

Evaluation Of The Neurosky MindFlex EEG Headset Brain Waves Data

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In human brain, either in the state of wakefulness or sleeping, different frequency changes are observable in the spectrum of measured electric signals of the brain. Regarding the frequency components of these signals that occur as a consequence of this electric activity, different brain waves can be distinguished. In the past, devices that could measure these brain signal alterations were mainly used in medicine. However, in the past few years cheaper and user friendly brainwave signal processing units have become available and the use of this technology has expanded. In this paper, the so-called Brain Computer Interface unit will be presented that was developed for further brain wave analysis and ensures the detection of brain waves. Moreover, an application for visualization and further procession of the measured and processed signals will also be described. The application can be used for EEG data acquisition, processing and visualization which could be the base of several further researches.

Brain Wave Type	Frequency Spectrum (Hz)	Amplitude (μV)	Significance
Delta	0,1-0,3	100-200	- deepest, dreamless sleep - unconscious state - cognitive tasks by frontal lobe
Theta	4,0-7,5	<30	- REM sleep, dreaming - physiological at the age of 1-6 - cognitive task by frontal lobe (Fourier analysis)
Alpha	8,0-12,0	30-50	- Intuitivity, creativity - the "basic" wave of the brain - when stimulated high frequency rhythm occurs (alpha block) - relaxed, but non-sleepy state
Beta	13,0-30,0	<20	- sensory and emotional influences - harmonic, wide awake, excited, conscious state
Gamma	30,0-50,0	<10	high mental activity

Frequency components of brain waves

therefore, the read of the information processed by the headset had to be solved in another way. Examining the internal construction of the EEG electrical unit, the power adapter providing 3,3 V supply voltage and a pin with a Tx label could be noticed. Having examined this Tx signal, a serial line information could be retrieved. To process the data coming from this serial communication with a computer, a converter was needed that could convert the information of a 3,3 V serial port signal to an input available on the computer. The simplest solution is to use an USB-3,3 V UART converter, for example the FTDI TTL-232-3V3 type. Its installation is shown in Figure 4. Using the converter, the noise of the measured signals increased greatly; therefore, an optical isolation unit had to be applied to prevent the noise coming from the computer. The Windows driver of the converter hardware unit was necessary to be able to use the cable, which could be downloaded from the FTDI's official site. The converter can be used as a virtual serial port with this driver.

The traditional EEG analysis

The traditional EEG analysis facilitates the graphical illustration of the temporal and spatial features of electric brain activity. The mathematical procession of the EEG signals could nowadays easily be done by digital signal processing units. The so-called quantitative EEG (QEEG) signal evaluation method, i. e. the frequency analysis of EEG signals with the application of computer processing, could be simply accomplished. With the use of Fourier transform, the digital EEG signals using QEEG are converted so that frequency bands and brain wave intensity can be defined and visualised in an exact way according to their frequency spectra.

Data Communication with EEG Headset

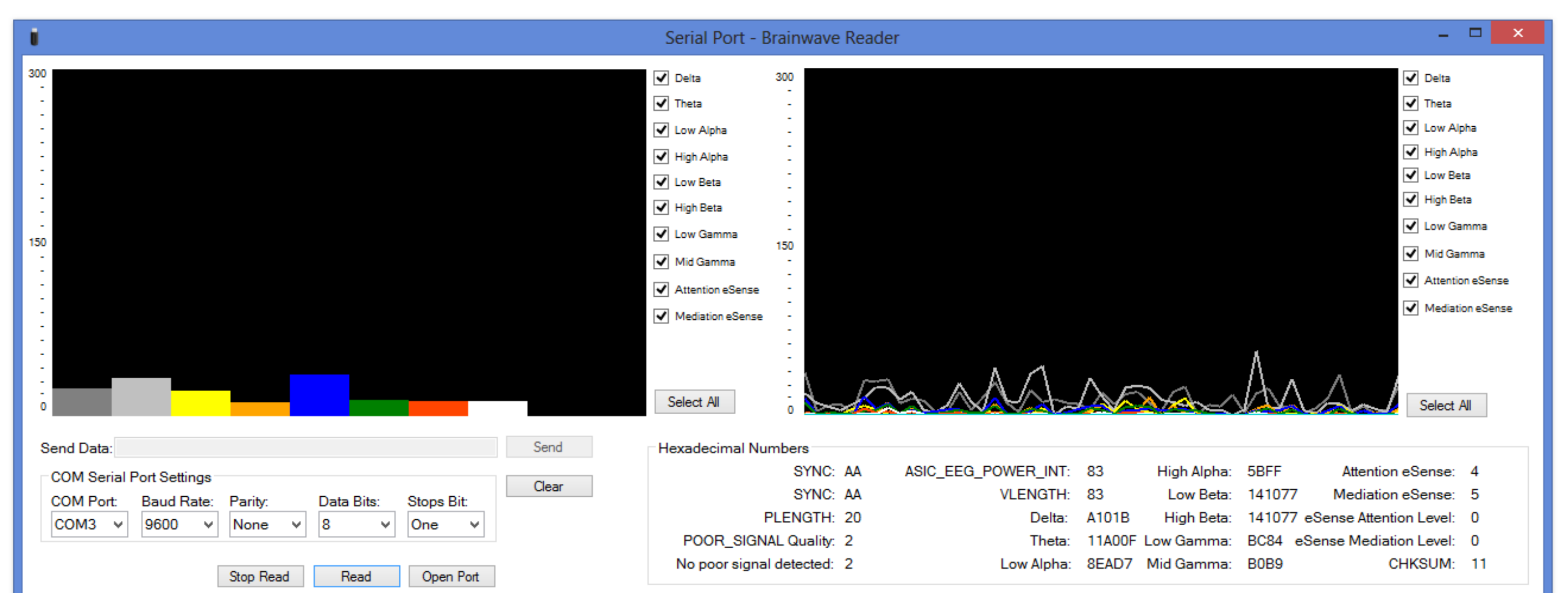
The MindFlex EEG Headset does not use a standard wireless communication channel the way of communication had to be solved to read the information provided by the headset, i.e. the connection with the headset had to be established differently. To do this, it was necessary to implement the receiver of wireless signals and the procession of the received data. The case containing the electronics of the EEG headset had to be disassembled to examine the type of wireless chip used in the headset. Unfortunately, the exact type of the chip providing wireless transmission in the headset could not be read;



Installation of FTDI USB-UART interface

BRAIN COMPUTER INTERFACE

The brain computer interface (BCI) is also called neural interface or brain machine interface (BMI), which is a direct communication channel between the brain and a separate device. A Windows Forms Application has been developed to evaluate and visualize the brain wave data of the MindFlex EEG headset, described in the previous chapter. This BCI program can run on a PC and has been written in C#. Microsoft Visual Studio was used to implement the program, which is a developing environment that supports modern object-oriented programming and has been used in Windows operating systems. The program can be divided into two main parts functionally: the data processing and the visualization parts. The data processing part reads, converts, processes data received from the headset through serial connection, and the visualization part displays given signals by a column chart and a time chart.



User interface and measured brain waves

Conclusion

The novelty of this development is the universal measuring, data collecting, data processing and visualizing software which could be the base of several further researches. The program described above enable users to investigate how brain wave signals - measured by the EEG headset - alternate in time and how they depend on the changes of brain activity. On the basis of the results, the information obtained by the processed brain waves can be used in several research areas, for instance medical research, multimedia applications, games etc. The program can easily be further developed and added new functions due to its modular build. The program allows the development of individual processing algorithms. On the other hand, the EEG headset could be interfaced to other devices owing to this application and the control of these devices can also be solved, for instance, the speed control of a mobile robot, so it can be claimed that the developed BCI can be the basis of future application developments.