QUANTIFICATION OF STABILISING BEHAVIOUR ON A 2-DOF PLATFORM

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A low cost, reliable system that allows for quantification of the stabilising behaviour of subjects on a POSTUROMED® platform was developed. This was achieved with an ordinary mouse connected to the RS232 interface of a standard PC. The system can be set up and used within minutes. The modular structure of the software facilitates customisation to a variety of measurement protocols. The system is well suited to quantify stabilising behaviour with an maximum relative error of less than 2 %.

KEY WORDS: stabilisation, measurement, RS232, MS mouse.

INTRODUCTION: The aim of the present project was the development of an easy to use inexpensive system to allow quantification of the stabilising behaviour of test persons standing on a 2-dof (degrees of freedom) platform. As in previous studies (Schlumberger, Schmidtbleicher, 1999) the path length z was chosen as performance indicator. It is commonplace to use expensive A/D adapter boards to record accelerometer signals. These signals are then smoothed and integrated twice to obtain the displacement information. Qualified staff is required for the testing and data analysis.
Hence, basic design requirements for the system presented here included:

- ease of operation,
- no special hard- and software needed,
- immediate availability of results,
- low cost,
- executable on any Windows platform.

The system was specifically adapted to quantify neuromuscular stabilisation and short term adaptation processes in elderly subjects (age > 60 years) standing on a POSTUROMED® platform. The measurements were to be taken in the subject's familiar environment, thus the system needs to be portable and easy to set up.

METHODS: The serial RS232 port of a standard PC is used to avoid the need of expensive extra hardware. This port with its different input and output pins can also be used for measurement and control tasks. Displacement information is obtained from a simple serial mouse fixed to the bottom of the POSTUROMED® base plate with a rectangular telescopic rod (Figure 1). Prior to the test, the base plate is moved from the resting position and then released by an electromagnet (Figure 2) to generate initial perturbation of the equilibrium. The signal controlling the magnet is also transmitted via the RS232 port.

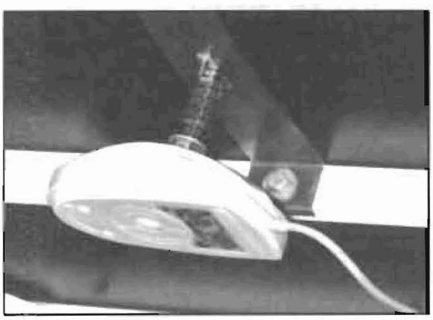

Figure 1. Fixation of the serial mouse.

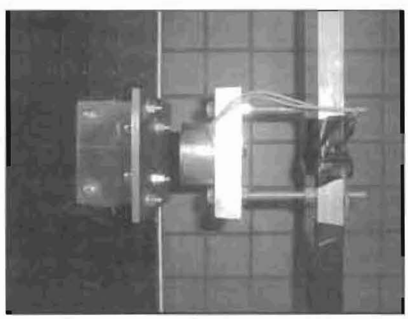

Figure 2. Electromagnet used to release the platform.

To protect the serial port, an optoelectronic coupler (Figure 3) was used to separate the supply voltage of the release mechanism

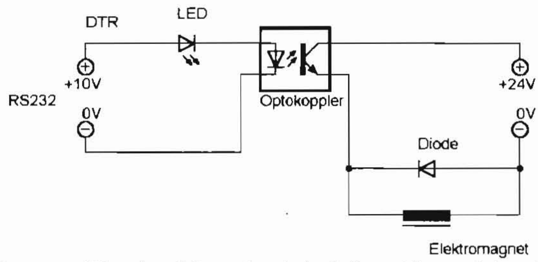

Figure 3. Schematic diagram of the circuit for galvanic isolation of the serial port.

The software program was written in VBA (Visual Basic for Applications) in the MS Excel environment. To read data from the RS232 port and to output the required control signals, the RSAPI.DLL was linked to the source code. Advantages of the VBA environment include simple adaptation to varying user demands and test situations, immediate availability of the data in an Excel spreadsheet and the simple user interface which ensures error free data acquisition even by laypersons. The accuracy of the complete system was checked with a Laser device (accurate in the nm range). Furthermore a calibration factor was established from 18 measurements using the equation:

Calibration Factor = $\bar{x}_{laser} / \bar{x}_{mouse}$ = 0,00622

The relative error computed from the smallest and largest values of the 18 measurements is:

$F_{rel} = \pm 1{,}98$ %.

RESULTS AND DISCUSSION: Tests of the stabilising behaviour of elderly (age > 60 years) sportive subjects were performed. The task was to stabilise the platform, initially displaced by 2cm within the shortest time possible. The maximum time interval was set to 10s. Five sets of five trials were performed with one minute rest. Figure 4 shows a typical adaptation observed for a single subject in one series.

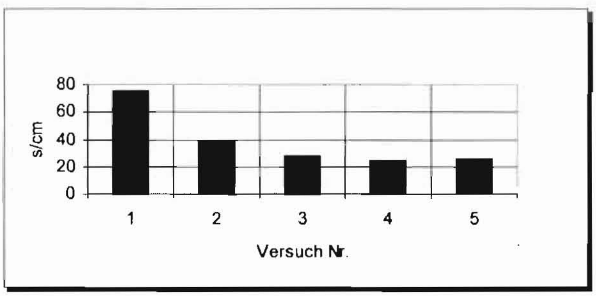

Figure 4. Measured path length for one subject, five consecutive trials.

Since X and Y co-ordinates are available, it is easily possible to generate Position vs. Time (Figure 5) and X – Y diagrams (Figure 6). From the measurements it was also possible to determine damping and mass-dependent oscillation of the POSTUROMED® platform. Results are presented in Figure 7.

CONCLUSION: Material cost, including the electromagnet used to release the platform, are about 100 US$. A standard PC or Notebook with no extra hardware is adequate. The test showed, that the system can be set up and used within minutes. The modular structure of the software facilitates customisation to a variety of measurement protocols. The system is well suited to quantify stabilising behaviour with an maximum relative error of less than 2 %.

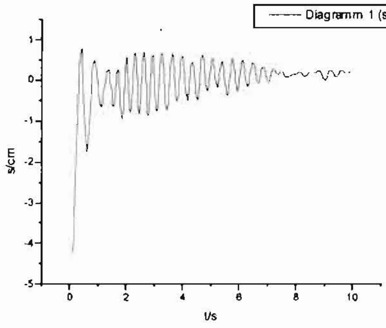

Figure 5. Position (X) vs. Time.

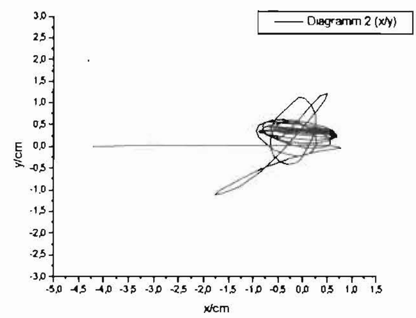

Figure 6: X - Y Diagram.

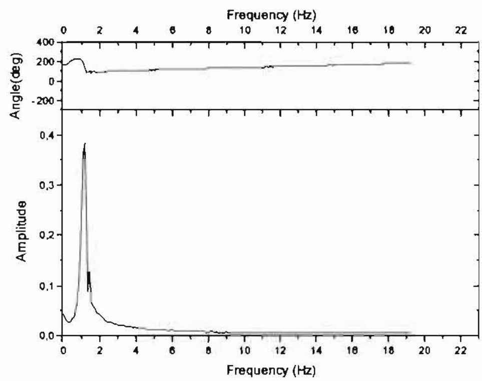

Figure 7. Damping and oscillatory properties: FFT Analysis of the Posturomed with added mass (m=80Kg).

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