Chapter XIII

Analysis of Temporal Patterns of Physiological Parameters

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Abstract

This chapter deals with the analysis of spontaneous changes occurring in two physiological parameters: the cerebral blood flow and respiration. Oscillation of the cerebral blood flow is a common feature in several physiological or pathophysiological states and may significantly influence the metabolic state of the brain. Our goal was to characterize the temporal blood flow pattern before, during, and after the development of CBF oscillations. Investigation of this phenomenon may not only clarify the underlying regulatory mechanisms and their alterations under certain conditions but also lead to the development of novel clinical diagnostic tools for early identification of developing cerebrovascular dysfunction in
pathophysiological states such as brain trauma or stroke. A disturbance in normal breathing may occur in several nervous and physical diseases. In the present study, we introduce a reliable online method which is able to recognize abnormal sections of respiration, that is, the most common breathing disorder, the sleep apnea syndrome, based on a single time signal, the nasal air flow. There are several common features of the above problems and signals under investigation that imply similar solutions. The chapter introduces the systematic way of selecting proper feature extraction method and optimal classification procedure. The introduced approach can be generalized for the analysis of similar time series featuring physiological parameters.

Introduction

This chapter deals with the analysis of spontaneous changes occurring in two physiological parameters: the cerebral blood flow and respiration. Oscillation of the cerebral blood flow (CBF) is a common feature in several physiological or pathophysiological states and may significantly influence the metabolic state of the brain. These low-frequency oscillations may be influenced by pharmacological interventions (inhibition of the nitric oxide synthesis) and by pathologic conditions (ischemia, large, and small artery disease). Our goal was to characterize the temporal blood flow pattern before, during, and after the development of CBF oscillations. The physiological parameter in this case was measured by laser-Doppler flowmetry recording the movement of red blood cells in the brain tissue. Investigation of this phenomenon may not only clarify the underlying regulatory mechanisms but also lead to the development of novel clinical diagnostic tools for early identification of developing cerebrovascular dysfunction in pathophysiological states such as brain trauma or stroke.

A disturbance in normal breathing may occur in several nervous and physical diseases. The most common breathing disorder is the sleep apnea syndrome (SAS). By definition, an episode of apnea occurs if someone’s breathing ceases for a certain period of time. A commonly used and reliable diagnostic method for the detection of apnea is the polysomnographic (PSG) assay which is a multichannel signal record measured during the whole sleeping process. The standard diagnostic nocturnal PSG consists of 9 to 12 physiological parameters. Even the limited-channel version of PSG records—recorded by portable devices—contain 5 different physiological signals. The evaluation method for PSG records is frequently off-line. An online evaluation opportunity is more frequent in the case of portable devices. The typical specificity and sensitivity of apnea