Ph.D. DISSERTATION INFORMATION

The Ph.D. Dissertation title: ANALYZING SLEEP STRUCTURE USING SINGLE-CHANNEL EEG SIGNALS.

Specialty: Engineering Physics Code: 62520401

Ph.D. candidate: Le Quoc Khais

Supervisor: Asc. Prof. Huynh Quang Linh, Ph.D; Ly Anh Tu, Ph.D

Academic institute: Ho Chi Minh City University of Technology – VNU HCM

SUMMARY OF NEW FINDINGS

Sleep is a common human activity and sleep structure study plays a significant role in diagnosing human health. Analysis of sleep structure is the basic step in research on sleep quality assessment. Accurate quantification in sleep structural analysis has an important influence on the diagnosis and treatment of sleep-related diseases and disorders. In addition to the usual form of night sleep, there are other types of sleep occuring the day such as napping, unwanted sleep states such as dozing, or pathologically related sleep states such as narcolepsy syndrome. The study of sleep structure has two basic international standards, namely R&K 1968 and AASM 2007 used to classify the different sleep states. Although there are mentioned uniform worldwide standards, the accuracy of the classification considerably depends on the traditional manual method which is based on the visual detection of polysomnography features by experts.

With computational tools, the thesis approaches the research direction of sleep structure intending to provide an automated process in analyzing polysomnography signals for accurate detection of sleep features. The study uses 153 records from the Sleep EDF Expanded of Physionet dataset combined with 55 experimental recordings at the Biomedical Engineering Laboratory. Besides, with the use of the latest update of the AASM 2007 classification standard, the thesis opened up more relevant sleep-related research directions than just applying the usual R&K standard. Based on the results of polysomnography analysis, the thesis developed a new direction of using single-channel EEG signals to study sleep structure to overcome the limitation of complex measurement configuration of polysomnography and show the availability for quick diagnoses without polysomnography monitor. A particularly new and important result of this approach is the improved accuracy and specificity of N1 sleep stage classification compared with existing studies serving as the basic tool for other applications.

With the approach of analyzing sleep structure using single-channel EEG signals, the thesis continued to apply the classification of mentioned important features to practical application cases such as determination of the time interval of state transition from wakefulness to sleep, or study on drowsiness in students. This approach has shown the suitability and prospect of using single-channel EEG signals to study and diagnose sleep-related problems, gradually replacing traditional studies based on polysomnographic signals.

In terms of methodology, the thesis has built a procedure to process and analyze raw data from polysomnographic or single-channel signals obtained from measuring equipment through the workflow of function blocks such as signal noise filtering, extraction of features, selection of features, implementation of training models and machine learning algorithms to classify the sleep structure of selected problems. The results of the thesis represented a significant contribution to the development of computer-aided polysomnographic or sleep structure research through a procedure of analyzing and selecting proper features for each specific research direction.