

Biometrics system using EEG signals: preliminary results

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Introduction: Nowadays, systems capable of guaranteeing security and confidentiality in data access are important. Biometric systems employ physical or behavioral characteristics of living beings under the premise that each individual is unique and has distinct characteristics that allow identification. In this study, brain signals collected by electroencephalography (EEG) were used to design a biometric system.

Methods and Materials: The database used to conceive the preliminary biometric system contained brain signals from 10 volunteers, while they were exposed to a scintillating visual stimulus at 10 Hz. The recording of the brain activity was performed with 16 dry electrodes by electroencephalography. Eight repetitions were conducted for each individual with 12 s of duration each. The biometry system was tested in two configurations, considering 12 s and 3 s windowing of signal. The identification system consisted of the following steps [2]: (1) the signals were filtered by the common average reference (CAR) technique; (2) the power spectral density was estimated in the frequency range from 9 Hz to 11 Hz, with a 50% overlap, using the Welch periodogram method; (3) a linear classifier based on the least squares method was applied. The system used 80% of the subject base to train the classifier and was validated with the rest of the data in a scheme of 120-cross validation.

Results: Table 1 shows the average accuracy of the preliminary biometric systems for each subject, considering the two scenarios of signal duration (12 and 3 s).

| Time/Subject | Average Accuracy (%) | | | | | | | | | | |
|--------------|----------------------|------|------|------|------|------|------|------|------|------|---------------|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | Total Average |
| 12 s | 96.7 | 75.0 | 76.7 | 97.9 | 70.0 | 100 | 75.4 | 96.3 | 50.4 | 74.2 | 82.0 |
| 3 s | 88.8 | 61.4 | 80.8 | 90.7 | 43.6 | 95.7 | 40.6 | 100 | 13.6 | 67.7 | 68.3 |

Table 1 – Average accuracy of the biometric systems.

Discussion: Results show that our preliminary biometry system is able to perform a correct validation in 82% of the cases using 12 s of signal and in 68% with only 3 s of the signal. However, we can note that, for some subjects, such as S5, S7 and S9, the system becomes very fragile with the reduction of the analysis time, while for others the system remains robust. Particularly, for the subject S9, the system is not efficient, even with the 12 s windowing: probably his signals have a low signal-to-noise ratio and need to be better processed.

Conclusion: The use of CAR, Welch method and linear classifier allowed the development of a biometric system capable of identifying individuals through EEG signals, mainly using a larger time window. To improve the system, features selection techniques will be tested and the database will be expanded.

Acknowledgments: The authors thank UFOP, CNPq, FINEP and FAPESP for the financial support.

References: [1] Leite, H. M. A. (2018). Design de interação para interfaces cérebro-computador baseadas em potenciais visualmente evocados. [2] Theodoridis S., et al. Pattern recognition, 2003.