GAIT ANALYSIS

3D Real Time Gait Analysis on Treadmill or Walking Range

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Features

- Simple and fast data acquisition based on the principle of the travel time measurement of ultrasonic pulses
- Real time measurement for monitoring and gait training
- Measurement on treadmill or walking range – Walking range up to 4 m with special feeding unit for the measuring sensors
- Fast and simple marker application with zebris marker set
- Automatic standard report with analysis of both sides of the body
- Comparison of several measurements through multiple display.
- Printout via color printer at low operating costs
- Export of data from individual measurements in ASCII format
- Form for entry patient data, findings etc.
- Combination with myographie and ground reaction forces
- „WinGait“ software for calculation and display of kinematic data, (optional) EMG and ground reaction forces
- Program operates under Windows XP

Introduction

The measuring system allows an objective kinematic analysis of the human gait by means of analysing the tracks of body surface markers.
In this way the extent of the gait disorder can be recorded precisely and the course of the treatment documented.

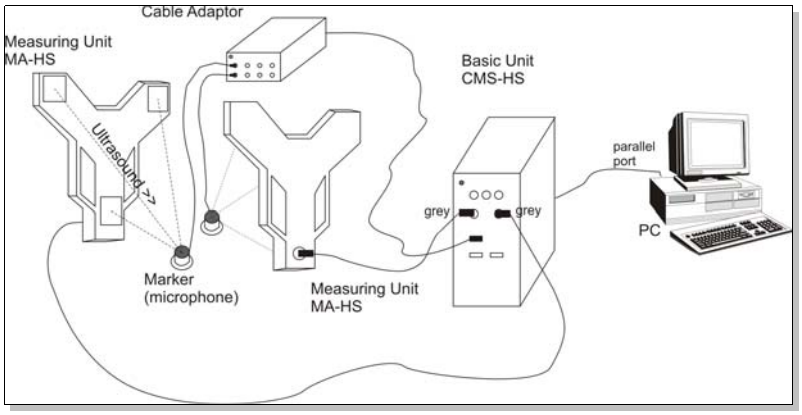
Components

The measuring system consists of a measuring sensor with stand, (and two measuring sensors with stands for both sides measured simul-taneously respectively), triple markers, an cable adapter with hip bag and a CMS-HS basic unit.
The system can be connected to any conventional IBM-compatible personal computer.
The measurement results can be printed out.
The measuring system is also available complete with computer and printer.

Principle of measurement

The measuring method is based on the determination of spatial coordinates of miniature ultrasound transmitters (markers) by measuring the delay between the emission of sonic pulses by the transmitters and their reception at the microphones of the measuring sensor.

The exact spatial position of the markers is determined by triangulation.
As a result, a presentation is given of the movement of the markers in the transversal plane, as well as the calculation of other characterstics.



Information on human gait analysis

Free walking of man begins approximately at the age of one. The adult heel-ball-gait develops no earlier than at the age of 3 ½ years.
There is hardly any difference in the way different people walk. Any deviation from the normal gait reduces the efficiency and leads to an increase in energy consumption.
The "step cycle" starts with touching the floor with the foot and ends with touching it again with the same foot.
The step cycle subdivides into two main phases, the "standing and swing phases".
With the normal gait, the stance phase begins with the touch-down of the heel and ends with the lifting of the toes. Afterwards, the swing phase begins.
The swing phase is defined as the time period between the lifting of the toes from the floor and touching it again with the foot.

The events during a step cycle happen regularly at moments that can be fixed in terms of percentage.
With normal walking, the lifting of the toes from the floor occurs approximately at 60 % of the step cycle. The stance phase, therefore, consists of 60 % of the complete step and the swing phase of 40 % of the complete step.
The lifting of the opposite foot occurs at 10 % and its touch-down at 50 %. While walking, there are two periods during which both feet

touch the floor. These constitute 10 % of the step cycle each and happen immediately after the touch-down of the foot and shortly before the lifting of the toes.
With normal gait, the individual phases are symmetrical.

Further gait analysis can be carried out by determining the step length, the step speed, and the cadence.
A step is defined as the distance that is covered by a complete step cycle. This corresponds to the total of the lengths of the left and right half step.
Cadence stands for the half steps and steps made during a certain period of time.

With 3-dimensional gait analysis, the gait is evaluated from three viewing positions.
The side view, for example, allows for the measuring of the flexion and extension of hip, knee joints, and ankle joints.
The front level is the level the proband approaches and goes away from.
It is best to measure abduction and adduction of the hip joints and extremities, respectively, as well as the pelvic inclination.
The transversal view is the view from above or below and represents for example the rotation of the feet.

The following normal gait characteristics are often absent with a pathological gait:

The stability during the stance phase.
This is endangered with an abnormal position of the foot resulting in an instable supporting area. Also, a balance impaired because of a lacking body control will impair the stability.

The release of the legs during the swing phase.
A loss in knee flexibility or an inadequate dorsiflexion of the foot may cause this kind of disturbance.

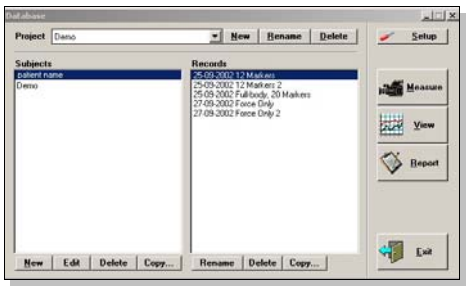
Touch-down of the foot in a suitable position.
This allows for an efficient energy transfer between the segments of the body. A bad position may be caused by an inadequate positioning of the foot during the terminal swing phase.

A sufficient step length.
This may be impaired by a reduced extension of the knee at the end of the swing phase, by an instable foot at the standing side, or by inadequate strength of the plantar flexors during the pushing off at the standing side.

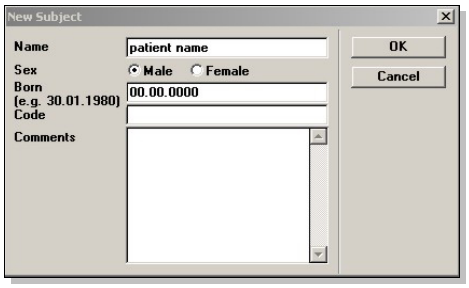
From: Normal Walking
Gillette Children´s Hospital
St. Paul Minnesota

The Software "WinGait"

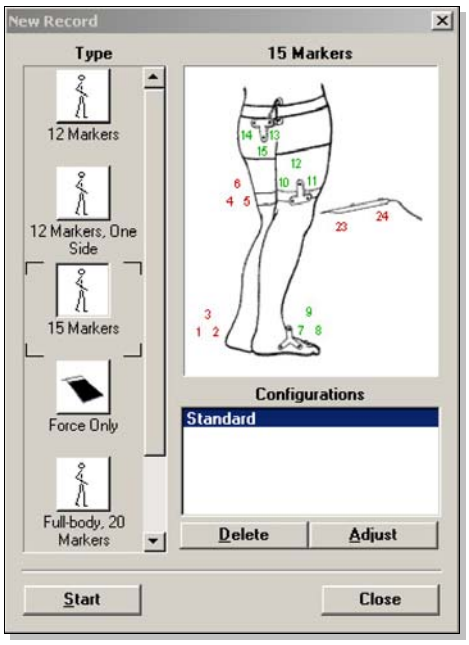
The program "WinGait" runs under up to date Windows operating systems.



The WinGait database system has three levels for measurement data management:
The highest level is the "project" level. Here, various projects, patient groups, or program users can be filed.
Patients' names are entered on the next level.
Measurement data files are listed on the last level.



In the "NewRecord" window the desired marker configuration can be selected under "Type“.



Preparation of the patient

At first the cable adaptor is fastened to the patient's back by means of the hip bag attached. Depending on the type of measurement, the triple markers are fastened to the feet, thigh or sacrum area using an elastic velcro strap or adhesive labels.
For the "Total-body measurement", markers are addtitionally fastened to the upper arm or wrist.

Preparation for measurement

The test person first stands next to one, or between both the measuring sensors. Using a pointer, anatomic points are defined with respect to the triple markers. Using thse points, a biomechanical model is calculated in the software program.

The anatomic points are, for example, on the top and underside of the foot, on the outer and inner side of the ankle and the knee joint centres.
The program calculates the pivot centres of the hip joints via the pelvis position entered.

Execution of measurements on treadmill

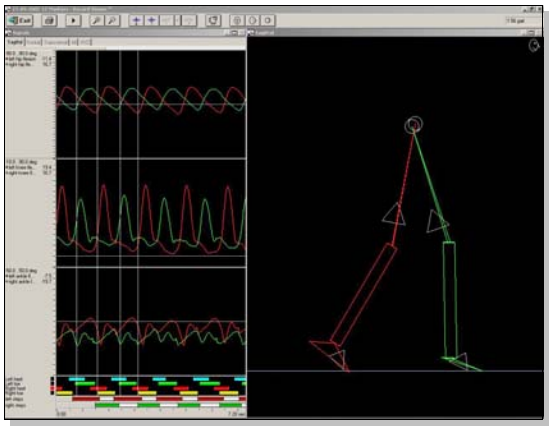
At first place the measuring sensors on both sides in walking direction parallel with available place it first on the left side. By means of the zebris calibration frame the two measuring sensors are calibrated to the treadmill plane by taking a brief measurement.

After starting the treadmill and the appropriate warming-up, press the start key and the store key, respectively. The measure-ment is brought to an end by pressing the stop key. By using only one sensor, the measuring sensor is then either positioned at the other side of the treadmill or the running direction of the treadmill is rever-sed. The same procedure is now repeated for the right side.

Execution of measurements on the walking range

The measurement on the walking range is taken in the same way as on the treadmill, whereby several steps can be taken on the walking range.
The walking range can be extended from appox. 2.5 m to 4 m by a feeding unit (see photo).

Afterwards leave the measurement screen. The time slots for evaluation now must be selected in the signal viewer.



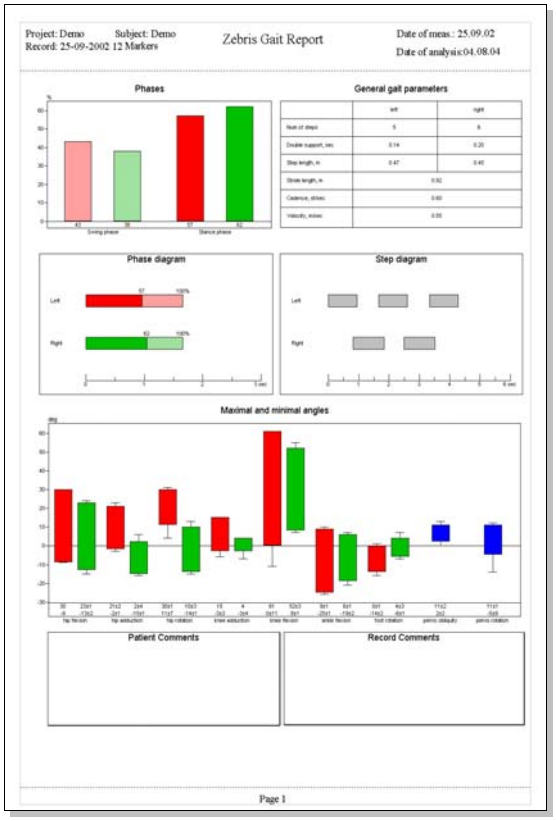
The presentation of the angle curves for the left side of the body (red curves) and the right side (green curves) can be displayed on the monitor using different projections or planes. Thus an exact evaluation is possible for each projection using the mea-surement curves.

For setting up a report, the step cycles have to be defined. These can be taken using the foot-switch or by viewing the foot move-ment. By correlating the angle values, the step cycles for a complete 'time window' are automatically calculated.

Report

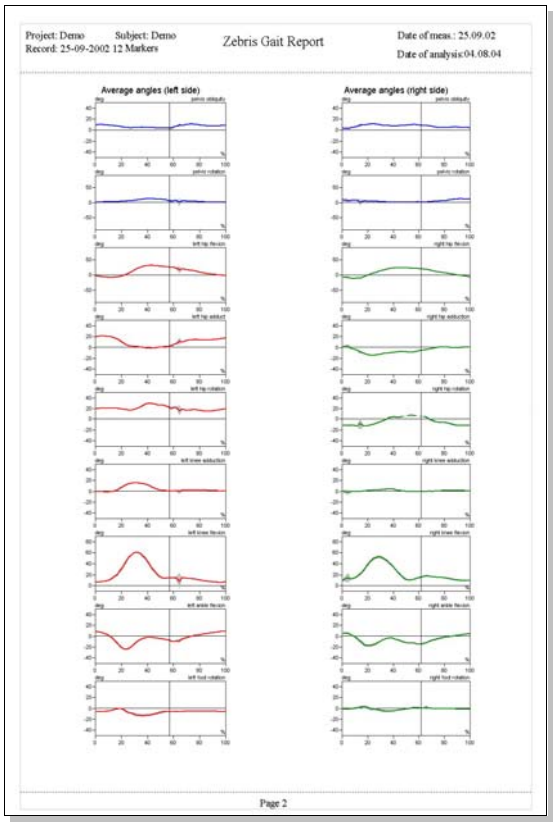
The report on the gait analysis is printed out on several pages. However, it is possible to arbitrarily modify the number of pages as well as the size and arrangements of the evaluations (frames).

Export of data
Original measurement data can be exported from WinGait in ASCII format for analysis in other evaluation programs.



On the first page, the most important gait parameters are listed as averaged numbers in a diagram, e.g. the step
lengths, the time of the double support, the mean speed, and the cadence (steps per second).

The mean maximum values of both sides together with the standard deviations as well as the numbers of the step phases (stance / swing phase) are presented in bar charts.

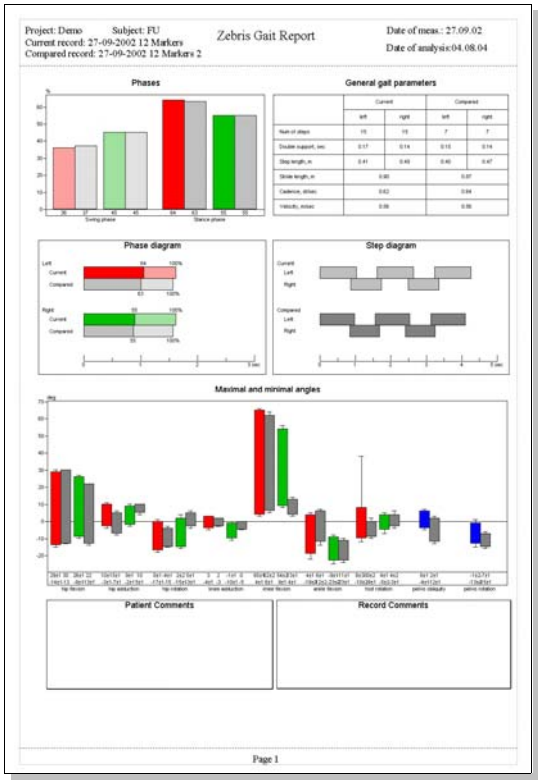


On the second page of the report, the mean normative angles of a gait cycle of the right and left side of the body are given in coloured lines. In addition, the standard deviations are represented in grey fields around the lines.
This representation also provides information about instabilities during the gait phases.

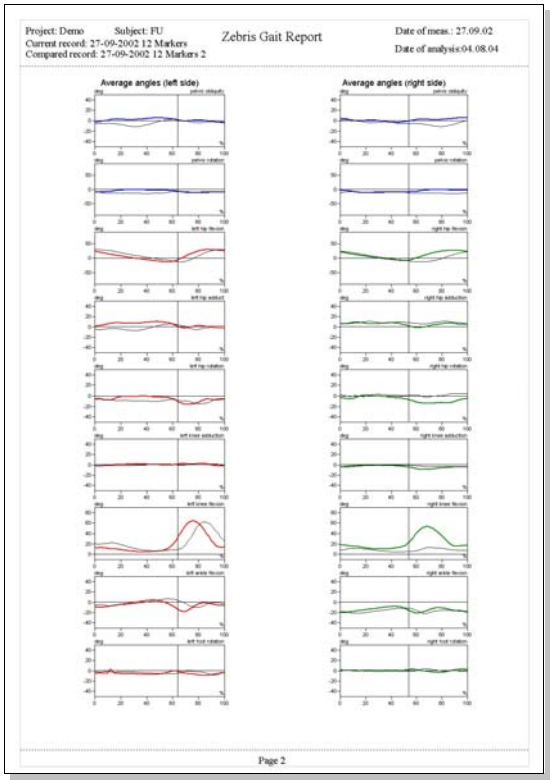
The time window left from the vertical line shows the stance phase, right of the line the swing phase is represented.

In further pages the analog signals (EMG) are displayed.

Comparison of measurements

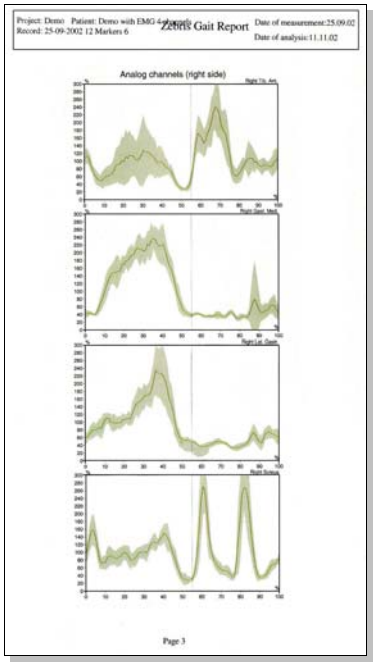


Two measurements can be compared directly, to provide an objective control for a therapy.



The bar charts are shown next to each other, the angle curves are displayed superimposed.

Representation of the EMG Data



Report with EMG

Up to 32 analagous channels can be recorded with time synchronization and presented in the report.

The EMG data are normalized to the step cycles and are averaged, smoothened and rectified.
The standing and swing phase are separated by a vertical line.

Technical Data for Systems CMS-HS (bilateral) / CMS-HSL (unilateral)

Maximum measuring rate:	max. 50 Hz pro marker CMS-HS (bilateral);
Measuring accuracy:	1 degree
Measurable walkig range:	2,5 - 4 m
Average examination time:	about 20 - 30 minutes

Other available programs

WinSpine	**Spinal column motion analysis**
WinSpine Pointer	Determination of Posture, Spinal Column Shape and Mobility with a Pointer
WinSpine Triple	Assessment of the mobility function of the cervical and lumbar spine
WinSpine Single	Examination of mobility and coordination with single markers
3DA	**Motion analysis in movement disorders**
WinBalance	**Equilibrium analysis**
WinData	**Data acquisition program**