Mavep: An Application for Mibyo by Analyzing and Visualizing Electrocardiogram and Plethysmogram

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Mibyou is a physical condition which is not a disease but heads toward developing a disease. Recently in developed countries, chronic conditions represented by **lifestyle-related diseases** have become leading causes of death. In these circumstances, primary or secondary prevention is the most effective way to avoid them. Hence, it is important to be able to monitor simply our health condition or Mibyou for both disease prevention and health promotion.

We have focused on **autonomic nervous activity** (ANA) because it responds with stress as well as changes in dietary patterns, and it correlates with heart diseases, e.g. hypertension [1]. In this work, we consider both **electrocardiogram** (ECG) and **plethysmogram** (PTG) as the physiological data, which reflects ANA. ECG and PTG obtained from healthy people provide several indices including **aging index** and **pulse transmission time** (PTT), which is derived from characteristic shapes of their waveforms, and could be available as signs of asymptomatic illness [2,3]. However, it is difficult to find predictive information from raw data of ECG and PTG because change of healthy people's data is slighter than that seen in patients, and these data interact with one another.

In our work, we propose **an application that analyzes ECG and PTG, and visualizes their indices and waveforms** and call Mavep; it offers a user interface (UI) enabling users or doctors to browse the two data checking their relationship, for brief assessment of ANA. We develop the application in Java language from the viewpoint of portability, independence from specific platforms, putting weight on its UI for providing it as a tool for doctors. Related studies propose several methods of analysis and give suggestions for us, but they do not focus on their implementation as tools [4–6]. Therefore, we implement both algorithms for analyzing raw data of ECG and PTG, and tailored UI that facilitates interaction between the biological data and users.

Analyzing **V**isualizing **E**lectrocardiogram **P**lethysmogram

USAGE

1. File Selection & Open
   - Users open CSV files of raw data of ECG and PTG
   - Mavep supports files in several column formats.
2. Automatic Data Analysis
   - Mavep detects feature points from each data of ECG and PTG by specific algorithms
   - It enables uses to adjust positions of detected feature points.
3. Visualize Charts & Indices
   - Mavep shows each time series charts and averages and SD of each index.
   - It recalculates in response to users operations to enable/unable each pulse.
4. Assessment of Autonomic Nervous Activities
   - Users browse and evaluate each information.
   - Users can save it as CSV files for further analysis with external applications.

ECG pane

The ECG pane shows time-series charts of indices calculated from raw ECG data in each tab page respectively.

- Indices of ECG
  - PR Interval, PR Segment, QRS Complex, QT(c) Interval, R-R Interval, and ST Elevation
- Instantaneous heart rate (IHR)
- Voltage of feature points (P, Q, R, S, and T)
- Waveform

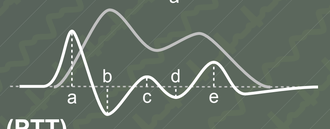
PTG pane

The PTG pane shows time-series charts of indices calculated from raw PTG data in each tab page respectively.

- Time and Height of feature points (a, b, c, d, and e)
- Area
- Acceleration PTG
  - Time, Height, Ratio
  - **Aging Index (AGI)**
- Waveform

Available as index indicates progress of arteriosclerosis

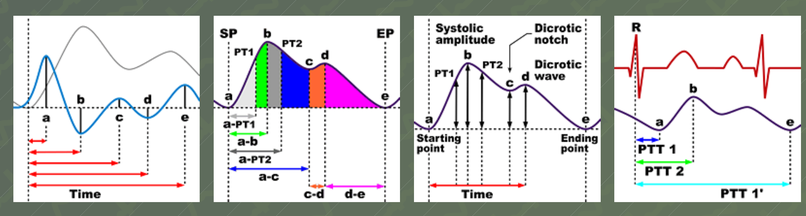
$$AGI = \frac{b - c - d - e}{a}$$



- **Pulse Transmission Time (PTT)**

INFO pane

The information pane shows values of indices at the current position of cursors, which is black vertical line or light blue box especially in the waveform tabs.



Healthy

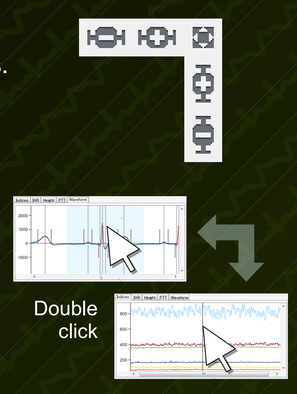
Hypertension
Hyperlipidemia

Arteriosclerosis

Myocardial Infarction
Cerebral Embolism
Angina Pectoris

USABLE

- **In synchronization with each chart**, users can change the view of the charts.
  - Zoom (Vertical, horizontal, fit chart)
  - Scroll (Scroll bars, dragging)
- Users can switch the current tab between the waveform tab and one of the other tab pages, keeping the cursor position.



PORTABLE

- Available on Windows, Mac OS X, and Linux
  - Written in Java
  - Same application package (binary files) can run on them

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4th International Conference on Health and Longevity Sciences (ICHALS)

Shizuoka, Japan, October 21, 2011