REAL-TIME PROCESSING OF ELECTROMYOGRAMS IN AN AUTOMATED
HAND-FOREARM ERGOMETER DATA COLLECTION AND ANALYSIS SYSTEM

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MOTIVATION
A custom, automated hand-forearm ergometer [1-3] is a useful resource to assess changes in electromyograms
(EMGs) acquired from the forearm musculature as a subject reaches fatigue. However, while this ergometer design
automates the data collection procedure, it does not incorporate mid-experiment signal processing mechanisms that
help the researcher identify fatigue onset and predict task failure: two important goals of this NASA-funded work.
Such assessments are currently performed with post-processing tools. A sensible next step is therefore to increase
the level of ergometer automation by incorporating real-time processing alongside the data collection features,
allowing fatigue assessments and predictions to be performed mid-experiment. Such an upgrade could help a
researcher visualize fatigue onset, spur ideas for new parameters that indicate fatigue, and perhaps lead to strategies
for just-in-time adjustments to workload or rate that could help to avoid a pending task failure.

BACKGROUND
The previous automated hand-forearm ergometer system [1-3] required a subject to squeeze two bars together at a
controlled pace while force and displacement data were recorded and displayed by a LabVIEW virtual instrument
(VI). A trial would continue, e.g., until the subject reached the point of fatigue. EMG data acquired in parallel by a
separate subsystem would then be supplied to post-processing algorithms that would identify individual EMG bursts
and calculate the median power frequency (MDF) and mean power frequency (MPF) of each burst based on its
frequency spectrum. These bursts and their respective parameters were then graphed and analyzed to obtain a post-
experiment assessment of fatigue onset and the trajectories of these parameters as task failure approached.

METHODOLOGY AND RESULTS
Recent efforts migrated these post-processing algorithms to semi-real-time processing components embedded in the
LabVIEW VI: the researcher interface now drives an experimental session and processes force, displacement, and
EMG data as they arrive. The subject interface remains unchanged. These updates include (a) a reorganization of
the existing LabVIEW-based researcher interface, (b) a conversion of the MATLAB algorithms that determine
work/power (from force/displacement data), EMG frequency spectra, MDF, and MPF into real-time sub-VIs within
the researcher interface, and (c) the introduction of new components that calculate parameters such as the RMS
power of each burst. These resulting data and burst parameters are graphed on the researcher interface mid-
experiment to allow the researcher to observe fatigue onset and predict task failure. All data are time-aligned and
stored to Excel spreadsheets as the experiment progresses.

CONCLUSION
This work represents real-time processing updates to a custom, automated hand-forearm ergometer that will help to
streamline the data collection and analysis process, offering mid-experiment insight into changes in EMG
parameters that can be used to track fatigue in the hand and forearm musculature and potentially predict task failure.
The research and development effort is a work in progress, and experiments that utilize human subjects are pending.

REFERENCES
Ergometer Data Acquisition and Analysis System, Master’s Thesis, Kansas State University, Manhattan, KS.