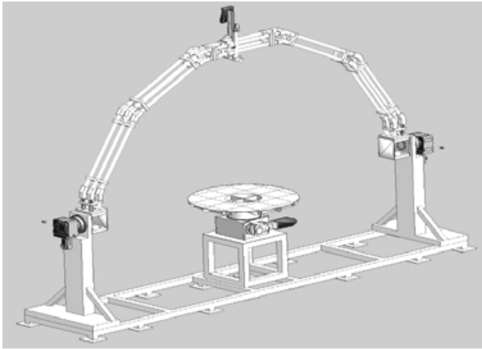

Automation of acoustic measurements in an anechoic chamber

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Eine große Zahl von Messpunkten und die notwendige Wiederholbarkeit während der Ermittlung von Richtcharakteristiken machen den Einsatz von automatischen Messerfassungssystemen erforderlich. In diesem Artikel ist ein Konzept für das Stellglied des Positionierungssystems im schalltoten Raum dargestellt. Es wird außerdem Konzept für ein universelles Messerfassungs- und Distributionssystem beschrieben.

A large number of measurements positions and measurements repetition during e.g. directivity pattern recognition cause necessity of apply of automated measurement systems. The article presents a concept for an actuator for positioning of the measurement system in an anechoic chamber and a concept of universal storage system for gathering and distribution of measurement data.

6 Introduction

The special character of acoustic measurements in an anechoic chamber requires designs that minimize disturbances to the acoustic field. Automation always involves the introduction of additional mechanical elements, which disturb this field but such disturbances are definitely less than influence of human staff.

7 An actuator for positioning of the measurement system

Automation of acoustic measurements in an anechoic chamber is a real challenge to designers. The special character of the measurements calls for solutions that minimize the disturbance to the acoustic field whereas automation systems always introduce additional mechanical elements which disturb the free acoustic field in an anechoic chamber. The anechoic chamber in questions is a reinforced concrete cubic shell resting on spring vibroinsulators. All the internal surfaces are covered with sound absorbing systems in the form of 1.2 m long wedges. The working floor has the form of a steel rope net suspended at a height of 0.3 m above the wedge apexes. On the chamber roof there is a room housing a hoist and a ventilation system. The chamber's outside dimensions are 10.4m [H] x 10.2m x 9.7m, the inside dimensions are 6.9m (H) x 7.2m x 6.8m, and the volume is 821.5m3. The chamber weighs about 600 tons and with the vibroinsulation in place the chamber's natural frequency is about 5 Hz.

The main goal of the manipulator under construction is to ensure greater precision, versatility, to facilitate the research work and teaching, and to conform to procedures specified in relevant standards. Analyses and studies so far show that these procedures require proper positioning of the microphone – chiefly on the hemisphere surface.

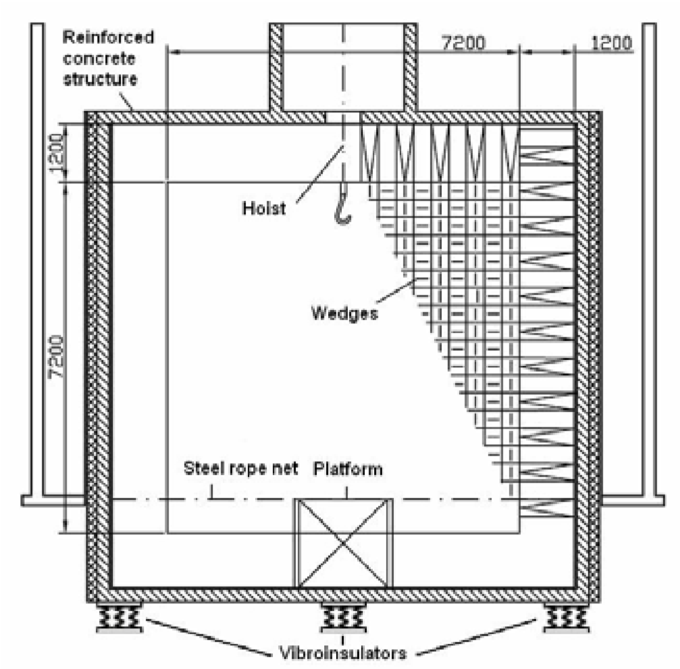

Figure 1: Vertical cross-section of the anechoic chamber

Figure 2: The hoist positioned over the chamber roof

Figure 3: The housing with springs located in the central point of support

Practically most geometric and dynamic requirements allowing automation of measurements are typical of the measurement procedures identified below:

Determination of the acoustic power level of noise sources (PN-EN ISO 3745:2005), Determination of directional characteristics of sound diffusion for electroacoustic transducers (PN-EN 60268-5:2005),

Determination of sound distribution pattern on a pre-set measurement grid, Multipoint studies of structures and sound sources using the impulse response method.

The measurement of acoustic power (PN-EN ISO 3745:2005), typical of the most frequent and most labour-consuming studies that require positioning of the measurement points on the hemisphere, was taken as a starting point for developing the idea of manipulator movements. Practically all the procedures mentioned above require positioning the microphone on the hemisphere surface and identifying directional characteristics of the source-object-microphone system. An exception is the determination of the sound intensity distribution on a plane measurement grid or on a grid matching the special shape of the machine studied. The latter option calls for special equipment and can be implemented in the future.

The structure of the chamber was analysed in terms of the possibility of installing a manipulator for measurements, with special regard to acoustic disturbance that can be caused by its drive system. Three possible concepts of positioning the manipulator were considered: on the chamber roof, under the floor slab and inside the chamber. The first two concepts were found difficult to implement: the first one, due to the increased length of the driving energy transmission path from the manipulator motors to the actuator units. This concept does not require breaking through the chamber's reinforced concrete owing to the presence of existing technological openings. The difficulty with the second concept is that it requires breaking through the chamber's reinforced concrete structure. Also, it turned out that the floor slab is supported in its central point (**Fig. 3**) which prevents positioning the axle of any drive in the centre. The concept of installing the manipulator drives inside the chamber proved most convenient for implementation in terms of construction. **Figs. 4 and 5** show the selected variants of the manipulator concepts considered, and **Fig. 6** shows the variant selected for implementation.

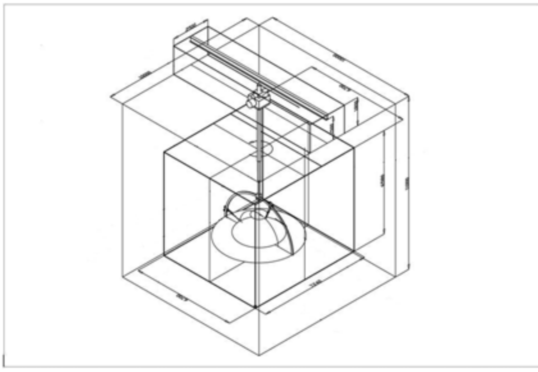

Figure 4: A concept of the manipulator with the drive positioned above the chamber

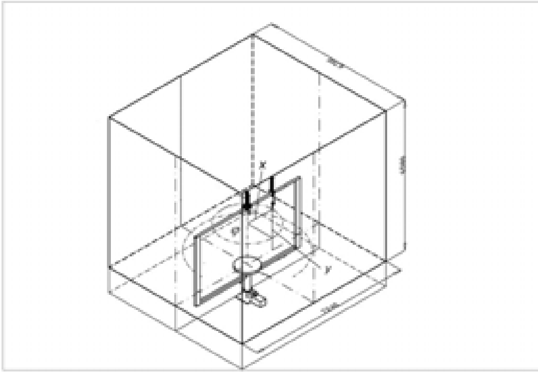

Figure 5: A concept of the manipulator with the drive positioned under the chamber

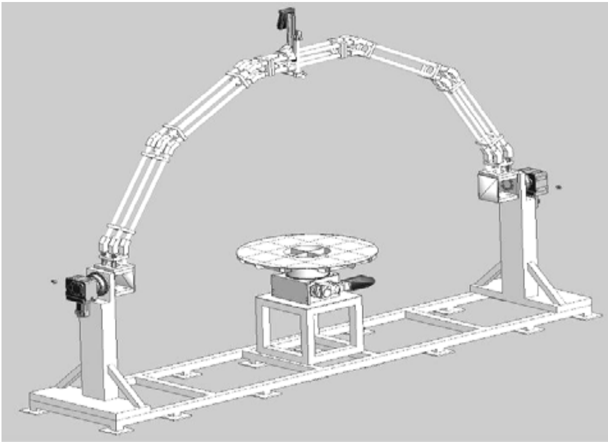

Figure 6: The concept of the manipulator selected for implementation

During the design work, several concepts of the manipulator design were analysed. The key problems in developing the concept were in ensuring the required rigidity of the supporting system structure under the assumed working space and the number of the device's degrees of freedom.

Ultimately it was decided that the device will have three degrees of freedom and the working space will be a hemisphere. One degree of freedom will be ensured by the rotation of the measurement turntable positioned in the centre of the chamber; the second degree of freedom will be ensured by a rotating frame supported by bearings positioned on the horizontal axis of the table plane thereby making it possible to change the angular position of the measurement system relative to the object studied. The third degree of freedom allowing the hemisphere radius to be changed will be ensured by installing a linear movement module on the rotating frame.

8 A storage system for data gathering and distribution

Technical solutions currently available allow gathering of acoustic and non-acoustic measurement data, e.g. air parameters, pictures or video. Most often measurement team goes to measurement point, sets up measurement equipment (sonometer) and additional equipment (camera etc.) and starts measurement. Usually it is several hours long and the presence of the team is necessary to control the SLM, register manipulator position.
In case of long term measurement it is inconvenient and demands engaging people for a long time. The solution for such a problem might be an automated storage system.

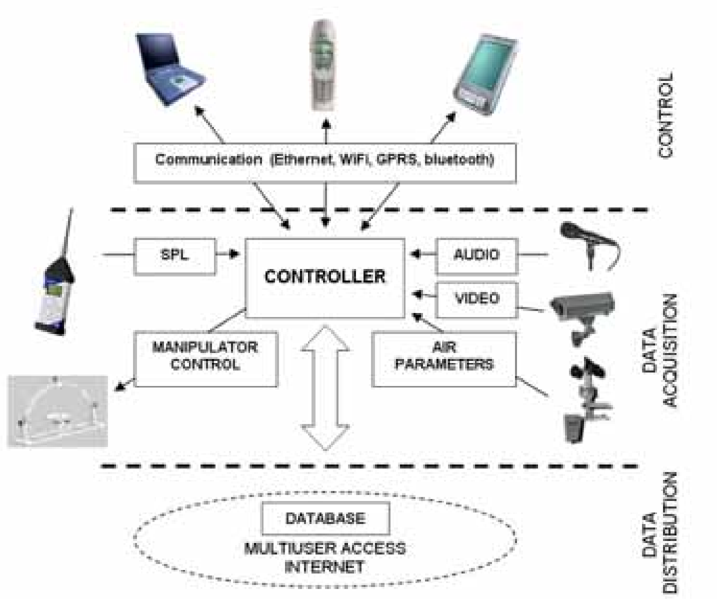

Figure 7: A storage system for gathering and distribution of acoustic and non-acoustic measurement data

The storage system schematic presented in **Fig. 7** shows: control module, communication and setting module and data distribution module. System controller is based on single board computer equipped with physical memory of 80GB. Measurement devices: SLM, manipulator, air parameter station and other modules are controlled by the central controller.

By means of cell technologies (GPRS) and radio networking the controller might be programmed from the mobile computers: laptops or Pocket PC's. The communication is held on bluetooth or WiFi. That allows system programming and data transfer without using a physical connection by a cable (but that is also possible for example for maintenance).

The transmission (for control or data transfer) is protected with the access code generated in the controller. The code is unique for each control device. The code check appears once in a minute and if the correct data is received automatically a connection is set up with the control device and since that moment the user has access to the settings of the parameters. The access codes and the access software for the measurement session programming might be installed on many mobile computers and are independent from the operation system.

If in the proximity of the station a Pocket PC or laptop is found the authorization takes place and the connection is set up and the data transfer or programming is possible. The control software allows:

- programming of the measurement session: start time, end time, name of the session. The application protects against wrong or incomplete data entry or the conflict with the earlier settings,
- preview of the gathered data, it is possible to view particular data during the measurement time (e.g. listening to the audio file),
- after the measurement it is possible to transfer the full data and to fully index them in the database,
- it is possible to quickly transfer the data on additional temporary storage (mass storage), transfer the data from the hard drive of the controller to the mobile computer, copying the measurement data to storage connected to the USB interface (hard drive or FLASH memory).

9 Summary

The result of the project was development of technological solution providing automation of process of acoustical and non-acoustical data gathering. The flexibility of the system allows implementation of other measurement modules and widening the usage range. That solution influences the number and the quality of the processed data.

By analyzing the virtues and faults of the system one might state that such solution will reduce the total cost of the measurements.

10 References

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