Walking analysis and simulation system

It is dedicated to biomechanical studies in order to evaluate and simulate gait. Biomechanical studies are performed using component subsystems, which ensure the acquisition of motion data, simulation, modeling in real time, through sensors to determine the forces of the lower limb in bipedal position, walking or running, movements, speeds and accelerations from the joints of the body.

Continuous movement analysis is necessary in medicine for diagnosis and objective documentation of rehabilitation processes. This is especially important after surgery, neural dysfunction, long-term illness, rehabilitation, physical therapy, prosthesis use, stroke, sports injuries and in various other areas.

The motion analysis and simulation system consists of the following subsystems:

1. Sensorized conveyor belt type plantar pressure measuring subsystem;

2. Integrated subsystem for tracking, motion acquisition, simulation, real-time modeling;

3. Integrated optical (noncontact) subsystem, intended for dynamic and static 3D coordinate measurements.

1. *Sensorized conveyor belt subsystem for foot pressure measuring*

It consists of:

- Tread conveyor with pressure sensors;
- Software for acquisition, analysis, processing, storage and display of the data, taken from the podiatric measurement system;
- Wireless motion sensors for detecting both slow and fast movement;
- Accessories:
    - Signal reception system;
    - Data recording system;
    - Sensor attachment systems on limbs and so on.

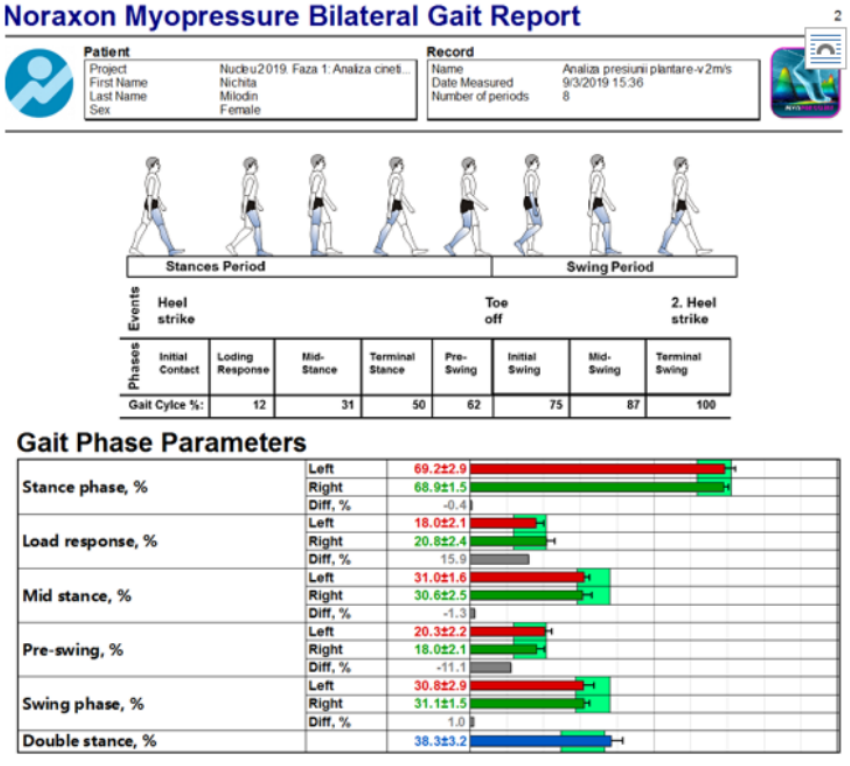
Sensorized conveyor belt

- ***The main technical characteristics of the subsystem:***
  - loading capacity: 250 kg;
  - active surface: 1500 x 500 mm;
  - number of sensors: 5,000 pcs;
  - sensor measuring range: 1-120 N / cm^2;
  - driving speed: adjustable from 0 to 19 km / h;
  - sampling rate: 100 Hz.
- ***Services offered:***
  - recording static measurements: displaying body weight on the 4 dials and displaying the center of gravity;
  - making and recording dynamic measurements: measuring gait and running parameters; measuring the size of the foot and sole; automatic detection of left and right foot; measuring the plate in both directions (along and across the strip); display of dynamic pressures and pressure center line; display in 2D, 3D, synchronized, pulse or roll off modes;
  - calculating the dimensions of the foot, obtaining pressure / time and force / time graphs for each area of the foot; display of foot axes and spatio-temporal parameters; establishing reference values; motion analysis (rotation, balance, flexion-extension, loads, pressure centers, etc.); 3D dynamic sizing; use of the Dupont model in 5 segments to evaluate the neuromotor problem.

2. *Integrated tracking, motion acquisition, simulation, real-time modeling subsystem*

The subsystem allows detailed analysis and comparison of positions and movements.

The 3D visualizations, graphical representations of the motion parameters and the biomechanical models provided, facilitate the understanding and analysis of the motion.



- ***The main technical characteristics of the subsystem:***
  - automatic tracking of markers or pattern recognition (pattern matching);
  - processing and analysis of 2D / 3D data in real time or off-line;
  - 6 pcs - video cameras with working speed of 100 fps and resolution of 2Mp, with scalability at 500 fps for 1 Mp and up to 1,900 fps at 0.3 Mp, with the necessary cables;
  - synchronous visualization of video images and data diagrams, with the possibility of software synchronization;
  - identification and automatic, semi-automatic, or manual video tracking of active or passive markers placed on the subject (without the use of infrared markers), with the possibility of using a color marker and color recognition;
  - automatic identification and tracking without markers, only based on video patterns;
  - correction of identification and tracking errors on separate frames/groups of frames, without the need to redo the entire acquisition process;
  - 2D reconstruction of a simple segmental model for each camera, for understanding the movement from various optical perspectives;
  - real-time capture of reflective markers on video recordings with direct calculation and display of 2D data in the form of graphs;
  - synchronous visualization of video data and diagrams;
  - simultaneous recording and tracking with video cameras;
  - 3D calibration;
  - automatic, semi-automatic and manual tracking, based on color markers and automatic, without markers, based on a model;
  - 3D reverse kinematic analysis for the calculation of joint centers, joint angles, etc.;
  - sampling rate: 100 Hz.

3. *Integrated optical (noncontact) subsystem for dynamic and static 3D coordinate measurements*

The motion analysis and simulation system, through the integrated optical (noncontact) subsystem, also allows the analysis of the movement of the prosthesis / endoprosthesis elements mounted on the test equipment, such as: deformations (torsion, bending, displacements, etc.), speeds, accelerations, vibrations.

Thus, based on the correlation of digital images, the system helps to understand the deformations and movement of the implant, at the interface with the fixing system or with the plastic mold that simulates the bone. The measurement results can also be used to validate numerical simulations.

- ***Main technical characteristics of the subsystem:***
  - generation and analysis of 3D coordinates marked on the subject measured for the study of human kinematics;
  - optical sensors for dynamic 3D analysis;
  - sensor control system and data acquisition;
  - computing system (PC) for image processing;
  - standard for calibration;
  - imaging processing software for static and dynamic conditions.