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APPLICATION OF PRESSURE SENSITIVE RUBBER IN HUMAN AND TECHNOLOGIC STABILOMETRY

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Abstract:
The contribution deals with determination of the balance centre either for the medical purposes or for the robotics. The results-review of the practical applications by the necessities of the pressure areal distribution knowledge is given. Any other improvements of the areal pressure transducer are presented especially what concerns the SW-processing of the output signals, and HW – elements, too.

Introduction

The balance centre position and its movement as the projection into the base plane can be estimated using the areal pressure transducer joint with processing these data.. The applications are not only in orthopaedy, but in any others branches too, as e.g.: by the back-bone diseases, scolioses determination, in sports medicine, psychology, in robots stability determination, etc. Any other improvements of the areal pressure transducer are presented especially what concerns the SW-processing of the output signals, and HW – elements, too.

Transducer principle

For measuring the pressure distribution in planethe semiconductive „rubber“ was used (due to the force acting its electric resistance changes) and the tactile matrix transducer has been realised. The quite simply construction (the rubber sheet between the belts electrodes) enables to collect the output signals from the 7500 measuring points for the further processing. The transducer and its layers arrangement can be seen in Fig. 2.

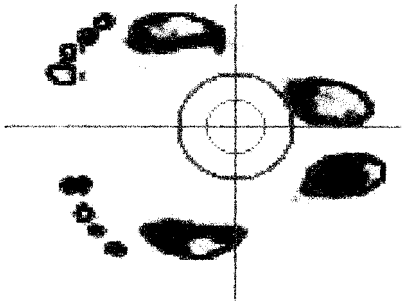
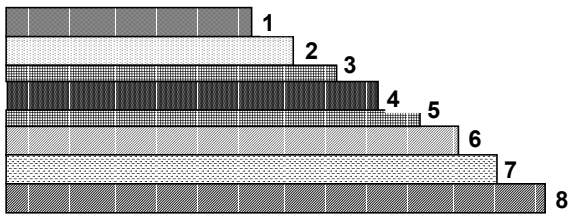


Fig. 1 Balance – centre – determination



1 - cover layer
2 - slip layer
3 - top electrode CUFLEX
4 - conductive elastic material CS 57-7 RSC
5 - down electrode CUFLEX
6 - antistatic layer
7 - dural plate
8 - antistatic layer

Fig. 2 Transducer arrangement

Signal processing

Multisensor system can be realised on the area 300 x 400 mm. The area's scanning is controlled by multiplexes (100 rows x 75 columns) by the 300 snaps per second. Being respected the medical safety precautions, the "safety" extra low voltage (SELV) has to be used for the sensing elements supplying (5 V DC), and no activated electrodes are grounded. The couple CMOS-unipolar transistors are used as switches. Microprocessor is controlling their activity and all logical controlling functions are programmed in PLA-memories. An analogue level of the output signal can be adapted either by means of the output resistors (these ones are connected in series with sensors being realised as voltage divider) or by means of the amplifier. Its output is connected to the 8-bit A/D converter - supplying the I/O special interface unit. The mentioned electronic components are solved as the peripheral unit for PC-by SMD technology - with the high sampling frequency 2.5 MHz, see Fig. 3.

The communication to PC and the control signals generating for multiplexes is carried out by means of the control microprocessor that is together with ultra fast 8 bits A/D converter and with 10 MB buffer in one special interface unit. This unit is connected with parallel port to PC. HDD can be included in this unit, too. On this HDD long time measurements can be recorded in real time. Having been measurements over, these data are transfered from interface unit to PC by parallel port. Besides that, this interface unit enables to visualize the measurements results on the PC monitor display in real time, too. The evaluation is provided on PC - with respect to the used SW-equipment (as e.g. : 2D-half tone view on the monitor, or the pressure-profile cuts of the activated loaded area etc.).

Briefly the others technical features:

sensor element dimensions	2x2 mm
analogue output signal (by max. loading)	50 mV DC
digital output	256 levels
supposed pressure range to be caught	
the balance centre	12 – 90 kPa
snap frequency	300 Hz
sampling frequency	2,5 MHz

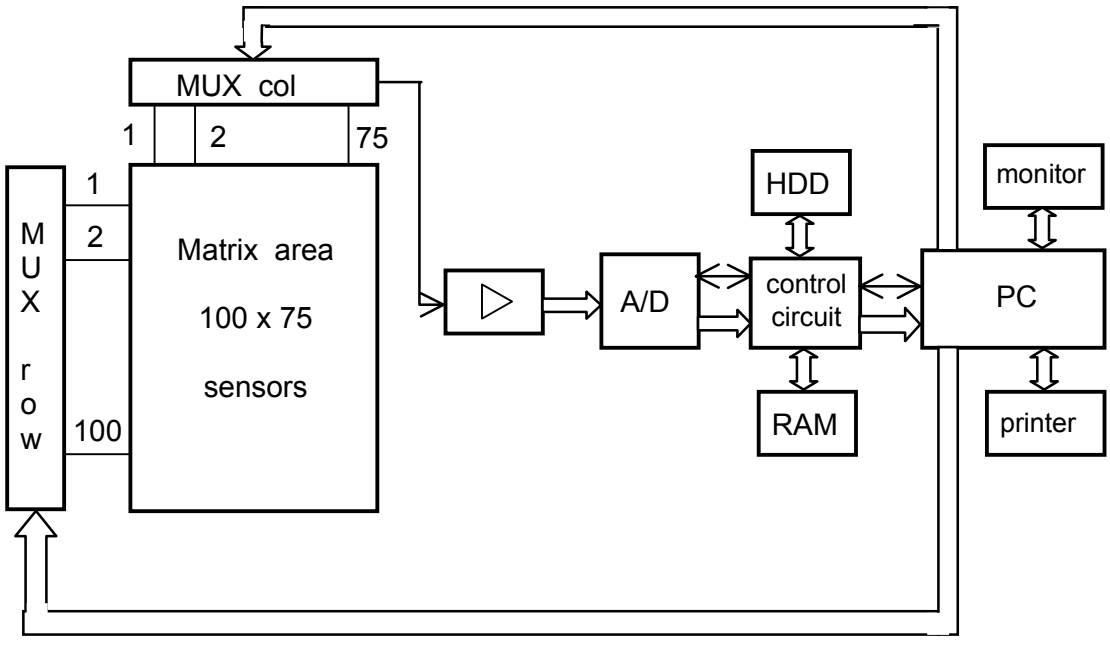


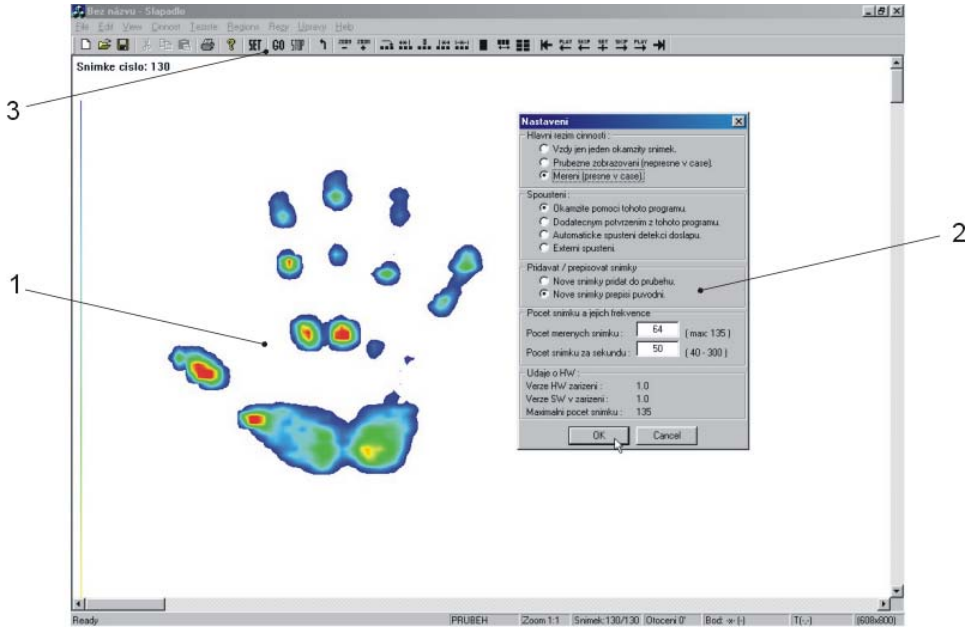
Fig. 3 Block diagram - Transducer pressure assembly

Software tools

The transducer pressure assembly consists of the following parts:

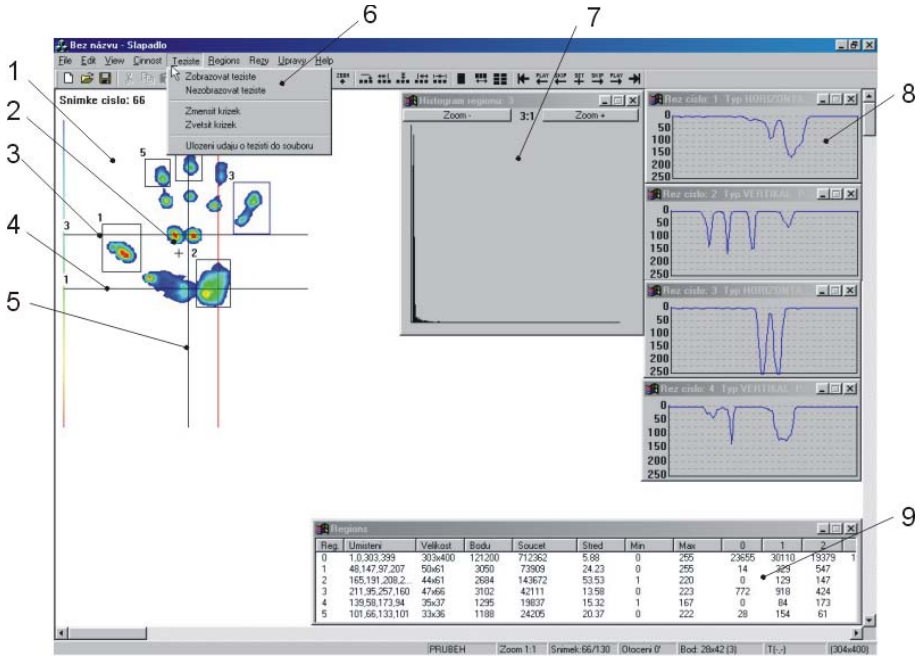
- matrix pressure transducer,
- operating electronics,
- interface and PC with driver and SW.

Being used operating system Win98/ME/NT/2000 in PC, our driver is installed there too, to be realised the communication activity between interface and operating software. Operating software has been developed in MS Visual Studio 6.0 and is divided on operating and analytical part. It is possible, to be seen the preview of an immediate load of the sensor, by speed frequency - up to 15 snaps per second.



1. Working window; 2. Dialog box for measurement adjustment; 3. Toolbar

Fig. 4 Window with hand image



1. Working window; 2. Cross representing COP; 3. Region of interest; 4. Horizontal section; 5. Vertical section; 6. Menu for COP; 7. Histogram of values from region 3; 8. Distribution of pressure in section; 9. Informations about regions;

Fig. 5 Windows with hand image

For measurements, the dialog window is prepared, where you can adjust: the measurements duration, snapshot frequency, and the noise level. It is possible to view the immediate changes of the pressure load in frequency 15 snaps per second, too. For an exact measurement, no possibility is to be seen the snaps in real time, due to the fact – that the data are stored in buffer in interface with the high speed scanning frequency (up to 300 Hz).
The next one dialog window is prepared for the measurement start adjusting:

- from SW by button click,
- by clicking keyboard,
- by touching external switch, or
- by auto detection of contact with pressure sensor (level is also adjustable).

There are possibilities - to save the measured data in several different formats (*.dat – working format, *.xls – Excel, *.bmp – 256 colours bitmap). For the data processing, the several dialog windows are prepared, which allow to be evaluated the snaps through:

- Centre Of Pressure (COP) movement,
- Region Of Interest (ROI),
- Vertical and horizontal sections – "cuts"

For analysis of the COP movements, as results can be set - stabilometry parameters:
MV [Mean Velocity] – computed by means COP coordinates and time, CEA [95% Confidence Ellipse Area], and FD [Fractal Dimension].
ROI creation – it is possible create "infinite" number of ROIs. Each ROI can be evaluated by computing of its own COP, by histogram of values of weight, or by computing the typical values for this region (sum, average, etc.) - see Fig. 4.
The last evaluating possibility is creation the number of the various horizontal or vertical "cuts" – sections, to be seen the loading curve - see Fig. 5.

Conclusion

The multisensor system enables to determinenot only the distribution of the pressure but also the balance centre trajectory not only in the real time, but the used SW enables the further more precise study, too. Both infprmations are of great importance for the medical practise, especially for the orthopaedy, what extends pedobarography methodes, ordinary platform stabilometry and brings new possibilities for the human movement system disorders studies and diagnostics.

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