# Realtime Brainwave Measurement and Data Analytics

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**INTRO**:

Brainwave data has long been seen as the pivotal “gold ring” in providing insights into a person’s health, performance potential, and the choices they make in life. Breakthroughs in quantitative brainwave data analytics are now showing statistically high cross-correlation with individual behavior, propensities, and health conditions. Cognitive state neurofeedback – the richest set of available biometric data – points to the next generation of non-invasive protocols for healthcare and human potential. WujiTech’s Patented software solutions open new dimensions into linking big data with mobile brainwave monitoring for a variety of industry solutions. Some research from the EEG Institute points to breakthroughs in quantitative brainwave data analytics which are now showing statistically high cross-correlation with individual behavior, propensities, and health conditions.

**PREMISE**:

WujiTech’s strategy ~~that~~ addresses the existing industry complexity in gathering, measuring, and interpreting brainwave data. The concept was to create a solution that was mobile, yet conformed to the highest standards of enterprise-level scalability and security. Gathering brainwave data needed to be user-managed, addressing lowest-common-denominator applications. Measurement needed to be accurate and consistent across users and multiple sessions. Data interpretation needed to be statistically valid and meaningful, showing high correlation to user self-beliefs and any qualitative data input they provide.

**APPLICATION**:

The software has three key components. One is the Brainwave App. This is the UI frontend that is hardware independent and receives brainwave data from any

medical-grade EEG source. To ensure simplification on this end, a single-sensor EEG device with a medical-grade amplifier was used that streams raw brainwave data via Bluetooth protocol. The Brainwave App was simultaneously developed on Windows, OSX, and iOS platforms. Raw incoming data is analyzed at .5Hz resolution and is processed via FFT so it can be displayed in a meaningful way for the user graphically using realtime 3D imagery. Brainwave data is gathered, measured, and interpreted using dynamic analytics at the App level. Customized algorithms have been developed to allow high-level, natural language, AI-style interpretations to be presented to the user in real time.

Second key component is the back-end code, which handles several areas. First, the back-end code receives data packets from the App via the cloud and provides a variety of analytics on the massive amount of data it receives. This data is then dynamically presented using graphics to allow the user a high level of interaction to visualize their brainwave data in a meaningful way. The UI is flexible to allow data comparisons, tracking change over time, and archiving of sessions for individual users by maintaining secure, encrypted accounts for each. Secondly, the back-end code maintains communities of users with a hierarchical structure for administering highly scalable groups consisting of Administrators, Managers, Coaches, and Members.

Dashboards provide a wide array of contextual data and user tools reflecting real world interactions ranging from surveys, event management, messaging, etc. A third level at the back end involves big data management for aggregating the massive amount of data that is collected from all the users. At the time of this writing, over 5 million key brainwave data points have been collected, stored, and processed.

Third is the focus on brainwave data collection for the purpose of refining the various algorithms in the Patent. The three main algorithms are Joy/Satisfaction, Attention/Focus, and Inner Calm. Other algorithms include Study Focus, Stress Reductions, Creative Relaxation, Deep Meditation, Inner Peace, and Empathy.

Raw brainwave data was analyzed and patterns were plotted. These patterns and brainwave frequency combinations were refined into algorithmic expressions and labeled to match natural language human experience. User-supplied qualitative data from Dashboard surveys served to correlate algorithmic brainwave quantitative data in the refining process.

**CORE UNIQUENESS:**

The main task in developing this code was running proprietary analytics on hundreds of beta users and then visualizing and mapping brainwave 50,000 core data sets in meaningful ways. Measuring brainwave data consistently and accurately is a massive task. WujiTech addresses this in several unique ways. First, the software recognizes whether a brainwave device is fit properly and electrically grounded on the user. Without the proper feedback signals, no brainwave data is recorded. Once a stream consistent with expected human electrical brainwave voltages are received, a “brainwave session” is recorded and maintained. If at any time in the session these conditions are not met, the software engages in an on-screen inquiry with the user. Secondly, brainwave data is displayed on screen in both raw data form and algorithmically. This feature of the App allows for both clinical/technical applications requiring precise brainwave data rendering while simultaneously, in realtime, showing algorithmic interpretations with natural language labels. For non-technical users, this provides a unique level of biofeedback as they can begin to see the relationships between raw data and the algorithmic “meters.” Raw brainwave data is being fed to the algorithm engines at the .5Hz analysis rate and displayed as dynamically changing graphical meters. Currently up to 12, user selected meters can be displayed on screen in real time.

Another factor in accurately measuring brainwave data involves this data being time-synced to stimuli experienced by the user being measured. Simply gathering brainwave data can certainly show brainwave state changes over time, but it does not show precise causal relationships to what the user is experiencing at the moment. A key part of WujiTech U.S. Patent # 9,268,905 B2 2/23/16 revolves

around the syncing of brainwave data to visual and audio stimulation so that at the precise second, accurate data is captured. These data sync points can be reviewed at any time – Admin selectable - by the user or by authorized users with the proper clearance. A key feature of the Brain-Computer-Interface (BCI) is that any video or audio source (including YouTube) can be used to sync with brainwave data capture.

There are tools that allow for viewing these data sync points for single users as well as aggregate pools of users. They can be displayed graphically as a snapshot aggregate for a point in time or shown as a series of points over a period of time. In this way, large groups of users can be tracked, with displays for aggregate averages and medians, and tools for automatically removing outliers and selected users.

Data access points along this processing pipeline are available for routing data streams to external analytics engines, AI processing services, or database services. Data can then be imported at various points in the pipeline and incorporated accordingly. The WujiTech Dashboard is designed to display contextually appropriate data to the user, combining both qualitative and quantitative data in an integrated fashion.