

Sistem akuisisi data EEG 16-channel berbasis mikrokontroler 32-BIT ATSAM3X8E ARM cortex-M3 dan ADS1299TI = Data acquisition system of 16-channel EEG based on ATSAM3X8E ARM cortex-M3 32-bit microcontroller and ADS1299TI

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Abstrak

Sistem instrumentasi akuisisi data yang telah dibuat berhasil diuji untuk mengakuisisi sinyal EEG (Electroencephalogram) berbasis mikrokontroler 32-bit ATSAM3X8E ARM Cortex-M3. Instrumen ini terdiri dari elektroda 16-channel dalam bentuk EEG head-caps yang terhubung dengan ADC (Analog to Digital Converter) ADS1299 Texas Instrument. ADC ini memiliki resolusi sebesar 24-bit sehingga dapat presisi mengakuisisi sinyal analog sinyal EEG dalam orde microvolt (V). Sistem front-end ADS1299 dirancang dalam format double-layer PCB (Print Circuit Board) dengan konfigurasi daisy-chain, sehingga dapat secara simultan mengakuisisi data sebanyak 16-channel. Protokol SPI (Serial Peripheral Interface) untuk proses aktivasi ADS1299 berhasil diuji dengan SPI Analyzer Hantek 4032L logic analyzer dengan sampling rate sebesar 400 MSa/s. Sistem akuisisi data dapat menampilkan hasil akuisisi secara real-time dalam bentuk grafik, brain-mapping 16-channel, serta hasil pengolahan sinyal (signal processing) dengan metode FFT (Fast Fourier Transform). Aplikasi firmware software GUI (Graphical User Interface) yang dikembangkan berbasis OpenBCI (Brain Computer Interface) dengan Java Processing dan dapat melakukan proses penyimpanan data dalam format *.txt. Sistem akuisisi data EEG telah divalidasi dengan EEG Simulator NETECH 330. Proses pengujian dilakukan pada frekuensi 2 Hz dan 5 Hz, dengan variasi amplitudo sebesar 10 V, 30 V, 50 V, dan 100V pada channel-1 hingga channel-16. Pada pengujian di frekuensi 2 Hz menghasilkan deviasi error maksimum sebesar $8.66\% \pm 2\%$ dan deviasi minimum sebesar $12.11\% \pm 2\%$, serta pada pengujian di frekuensi 5 Hz menghasilkan deviasi error maksimum sebesar $7.18\% \pm 2\%$ dan deviasi minimum sebesar $0.03 \pm 2\%$.

.....The data acquisition instrumentation system has been successfully tested to acquire of EEG (electroencephalogram) signals with 32-bit microcontrollers based on the ARM Cortex-M3 ATSAM3X8E. The instrument consists of a 16-channel electrodes in the form of EEG head-caps connected to ADC (Analog to Digital Converter) ADS1299 Texas Instruments. The ADC device has a 24-bit resolution so that it can precision to acquire the analog of EEG signals in order microvolt (V). The ADS1299 front-end system has been developed in the format of a double-layer PCB (Print Circuit Board) with a daisy-chain configuration, and also can simultaneously acquire as much data as 16-channel. The SPI (Serial Peripheral Interface) protocol for activation process the ADS1299 has been successfully tested SPI Analyzer based Hantek 4032L logic analyzer with 400 MSa/s sampling rate. The data acquisition system can display the results in realtime format in the form of graphs, brain-mapping of 16-channels, as well as the results of signal processing FFT (Fast Fourier Transform) based. The firmware application software of GUI (Graphical User Interface) have been developed based on OpenBCI (Brain Computer Interface) with Java Processing and can saved of data results in *.txt format. The EEG data acquisition system has been validated with EEG Simulator NETECH 330. The system has been tested at a frequency of 2 Hz and 5 Hz with amplitude variations of 10 V, 30 V, 50 V, and 100 V on channel-1 to channel-16. The final results of

validation process at a frequency of 2 Hz was produced a deviation error maximum of $8.66\% \pm 2\%$ and minimum deviation $12.11\% \pm 2\%$, as well as at frequency of 5 Hz was produced a deviation error to a maximum of $7.18\% \pm 2\%$ and minimum deviation of $0.03 \pm 2\%$.