EMGworks®
Software

Flexibility and Features to Bring Research Ideas into Reality

Integrated Database • Signal Quality Check • Workflow Designer • Tasks Template • MVC • Biofeedback • Amplitude Analysis • Cyclical Analysis • Timing Analysis • Template Matching • Simultaneous Analysis of EMG, Video and Pressure Data • Heart Rate • Muscular Force • Histogram
Software Overview

EMGworks® is a comprehensive software management program designed for in-depth recording and analysis of physiological and biomechanical signals. The software package consists of Acquisition and Analysis modules.

Typically is used in motor control research laboratories for exploring the inner workings of the neuromuscular system, in physical rehabilitation centers for muscle re-education, muscle performance and for monitoring the progress of rehabilitation; in sports laboratories for enhancing muscle performance or injury analysis; in ergonomics for providing quantitative evaluations in workers performing tasks.

EMGworks® ACQUISITION

EMGworks® Acquisition module is designed for simultaneous data recording and real-time monitoring EMG, biomechanical sensors and signals from external devices.

The acquisition module offers a comprehensive set of capabilities including real-time filters, support for multiple data acquisition cards, user-friendly interfaces for user-friendly experiment design, a library of ready-to-use tasks and real-time signal quality assessment.

Live Signal Exploration allows for freezing data on the screen without stopping data collection, and performs quick analysis of signal amplitude and frequency.

Integrated database enable EMGworks® to manage data with subjects, workflows, and data files in a relational database. Filtering and grouping features allows intelligent searching of data across experiments to build up data sets for comparative studies, or for tracking subject progress.

EMGworks® ANALYSIS

EMGworks® Analysis module incorporates all the functionality essential to any laboratory.

It includes the power of the EMGscript™ and a library of ready-to-use calculations for signal processing and calculations the way you want.

User-friendly graphical interface, quickview tools and batch processing capabilities make post-processing of EMG, biomechanical sensors signals simple and efficient.

EMGworks® allows seamless integration with video files and external data files via Import/Export features. It supports frame-by-frame video playback option for inspecting the EMG activity collected in synchronization with 3rd party video capturing system.
List of Features

**EXPERIMENT SETUP**
- Workflow Designer
- Template Library
  - Signal Preview
  - Plot and Store
  - MVC (Force & RMS EMG)
  - Fixed Target Force
  - Profile Tracking
  - Bar Feedback
  - Offset Compensation
- Auto-Export to Analysis Software
- Signal Quality Monitor
- Anatomical Maps
- Visual Trajectory Editor

**DATA COLLECTION**
- Real Time Signal Quality Check
- Real Time Inclination Angle Information
- Real Time Impact Information
- Real Time EMG Root-Mean-Square
- Audio Feedback
- Flexible Voice Prompting
- Noise-reduction Real Time Filters
- Live Signal Exploration
- Customizable Zooming
- Automatic MVC Peak Detection

**HARDWARE SETUP**
- Smart-sensors for EMG & other Biosignals
- Sensor Calibration
- Triggering Options
- Multiple Monitor Support
- Support of Multiple A/D Devices
- Software Development Kit (SDK)

**DATABASE**
- Integrated Database
- Copy, Import & Export
- Search Filter

**ANALYSIS TOOL**
- Workspace Data
- Workspace Plot
- Quick View
- Video Import
- User-Friendly Interface for Data Analysis
- Script Manager
- Customize Analysis Procedures
- Import & Export
- On-Line Help
- Plot Wizard
- Customizable Plotting Options
- Background Tasks Monitor
- Batch Processing
- Data Gridview
- Automatic Memory Management
- Video Files
- Pressure Measurement (Tekscan, Gaitrite, etc.)
- ASCII Import (Force, angles, etc.)

**CALCULATIONS & REPORTS**
- Root Mean Square
- Power Spectral Density
- Simple Math
- Accelerometer Impact Filter
- Accelerometer Inclination Filter
- Filter IIR
- Integrate
- Differentiate
- Mean Absolute Value
- Histogram
- EKG Rate
- Mean Absolute Value
- Mean Frequency
- Median Frequency
- Moving Average
- Cyclical Analysis
- Timing Analysis
- Template Matching
- Template Finder
- Amplitude Analysis
- Scale and Offset
- Curve fit
- Smart Threshold
- Cross-Correlation

**EMGworks® IS ROUTINELY USED IN:**
General Physiology Laboratories • Neurophysiology Laboratories • Biomedical engineering Laboratories • Motor control Research • Biofeedback studies • Gait Analysis • Balance Studies • Sports Research • Ergonomics • Robotics/HCI • Rehabilitation • Speech Pathology
EMGworks® acquisition provides students and scientists an interactive and easy-to-use platform for accessing signals from Delsys EMG systems and multiple A/D devices simultaneously, live visualization of raw and filtered data and a comprehensive tool set for designing experiments per user-specific needs.

The acquisition module is packaged with a wide array of data collection templates to facilitate the set-up and repetition of complex tasks such as maximum voluntary contraction or biofeedback assessments in “one-click”.

Features such as the patent-pending Real-time Signal Quality check, Signal-to-Noise ratio and baseline level assessment allow novice researchers to automatically monitor the quality of the recorded signal during entire data collection.

Integrated Database • Real-time Signal Quality Check • Protocol Template for Multiple Applications • Intuitive/fail-safe Workflow Design • Multi-Sensor Configuration • Real-time Analysis of RAW and Filtered Signals • Visual and Auditor Biofeedback • Anatomical Maps for Sensor Placement • Voice Prompts/Feedback

Experiment Setup

EMGworks® Software interfaces directly with Delsys hardware and with any National Instruments M-series A/D card.

Options for start and stop input triggers, as well as comprehensive output trigger ensures no latency between signals acquired on different hardware devices. This versatility makes it easy to integrate several input devices, calibrate both Delsys and third-party sensors, and synchronize with external systems.

Experimental protocol can be quickly built from configurable data acquisition tasks, each tailored for specific physiological testing. The experiment can include one or multiple tasks added through a user-friendly drag-and-drop interface to the “Workflow Designer”.

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SENSORS

Data from EMG sensors and a variety of other smart sensors including EKG, accelerometer, goniometer, footswitch, force etc. can be recorded. EMGworks® software automatically identifies the sensor type and applies preloaded calibration values, simplifying protocol setup.

ANATOMICAL MAP

Drag-and-drop for quick and easy selection of sensors. Muscle name and location are integrated into the software to ease sensor placement and promote muscle familiarity and repeatability of data collection.

FLEXIBLE VOICE PROMPTING

Fully customizable text prompting for the subject and operator are available (use pre-recorded sounds of voice synthesis from text you enter) to standardize instructions or automate your experiment.

SUBJECT AND OPERATOR DATABASE

The strong relational database in EMGworks® associates each collected data set with both subjects and operators, ensuring relevant information is automatically stored with the recorded data allowing for data retrieval after the experiment.

INTEGRATED DATABASE

Search through projects and data collections, track subject information, categorize experiments, and load data directly into EMGworks® Analysis software. By using the database, you can quickly find recently acquired data, search or group database entries by name, configuration, project, operator or subject.

PROTOCOL TEMPLATE LIBRARY

Protocol templates are provided in the Workflow Designer to construct flexible configuration to suit any research application.

Available Protocol templates cover a wide array of data collection tasks, including the performance of: 1) maximal voluntary contraction force, which allows automatic detection of the maximum force of the subject and use for subsequent normalization procedures, 2) tracking paradigm, which allows feedback-based tracking of specific predefined trajectories to track force vs. EMG, and 3) bar feedback, which allows performance of biofeedback tasks.

Drag-and-drop feature combined with fail-safe work-flow selection design allows for intuitive and easy selection of templates for quick experimental setup. The Workflow Designer ensures repeatable experiments, while allowing the task sequence to be performed for each subject.

The protocol is specified as a series of customized task templates, where each template defines what sensors are used, how they are plotted for the operator and the subject, and any real time processing, as well as any task-specific settings. Tasks can relate to each other, such as a MVC task which determines the normalization for subsequent tasks.
Data Collection

EMGworks® software combines advanced functionality, ease-of-use, and sheer capability to make it the ideal choice in electromyographic data acquisition.

REAL-TIME DATA DISPLAY WITH INTUITIVE & CUSTOMIZABLE USER INTERFACE

EMGworks® software provides real-time information about muscle activations while allowing a greater flexibility in data presentation. Control zoom levels, background colors, plot options, gridlines, and markers to view the signals. Autoscale option fits the Y-axis to accommodate the data on screen. Time unit displays as samples, seconds, milliseconds, minutes or absolute time of day.

REAL-TIME SIGNAL QUALITY CHECK

This patent-pending feature of Delsys allows a real time feedback of the quality of the recorded EMG signal by assessing 1) the signal to noise ratio, 2) the baseline level, and 3) the amount of interference from power lines and other sources. Being able to automatically detect whether the recorded signal is good, and whether the signal quality degrades during the duration of an experimental session, is a critical tool for both the novice and experienced researchers.

REAL-TIME SIGNAL EXPLORATION

EMGworks® offers both real-time and non-real-time viewing options to let you examine the details of a signal while recording. You may also perform a quick analysis of signal amplitude and frequency by freezing data on the screen without stopping data collection.

REAL-TIME FILTERS

Real-time filters are available during data acquisition to remove noise contamination from the EMG signal. The AC-coupling filter removes any DC component in the EMG signal and eliminates the need for additional post-processing. For example, the motion artifact suppression removes movement artifact, if present, by filtering the signal between 30-450 Hz and ensures that only relevant and meaningful data is analyzed. The adaptive noise rejection filter removes noise at a specific frequency from the EMG signal, such as noise from third parties instrumentation.

ACCELEROMETER FILTERS

Real-time filters are available to view the accelerometer data as sensor inclination or impact during data acquisition. Valuable information is provided for easy and quick assessment of limb “movement” (inclination) during a task or for events identification, such as heel strike during gait.

AUDIO FEEDBACK

The EMG signal can be played over the computer speakers or headphones in real-time as the signal is being acquired, expanding the potential for biofeedback and teaching applications.
EMGworks® analysis combines the power of basic analysis tools and advanced EMGscript™ to provide an efficient platform for data analysis of physiological and biomechanical signals.

With little or no programming required, students and researchers can quickly master the know-how of EMGscript™ to generate comprehensive analysis and reports. When EMGscript™ is combined with Delsys EMG systems and data from external hardware (video & pressure) researchers have a powerful, customizable and a friendly analysis software at their command.

Workspace, Data Storage and Display

Workspace is the heart of the EMGworks® analysis as provides a number of features for storing and display of EMG and external data simple and efficient.

These include:
- Organize projects within the workspace
- Separate plots and data
- Quick View toolbar for fast assessment of data
- Grid View displays data in a tabular format
- Data Storage
Plot Settings

A full set of plot options allow personalizing analysis/reports. Manipulating color schemes, plotting in a logarithmic scale, individual zooming options on separate plots, and placing legends and labels on your plots are just a few of the ways you can customize your graphics.

EMGscript™ - For simple and complex Data Analysis

EMGscript™ is the brain of the EMGworks® analysis that allows easy automation of many signal processing tasks. EMGscript™ uses JavaScript syntax with extensions for the convenient processing of time-series data.

The script allows for post-processing and visualization of captured data sets with built-in functionality such as Amplitude Analysis, Time Shift, Mean, Curve Fit, Simple Math, Threshold, Cyclical Analysis, etc. These tools are designed to expeditiously analyze and process large amounts of data and provide detailed in-depth analysis.

Import & Export

EMGworks® makes it easy to import and export data in various formats. Configurable import allows batch import of most text file (ASCII) format, accounting for headers and settable delimiter characters. Stand-alone conversion utility can be invoked silently from a MATLAB or batch script for on-the-fly conversion to and from Delsys file formats. All options may be set with command line flags for power users.

- Export as text, .CSV, or Excel files
- Batch import most text files
- Direct COM Interface for reading data from HPF files to MATLAB and LabVIEW
Video & Pressure Measurement Capabilities

Video and Pressure Measurement recordings can be done simultaneously with any Delsys EMG System.

EMGworks® Analysis offers frame-by-frame video playback tools for quick and flexible means for inspecting the associated EMG activity. This allows researchers to explore the relationship EMG data or any biomechanical data during a specific frame of data from video and pressure.

Custom Solutions

The ability to edit existing routines and create custom solutions provides a comprehensive tool.

EMGworks® Analysis includes the code editors, compilers, and execution engines to build, test, and distribute data processing algorithms of your own design. Scripts you have created in your lab will automatically be accessible through user-friendly graphical interfaces.
Signal Processing

**AMPLITUDE**

- **Root Mean Square**
  - Assess Muscular Force
  - Estimate amplitude of signals
  - Compare EMG activity

- **Moving Average**
  - Calculate time-varying Mean
  - Smooth high variance measurements

- **Integration**
  - Assess Energy Expenditure
  - Compare cumulative muscle activity

**FREQUENCY**

- **Median Frequency**
  - Fatigue assessments
  - Track Spectral Variation

- **Power Spectral Density**
  - Map frequency content signals
  - Check for hidden sources
  - Compare Spectral Distributions

**TIMING**

- **Threshold**
  - Mark EMG events
  - Muscle timing comparisons
  - Amplitude-driven events

- **Rate**
  - Track heart rate
  - Track respiration rate
  - Foot-step pace and cadence

- **Histogram**
  - Count number of threshold-driven EMG bursts
  - Amplitude-driven event counter
Applications

**EMG Recording**
Analysis & Reporting

Easy processing of EMG amplitude, frequency and timing information for any application.

Friendly user-interfaces allow to personalize data reports intuitively and effortlessly.

**Gait Analysis**
Cyclical Activity Monitoring

Monitor muscle activation and force sensitive resistor signals during gait or other repetitive movements, such as biceps curls or other training exercises.

**Muscle Performance**
& Endurance Monitoring

Identify signal characteristics during muscle activation such as amplitude and frequency content to assess muscle function and fatigue while also being able to process time-related EMG events.

**Posture & Balance Studies**
EMG Timing

Include the investigation of reaction times to perturbations, muscle co-activation or bilateral differences in studies of posture and balance impairments.

**Motor Control**
Motor unit decomposition

Go to the heart of the EMG signal by investigating the neural activation of individual motor units during muscle contractions.

**Biofeedback**
Rehabilitation

Make use of our biofeedback tools to seamlessly create rehabilitation protocols to retrain muscles and monitor progresses.
Applications

**Motor Learning**
EMG & Co-activation

Monitor the progress of motor learning from EMG and physiological signals, such as reduced co-activation or compensatory muscle behavior.

**Ergonomics**

Analyze EMG, accelerometer, force and pressure information to determine the physiological effects of using work tools, such as an impact drivers or pneumatic drills.

**Activity Monitoring**
Activity Classification

Classify different activities, such as walking and running, based on their specific signature in the EMG or other physiological signals, such as acceleration.

**Exercise Physiology**
Energy Expenditure

Estimate energy expenditure from everyday activities or sport training by combining EMG, motion information, heart rate measurements and respiration data.

**Games & Real-time**
Applications - SDK/Android

Use EMG and motion information from inertial sensors to improve movement and rehabilitation.

**Robotics**
Prosthetics

Use EMG and motion information from accelerometers and inertial sensors to design better control of prosthesis or to investigate prosthesis functionality.
Applications

Animal Studies

Use Bagnoli™ Desktop or Trigno™ Wireless Systems for biomechanical investigations in sheep, horses, and more.

Speech Recognition & Emotional Responses

Use Trigno™ Mini miniature sensors for tracking small muscles in EMG-works®

EMG, Video & Pressure Integration

Simultaneous analysis of EMG and video information or pressure maps can be performed within EMG-works® software, thanks to the capabilities of importing and synchronizing these information.

Signal Integration

Our family of Trigno wireless sensors allow for reliable and seamless recording of EMG, accelerometer data, pressure, force, EKG and joint angle to provide a complete biomechanical assessment.