Multichannel, temperature and velocity measurement system with PC computer in applicationto room air movement tests

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1. Introduction

A multichannel instrument for temperature and velocity measurement makes it possible to carry out more complex tests of air motion in rooms. Simultaneous measurement in few points is necessary when it is difficult to maintain long-term stability of flows and this problem occurs very often.

In 1986 an eight-channel anemometer-thermometer ATL-1 was constructed on the basis of a microprocesor Intel 8080 at the Institute of Heating, Ventilation and Air Protection of the Silesian Technical University in Gliwice. The instrument measures air temperature and velocity, simultaneously in 8 points, the measurement results are displayed on two LED 4 digit displays and printed. The measurement probes are connected with the instrument by means of a cable, 7 m long (1).

In 1987 the work was begun on the design of a multichannel system for air velocity and temperature measurements of similar application but assuming that the system will be based on a personal computer XT or AT, compatible with IBM. The work resulted from the need to enable more versatile system elements selection and to facilitate the measurement control as well as the measurement results collecting and processing.

The purpose of the work was to create a system which could be gradually developed depending on needs and possibilities. The system was to be employed in tests carried out in large objects where distances between measurement sensor and the central unit may be rather long (up to 100 m).

2. Configuration of the measurement system

The multichannel system for air velocity and temperature measurements, denoted with symbol ATS is shown in Fig.1.

The system consists of:
- Velocity transducers HST-2
- Temperature transducers TT-1a with probes TS-1
- Power supply/interface TPS
- Computer PC XT/AT with card ADDA-12
- Special software package called CRPD

There are 16 measurement channels owing to which it is possible to measure air velocity and temperature simultaneously in 8 points. The numbers of velocity and temperature transducers need not be the same, e.g. 8 velocity transducers, 6 temperature transducers and two other transducers may be connected to the system. The voltage signal of other physical parameters of the transducer should be consistent with the card ADDA-12.
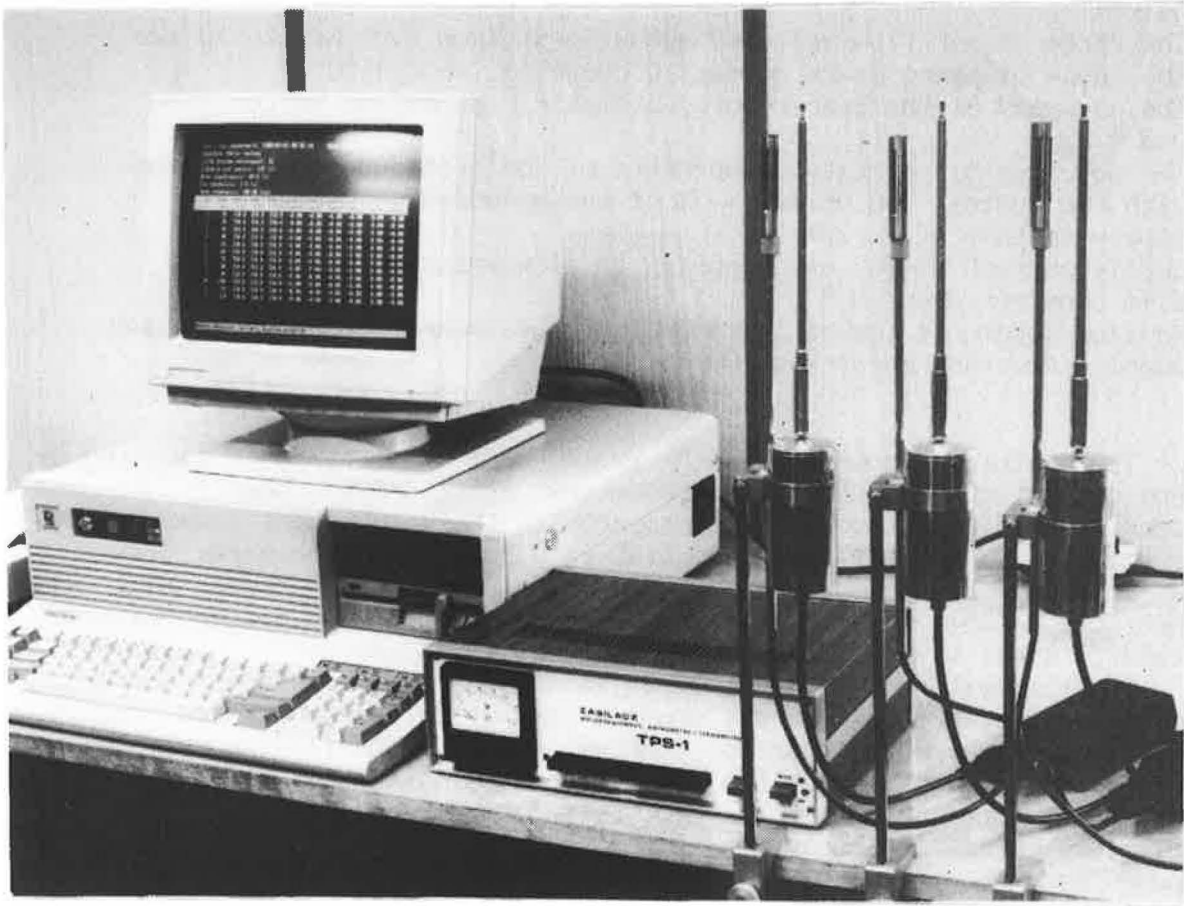
Fig.1 Multichannel measurement system ATS

Velocity transducer. In order to measure the air flow velocity a thermoanemometer measurement transducer type HST-2 with an omnidirectional sensor was used in the system. The omnidirectional sensor is particularly useful for tests of highly turbulent free flows where it is difficult to define the average flow direction (2, 3, 4).

The omnidirectional spherical sensor is made of enamelled copper wire pressed into the shape of a sphere of 3 mm diameter. Another sensor, serving for automatic compensation of the effect of air temparature changes is made of thin nickel wire and its shape is cylindrical. Both the sensors, being the measurement probe are vaccum covered with special Al coating, increasing the resistance of the sensor to contamination and decreasing the effect of thermal radiation on the velocity transducer readings.

The electronic system of the velocity transducer is placed in a cylindrical closed container, near the measurement probe. The system consists of an anemometric constant-temperature bridge with automatic temperature compensation, a transducer of the negative supply voltage, constant voltage regulators, an output differential amplifier and a filtering system. A quality of the constant temperature anemometer, is its wide measurement range and good dynamical characteristics.

The velocity transducer is connected to the system by means of a four-wire shielded cable. Two wires of the cable are used for analogue output signal transmission, two others for the transducer supply.

The following technical parameters of the velocity transducer were acquired:
- The range of air flow velocity measurement from 0.05 m/s to 20 m/s
- The range of temperature automatic compensation 0-60°C
- The accuracy of the temperature automatic copensation better than 0.3 %/K
- The accuracy of velocity measurement of the transducer cooperating with the system (0.05 m/s + 5% of the measured velocity)
- Supply voltage 12 V 20%
- Supply current 55-160 mA depending on flow velocity
- Time constant about 0.5 s
- Maximum length of the cable connecting the transducer with the power supply/interface more than 100 m

Temperature transducer with probe. Air temperature is measured by means of platinum resistance thermometers Pt 100/0°C. The method was chosen regarding the possibility to acquire the measurement accuracy better than 0.2 K and the long-term stability of platinum sensors.

In order to measure air temperature a special probe TS-1 was constructed. The probe was equipped with an openwork double radiation shield to limit the effect of thermal radiation.

The temperature transducer TT-1a is a linearized transducer cooperating with resistance temperature sensors in a so-called four wire system. The stable source of current forces the current flowing through the sensor, the voltage drop on the sensor is measured in the transducer. The current is supplied to the sensor by two so-called current cables. The amplifier, measuring the voltage drop on the sensor is connected to the sensor by two other cables. Such the system makes it possible to change the resistance of the connecting cables within a wide range so practically it is possible to lengthen the cable connecting the sensor to the transducer without worsening the measurement accuracy.

The temperature transducer TT-1a is linearized and its linearization error is less than 0.1 K within the temperature range from −50°C to +200°C. Practically it does not respond to the supply voltage changes from 10 to 14 V. The cables connecting the temperature probe TS-1 with the transducer TT-1a and those connecting the transducer with the power supply/interface TPS-1 may be up to 100 m long.

Power supply/interface TPS, mechanical elements. The power supply/ interface type TPS is to supply the voltage 12 V to the measurement transducers and to go between the signal transmission from the transducers to the card ADDA-12. TPS is equipped with an analogue indicator and suitable switches so that the level of the output signal obtained from the measurement transducers may be easily checked. The power supply/interface TPS is connected to the card ADDA-12, placed inside the computer, by means of a special 25 pin connector.

In order to facilitate the measuring probe fitting, special fitting holders were also designed. The holders make it possible to fasten the temperature probe TS-1 and the velocity transducer HST-2 as well as to control the fastening height and angle.

3. Computer and software

The system requires a computer PC–XT, the configuration of which should at least include:
- Matherboard 640 kB RAM. turbo 8 MHz
- Power supply 150 W
- Graphical card (Hercules or EGA)
- Two floppy drives 2*360 kB
- Card ADDA–12 (14)

The program CRPD has 9 main options. The first one is used to activate or switch out the measurement channels and to introduce the names of each channels. The second option assigns suitable linearization tables to the separate channels, introduces the sampling period, averaging time and recording interval. The next option is used to determine the kind of the measurement cycle; which may occur only once or be repeatable, and to introduce the length of the cycle. The above parameters of the measuremant cycle are written in the form of a configuration file. A re–start of the program does not require the above parameters reset, but only choosing a suitable configuration file.

The other options of the CRPD program define the disc parameters, create linearization tables, test the card ADDA and converse the measurement data files from binary to ASCII code.

Fig.2 presents the main menu of the program CRPD, fig.3 – an example of set parameters of measurement cycle. Fig.4 is an example of the measurement results report.
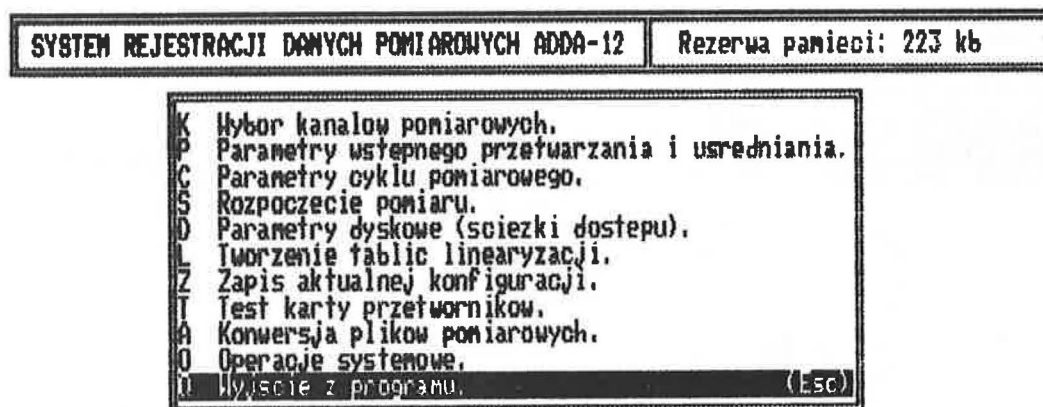

Fig.2 Main menu of the CRPD program

The files with measurement results may be then processed by popular statistic–graphic packages or by other specialized software.

The multichannel system for air velocity and temperature measurements type ATS was applied in various measurements including tests of air diffuser used in displacement ventilation. It proved to be convenient for measurements of mean values of velocity and temperature fields in air movement tests.

AKTUALNA KONFIGURACJA

Cykl pomiarowy: powtarzalny
Nazwa cyklu : Air velocity and temperature of the
Dlugosc cyklu : 00:00:10:00
Filtracja: usrednianie
Zapis pomiarow: wylaczony

Punkt	Aktyw.	Nazwa punktu	Tablica linear.
0	NIE	we 01	STANDARD
1	TAK	vel 1	VEL
2	NIE	we 03	STANDARD
3	TAK	vel 2	VEL
4	NIE	we 05	STANDARD
5	TAK	vel 3	VEL
6	NIE	we 07	STANDARD
7	TAK	vel 4	VEL
8	NIE	we 09	STANDARD
9	TAK	temp 1	TEP
10	NIE	we 11	STANDARD
11	TAK	temp 2	TEP
12	NIE	we 13	STANDARD
13	TAK	temp 3	TEP
14	NIE	we 15	STANDARD
15	TAK	temp 4	TEP

Okres probkowania w [ms]
100
Przedzial usredniania
00:03:00:00
Okres rej. wart. sredn.
00:00:60:00
Dopuszczalna odchylka
4095

Wykonac wedlug tej konfiguracji [T/N] ?

Fig.3 An example of measurement cycle parameters

Data i czas rozpoczecia: 1989-11-03 09:02:00   Rezerwa pamieci: 203 kb
Sygnatura: Air velocity and temperature of the diffuser
Liczba kanalow pomiarowych: 8
Calkowity czas pomiaru: 600 [s]   Filtracja: usrednianie
Okres rejestrowania: 60.0 [s]   Stan realizacji cyklu: 100 %
Czas usredniania: 180.0 [s]   Zapis pomiarow: wylaczony
Okres probkowania: 100.0 [ms]   Srednia z 1800 probek
Probka z 8 pomiarow

Lp	Czas [s]	vel 1 [m/s]	vel 2 [m/s]	vel 3 [m/s]	vel 4 [m/s]	temp 1 [°C]	temp 2 [°C]	temp 3 [°C]	temp 4 [°C]
1	0	0.03	0.31	0.55	0.75	19.5	19.4	19.6	19.8
2	60	0.03	0.29	0.51	0.70	19.6	19.6	19.6	19.9
3	120	0.01	0.25	0.46	0.63	19.8	19.7	19.8	20.0
4	180	0.01	0.26	0.47	0.64	19.7	19.7	19.8	20.0
5	240	0.02	0.28	0.50	0.68	19.7	19.6	19.7	19.9
6	300	0.04	0.33	0.57	0.78	19.4	19.4	19.5	19.8
7	360	0.04	0.33	0.58	0.78	19.4	19.4	19.5	19.8
8	420	0.04	0.34	0.59	0.80	19.4	19.4	19.5	19.7
9	480	0.06	0.36	0.60	0.81	19.4	19.3	19.6	19.8
10	540	0.05	0.35	0.61	0.82	19.4	19.3	19.5	19.8

Pomiary zakonczone, nacisnij dowolny przycisk.

Fig.4 An example of measurement results report

4. References

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SUMMARY

The paper presents the way of construction and metrological
properties of the velocity and temperature probes and transducers and
other components of a multichannel system for simultaneous air velocity
and temperature measurements in rooms. The system consists of hot-sphere
omnidirectional constant temperature anemometer transducer and resistance
air temperature transducers. These transducer via an interface-power
supply are connected with ADDA-12 PC card. Especially developed software
for PC XT/AT computer controls measurement data collection and processing.