the automatic mass measurement system, this paper designs an automatic measurement data processing software to realize the measurement data splitting and recombination, air buoyancy correction calculation, and measurements record and the certificate reports automatic generation.

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