UNIVERSAL MICROPROCESSOR EQUIPMENT FOR MEASUREMENT OF TIME INTERVALS IN VARIOUS MOTOR ACTIONS OF MAN

SALINGER, J.; VAVERKA, F.; ČEPL, M.; MACHÁČEK, I.
Top Sports Laboratory
Palacky University
Olomouc
Czechoslovakia

Information about an individual's motor abilities or about the techniques of the motion performed can be obtained at varying degrees of exactness. In practice methods range from very simple motor tests to intricate biomechanical procedures that yield a wide variety of data. The quality of motion can be quantified using physical data (strength, path, time, etc.). The time factor of the motion performed provides valuable diagnostic data, therefore it is frequently used in investigation. Measurements of time intervals in connection with other measured data can characterize motion through derived physical quantities like velocity, acceleration, performance, etc. The interpretation of temporal data varies according to the specific features of the motion investigated.

For temporal measurement single-purpose instruments are often used, which is uneconomical as a new testing line has to be constructed for every test. On the basis of our long-term experience of measuring temporal data (1,2,4,5,7,8) we undertook to design and realize a universal diagnostic system that enables measurements of a large number of temporal data by various sensors in real time. In the construction of the system the following tasks were pursued:

- high capacity of time signals measured,
- parallel recording of time signals by different sensors,
- immediate evaluation and statistical processing of the ON-LINE system data,
- university of the system enabling simple connection of various types of sensors according to the characteristics of motion investigated,
- openness of the system with regard to both hardware and software.

In order to comply with the above tasks an IBM PC XT/AT microcomputer was used with a programmable plug-in module LVS-PC 1, which renders it possible to attach both standard and non-standard sensor elements. The programming equipment provides for controlling of the measuring process, evaluation of the data obtained and presentation of a printed record of the measurement results.

The system renders it possible to attach 8 measuring channels, each of them being able to register as many as 200 temporal data. The precision of measuring of time intervals is optional up to the value of 10^{-4} s. The conception of the system presents the possibility of being continuously supplied in the field of both hardware and software, and extended according to the user's special requirements as to the diagnostics of man's motor activites.

At the present stage the system under discussion can be made use of in the following areas (as represented in Fig.1):

1. Measuring of vertical jump from the period of support-free phase.
2. Measuring temporal parameters of tapping.
3. Measuring of the duration of the support and support-free phases of walking and running.
4. Measuring from 1 to 8 general time intervals.
5. Measuring run-on velocities in a ski-jump.

The designed diagnostic system provides, besides basic measurement data, also the values of other parameters, like the differences between various input signals, minimum and maximum values, average and standard deviation, etc. The basic parameters that have been measured and calculated are immediately presented in clear tabular and graphic from. In later investigation it is also possible to select and mark extreme values, these were not considered for further processing , the data however will not be cleared.

The measurement data and parameters obtained are provided in the form of reports which include the initials of the person measured with tabular and graphic representation of the measurement results and parameter evaluation.

VERTICAL JUMP MESUREMENT

The measurement principle is based on the support and support-free phases of the jump and on calculation of the jump height (3,4,6,7,8). Time limiting precondition of this measurement is landing on stretched legs.

The types of jump performance with corresponding parameter evaluation that are processed by our system are as follows:

a) individual jumps

sensor: a contact take-off plateau

- support-free phase measurement t_B
- height of jump calculation h
- results:
  - table of values h
  - statistical table of values t_B and h
  - graphic representation of values h

b) I. iterative jumps (Fig.2)

sensor: a contact take-off plateau

- measurement of support phase t_0 and support-free phase t_B
- heigh of jump calculation h
- results:
  - table of values h and t_0
  - statistical table of the values above
  - graphic representation of the values above

II. iterative jumps (symmetry)

sensor: a dual contact take-off plateau

- measurements of support phase t_0 and support-free phase t_B separately for left leg L and right leg P, i.e. t_{OL}, t_{OP}, t_{BL}, t_{BP}
- height of jump calculation h
- results
  - table of values t_{OL}, t_{OP}, t_{BL}, h
  - graphic representation of interrelations between values t_{OL}, t_{OP}, and t_{BL}, t_{BP}

MEASURING TIME PARAMETERS OF TAPPING (FIG.3)

The described system renders it possible to measure, with either contact or contactless sensor within the pre-selected time interval, the maximum number of switch-on impulses N or their frequency F. The time switching on t_0 and time of switching off t_B can be measured as well. Measurement results are provided by a report which includes the following data:

- pre-selection of the interval to be measured,
- table of values t_0 and t_B,
- statistical table of values t_0 and t_B jointly with values N and F
- graphic representation of values t_0 and t_B.

Measuring the duration of support and support-free phases of walking or running (Fig.4)

During these measurements it is possible to carry out basic analysis of the differences, in the support and support-free phases, between the left and right leg in walking or running. Two variants have been considered for these measurements, namely on-the spot movement with a dual contact take-off board, or normal walking with the use of 1 - 8 single take-off plateaus.

The measuring system evaluates items t_{OL}, t_{OP}, t_{BL}, t_{BP}, indicating whether the activity being evaluated is walking or running. The results are presented in a report which contains:

- a table of values t_{OL}, t_{OP}, t_{BL}, t_{BP}, identifying either walking or running,
- a statistical table of the values above,
- graphic representation of the interrelation of values t_{OL}, t_{OP}, t_{BL}, t_{BP}.

MEASURING 1 - 8 TIME INTERVALS (FIG.5)

The purpose of general time intervals is to analyse motor activities, e.g. running, the progress of which is followed by several contact or microelectronic sensors. Prior to the start of the motion preselection of either audio- or videosignal is possible. Measurements are represented in a report which contains:

- a table of progresive values of time intervals t_1 to t_8,
- a table of differential values.

MEASURING RUN-ON VELOCITIES ON A TAKE-OFF

This measurement represents a variant of the previous measuring system, the difference being in evaluation of the values measured. Input is represented by signals of photoelectric sensors situated at a set distance, the values obtained are used to convert the data into velocity, i.e. km/h or m/s. Provision is made in the program for inserting during its run data of jump length, after each measurement new values of run-on velocity and statistical analysis are presented, both values being constantly reappraised.

CONCLUSIONS

- Our paper brings a description of a measuring system aimed at measuring temporal parameters, in our case oriented at diagnostic motory action of the human body.
- Five motory actions are described to demonstrate the potential use of our system.
- The designed system for measuring temporal characteristics is an open one with regard to both hardware and software.

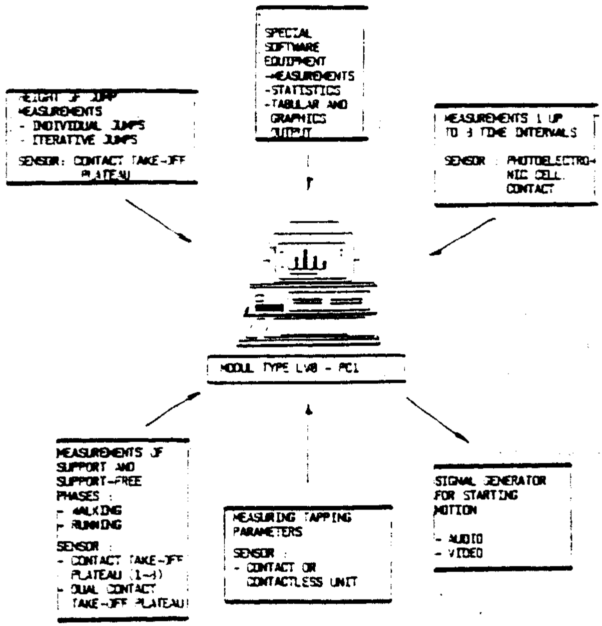

Figure 1: Universal diagnostic system for measuring temporal parameters of motory actions of human body

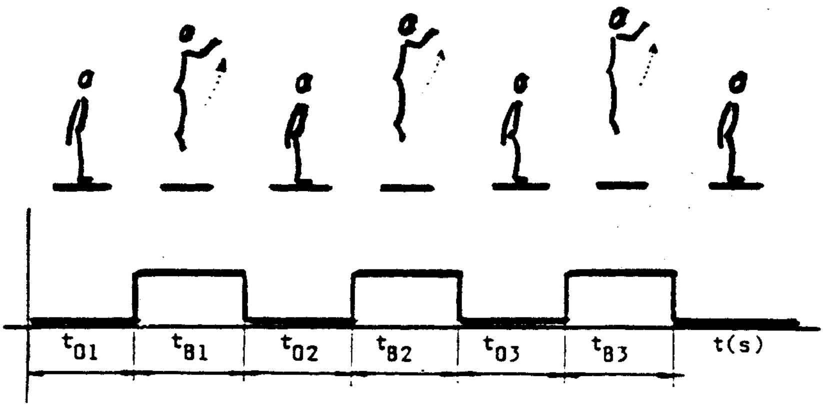

Figure 2: Iterative jumps

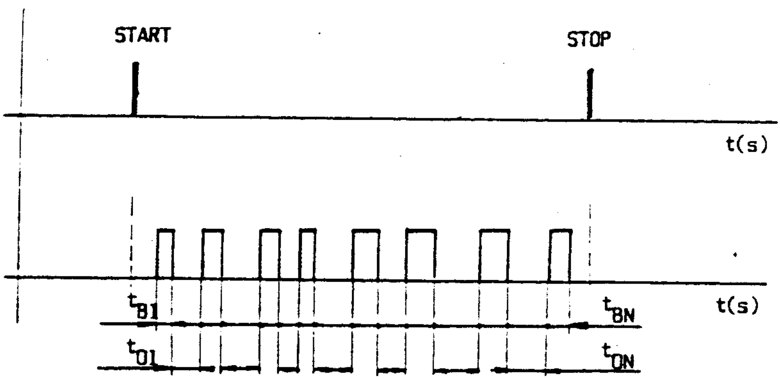

Figure 3: Tapping

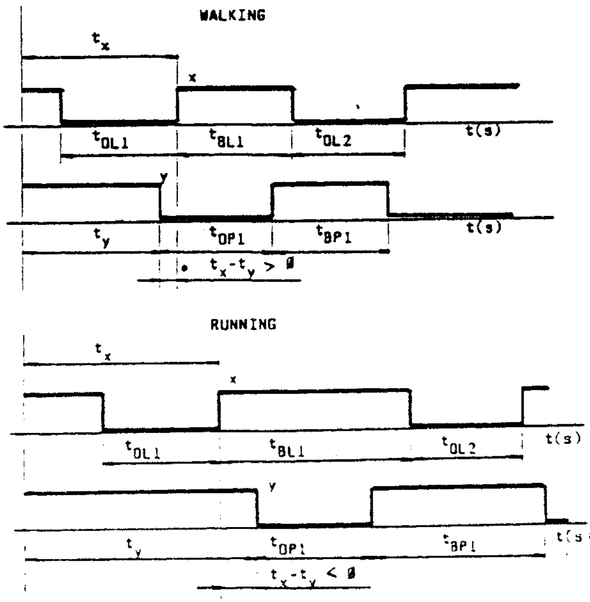

Figure 4:

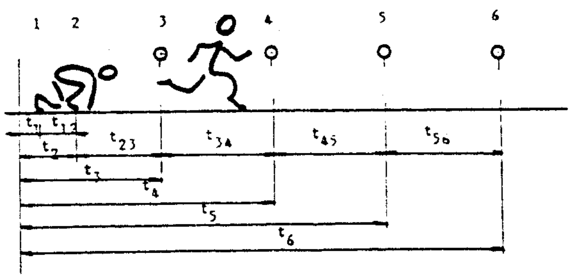

Figure 5: Measurements of 1-6 time intervals

REFERENCES

1 FRANK V., SALINGER J. (1985). Měření maximálního anaerobního výkonu jako ukazatele alaktátového potenciálu (I.). Teorie a praxe Tv, 1, 50 - 54.
2. FRANK V., SALINGER J. (1985). Měření maximálního anaerobního výkonu jako ukazatele alaktátového potenciálu (2.). Teorie a praxe Tv, 2, 93 - 97.
3. HAMAR D., TKAC M. (1990). Die Erfassung der maximalen alktaziden Leistung der untered Extremitaten. Leistungsport 1, 19 - 23.
4. NOVOSAD J., BURIANKOVA D., SALINGER J., VAVERKA F. (1986). Faktory sportovního výkonu lyžaře skokana. Univerzita Palackého, Olomouc, pp. 168.
5. SALINGER J. (1987). Fyzikální měření výkonnosti vrcholových sportovců lyžařů skokanů s uplatněním mikroprocesorových měřících a vyhodnocovacích systémů. Kandidátská dizertační práce, pp. 160.
6. SALINGER J., VAVERKA F., NOVOSAD J. (1980). Zapojení pro měření doby bezoporové fáze skoku a výšky vertikálního skoku. Přihláška vynálezu PV 3377-79. Autorské osvědčení č. 203 378, CSFR
7. VAVERKA F., SALINGER J., NOVOSAD J. (1979). K problematice testování vertikálních skoků. Teorie a praxe Tv, 27, 12, 732-738.
8. VAVERKA F., NOVOSAD J., SALINGER J. (1980). K otázce měření finální charakteristiky vertikálního skoku pomocí silového impulsu a doby bezoporové fáze skoku. Teorie a praxe Tv, 28, 1, 46-54.