PTB news
Metrology
Technology
Services
Cooperation
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Evaluation of Room Acoustical Software

To a steadily increasing extent, computer programs are used to predict the acoustic qualities of rooms already at the planning stage. However, the results obtained in this way are still afflicted with shortcomings. By performing objective tests of this kind of software, PTB supports the further development of the software and helps with the valuation of the program's capabilities.

Within the scope of an international intercomparison coordinated by PTB, the quality of software for the simulation of room acoustics has recently been tested by 16 participants from nine different countries. The computer programs used had to prove their efficiency on a concrete object: the participants had to calculate the acoustic properties of a Swedish concert hall and compare them with independent measurement results determined by PTB and two other teams.

For various combinations of sound transmission and auditor positions, nine parameters of room acoustics, such as the reverberation time and the definition, had to be calculated in six octave bands. The results were compared with the measured values. The comparison revealed that the deviations are clearly greater than the difference which is subjectively perceptible, in particular in the lower frequency range (125 Hz octave). The large errors at low frequencies are due to a general deficiency of the simulation programs which cannot yet take diffraction effects into account. Possible applications of the software are, therefore, restricted to obstacle-free, large rooms. Another factor which influences all computer programs is the strong dependence of the results on the input data, for example, the acoustic absorption properties of the surfaces. In most cases these are known only as estimates.

Both software developers and software users can gain by a comparison of this type. Comparing their results with those of other simulation programs and with thoroughly measured data, software developers can identify sources of errors and further improve their simulation programs. On the other hand, the comparison helps acousticians, architects and civil engineers to assess the quality of the software they use.

This concert hall in Jönköping, Sweden, served as the test object for room acoustics simulation software in an international intercomparison. The hall has 1100 seats and a volume of 11 000 m³. Two different transmitter positions on the stage and six receiver positions in the audience were selected for the calculations.

The data of the Swedish concert hall will be made available at the PTB WWW server within the next months. Along with the room data and the measured values, recorded real sound patterns will be supplied which allow to test room-acoustics simulation software by means of a so-called auralisation: Sound signals recorded with low reverberation are convolved with the impulse response of the room and conditioned for earphone reproduction like an artificial head recording.

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ECG Interpretation by Means of Pattern Recognition

What has been successfully accomplished in the case of fingerprints, namely the direct comparison of the patterns, is now also possible with heart signals. A new method allows signal patterns of a patient's electrocardiogram (ECG) to be compared with evaluated patterns of other patients' ECGs stored in a data base. The results will help the doctor to ascertain the patient's state of health.

The computer programs so far available for the automatic interpretation of ECGs propose a diagnosis on the basis of complex decision rules or with the aid of neuronal networks. Even though many of these methods are rather sophisticated, they can detect, and take into account, the large number of biological signals to a limited extent only. To include

continued on page 4

Alleviations to Trade for the Weighing Industry

An agreement about the mutual recognition of tests of weighing instruments has been signed by the Japanese National Research Laboratory of Metrology (NRLM) and the PTB. The agreement eliminates barriers to export between Japan and Germany.

Weighing techniques play an important part in commerce, trade and daily life. This concerns, for example, electronic counter scales in supermarkets and shops, person and domestic scales, postal and luggage weighers, analytical and high-accuracy weighing machines in medical and pharmaceutical laboratories as well as weighing machines to control industrial processes. In order to guarantee fair trading with correct weighing and price calculations and to protect consumers from faulty measurements and fraud, all weighing machines used for commercial or official transactions and measurements or for medical purposes are subject to legal control and need a pattern approval – by PTB, for instance – as a prerequisite for verification.

T. Sakurai, Director of the Measurement System Department of the NRLM (on the right), and M. Kochsiek, Vice-president of the PTB, signed the agreement about the mutual recognition of tests of weighing instruments on the occasion of the 34th CIML meeting of the OIML in Tunis in October 1999.

Mutual recognition of the results of weighing instruments' tests, as agreed upon by Japan and Germany now, has already been common practice in Europe for many years. Because of the harmonisation of the European internal market, numerous national requirements have been abrogated which had to be met by weighing instruments in former times. As a result, there are only European and no more national pattern approvals today. While Europe has made an important step towards harmonisation in this field, barriers to trade still exist on other significant markets of the world, for example in the USA, due to varying testing provisions. The bilateral agreement between Japan and Germany sets an example for future multilateral agreements to make way for further alleviations to trade for globally acting industries.

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Software Testing for Pattern Approval

Measuring instruments used in commercial transactions are more and more developed as network systems controlled by complex software. In order to check the system properties with sufficient depth and in an adequate period of time a software tool was developed enabling analysis and testing of complex measurement systems by simple application of the manufacturer documentation.

In pattern testing of software controlled systems it is no longer sufficient to check the measurement correctness by traceability to standards. To an ever increasing extent the tests have to comprise an assessment of protection from manipulation and the conformity of the pattern with the individual production unit. With the new software tool the tester analysing an unknown system will be provided with a systematic instruction for the drawing-up of a model of the hardware components, e. g., subassemblies, and of the software. Accordingly, a total model of the measurement system will result considering the close interdependence of hardware and software. By this data flow analysis the flow of the measured values between the instrument components, inside the components and in the data domains of the software is tracked and illustrated as a so-called data path.

The set-up of the data paths is undertaken step by step. In parallel to each incremental step on the data path the tester will infer from the manufacturer documentation the partial function processing the measured value which is linked to the incremental data flow. By this guidance through the documentation of the measurement system supported by the software tool only the information relevant to the test will be selected. Thus quite different documentation forms may be effectively analysed.

The requirements applicable to the testing of the measurement system are stored in a data base specific of the measuring system. Parts of the tests, e. g., the functions required for the measurement task, will be automatically performed. All the other tests will be carried out in a dialogue with the tester on the basis of check lists. Finally a test report will be automatically generated and all the data characteristic of the measurement system will be secured so that these will be available at short notice when modifications to the instrument under test will be made at a later date. PTB is presently preparing for the use of the software tool in tests for EC and national pattern approvals.

The software tool X-Ass developed by PTB will simplify the pattern testing of complex measurement systems which are to obtain the CE mark.

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PTB

Calibration Standards for Scanning Probe Microscopes

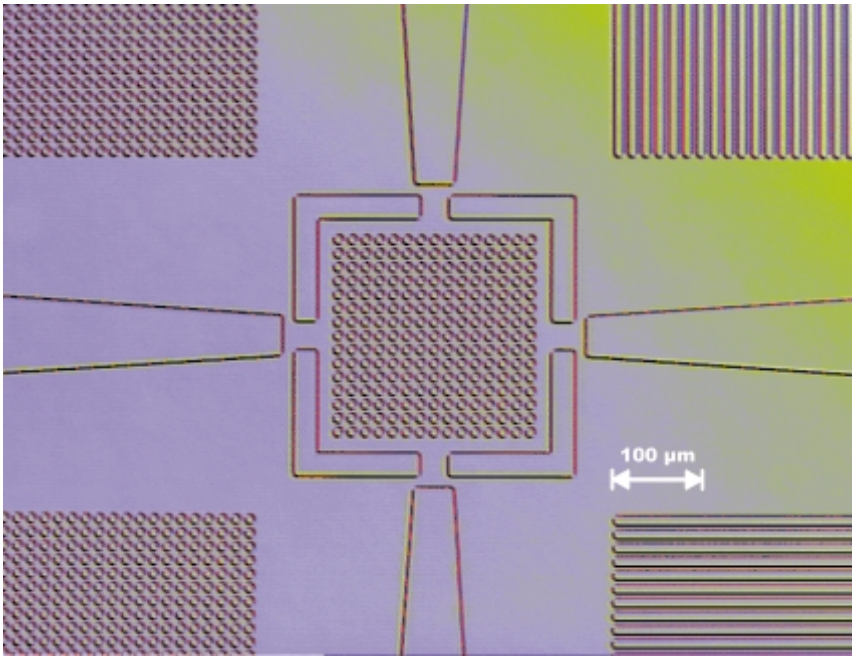
Scanning probe microscopes allow to obtain unique insights into the microworld of surfaces. So far, they have been used mainly as imaging systems. Now, they are becoming real measuring instruments. This development will be accelerated by novel calibration standards, which allow economic calibration and direct traceability.

For the quantitative determination of microscopic geometries, some metrology institutes have specially designed scanning probe microscopes (SPMs) at their disposal. These SPMs are usually equipped with laser interferometers. In view of the sophisticated equipment required, this is not a suitable procedure for industrial and scientific applications. Calibrations with the aid of standards, as they are common practice for other measuring instruments used in dimensional metrology, would be an adequate solution.

Though material measures with microscopic dimensions are already available, these have mainly been developed for scanning electron microcsopes and not especially for SPMs. A recently completed EU project has improved of this unsatisfactory situation. Within the scope of the project, SPM calibration standards were manufactured by two companies, IBSEN (Denmark) and NanoSensors (Germany), and calibrated by the NPL (UK) and PTB. In addition, a calibration software was developed by the Dansk Institut for Fundamental Metrologi. Since the lateral dimensions and structural arrangements are adapted, the standards can be measured by optical methods. Compared with an SPM calibration, the measuring time is drastically reduced from about two hours to a few minutes. This also considerably reduces the calibration costs.

The following kinds of standards with etched structures were manufactured for calibration and testing the image quality of SPMs: one flatness standard, six step-height standards (8 nm to 2,4 µm) and five lateral two-dimensional standards (100 nm to 10 µm). The standards were calibrated with interference microscopes and laser diffractometers.

In result a complete set of standards for the calibration of SPMs has been furnished. For the first time, industry and science are in a position to comply with the quality requirements according to DIN ISO 9000 and DIN EN 45 000 also for SPMs used as measuring instruments.



Detail of a step-height standard
The reference structure in the centre is a two-dimensional array of «holes» with identical nominal depths covering an area of approximately 240 µm × 240 µm. This pattern is a step-height standard with calibrated mean step height (deviations from the mean value are less than 1 nm). In the corners, parts of other one- and two-dimensional structures with identical nominal step heights are to be seen, which can also be used in conventional measuring instruments such as mechanical or optical profilometers. All structures are located on an Si chip of 5 mm × 7 mm, which is fastened to a standard sample holder with 12 mm diameter.
Photo: NanoSensors, Wetzlar, Germany

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Events

(Further information can be found in the WWW via http://www.ptb.de choosing "English", then "News")

European Meeting on the Technology and Application of SET Devices
PTB Braunschweig, 5 and 6 June 2000
Information and registration: H. Scherer, fax: (+49 531) 592-22 95, e-mail: hansjoerg.scherer@ptb.de

Hermann-von-Helmholtz-Symposium 2000 «New Frontiers and Opportunities in Biomagnetism»
PTB Berlin-Charlottenburg, 21 August 2000
Information and registration: H. Koch, fax: (+49 30) 34 81-490, e-mail: hans.koch@ptb.de

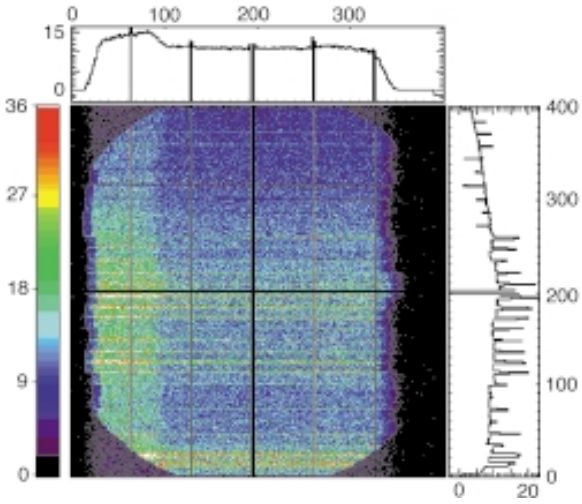
Metrology with Synchrotron Radiation
(Satellite Conference of the 7th International Conference on Synchrotron Radiation Instrumentation)
PTB Berlin-Charlottenburg, 26 August 2000
Information and registration: G. Ulm, fax: (+49 30) 34 81-490, e-mail: gerhard.ulm@ptb.de

Radiometry for X-ray Astronomy

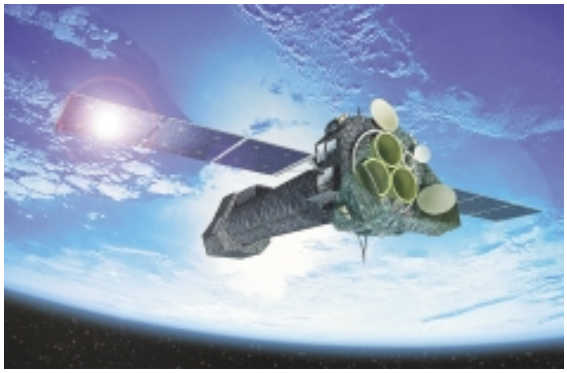
Quantitative X-ray astronomy with space born observatories relies on accurate radiometric calibrations provided by PTB's synchrotron radiation laboratory.

The space observatories Chandra of the US National Aeronautics and Space Administration (NASA) and X-ray Multi Mirror Mission (XMM-Newton) of the European Space Agency (ESA), successfully launched last year, are expected to lead to new scientific insights from the detection of cosmic X-rays. One project, for example, aims at the determination of the age of the universe by a measurement of the X-ray emission from distant objects.

In PTB's laboratory at the Berlin Electron storage ring for Synchrotron radiation (BESSY), methods and instrumentation for the determination of the spectral responsivity of detectors and for the characterisation of X-ray optical components and modules were developed. The detector calibrations are based on the utilisation of the electron storage ring as a primary source standard for the spectral range from the visible to the X-ray region and cryogenic radiometers as primary detector standards.



Calibration data for the flight module of the CCD camera of the XMM satellite with an area of 6 cm × 6 cm measured at the 6 T wavelength shifter of BESSY



In this artists view of XMM in orbit, the three telescope apertures at the front and the focal-plane instruments box at the end of the observatory are clearly visible. *Photo: ESA*

One of the three focal-plane instruments of XMM, the flight module of the pn-CCD camera from the Max-Planck-Institute for Extraterrestrial Physics, was calibrated directly at PTB. The pre-launch calibration of the telescope for Chandra has been performed at NASA's X-ray calibration facility at the Marshall space flight center by comparison with transfer detector standards calibrated with a relative uncertainty of 1 % in PTB's laboratory at BESSY. Therefore, the measurement of cosmic X-rays can be traced back to the radiometric scales of PTB.

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ECG Interpretation by Means of Pattern Recognition

(continued from page 1)

rarely found special cases or new medical findings requires software adaptations which are often very expensive.

A method developed by PTB scientists has none of these disadvantages. It starts with the assumption that the same diagnosis can be assigned with high probability to ECGs the signal patterns of which are in good agreement. With the aid of modified correlation methods, reference cases are selected from an ECG database which agree best with the signal patterns of the unknown ECG. When similar ECGs have been found, the results of the corresponding cardiac examinations or the diagnoses can be used to interpret the unknown ECG. The reliability of the method depends decisively on the size and completeness of the database used for this purpose. It has to reflect the spectrum of the most significant cardiac diseases.

The method was tested using 10000 ECGs. The percentage of correct diagnoses ranged between 75 and 95 depending on the respective categories of heart conditions.

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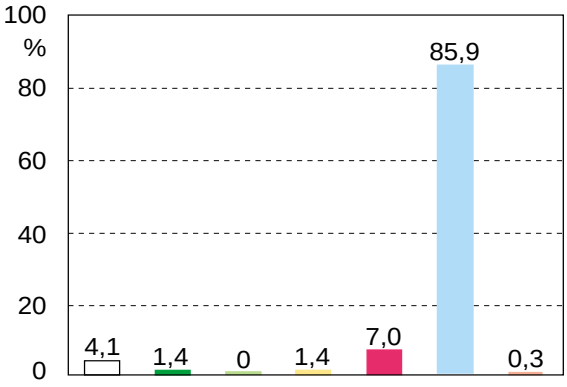

Example of ECG evaluation by pattern recognition
The bar graph is the result of the evaluation of those ECGs stored in a database, whose signal patterns are most similar to those of the unknown ECG. While 85,9 % of them (blue bar) point to a block in the heart's conduction system, indications of other heart diseases (remaining bars) are distinctly less pronounced.