Classification of Fetal Behavioral States by employing 1D-CNN based on Fetal Electrocardiography

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The study of fetal brain development at different gestational periods is a major area of research nowadays. It is essential to understand the Fetal Behavioral States (FBSes) in order to comprehend the development of the Autonomic Nervous System (ANS). The aim of this study is to classify FBSes into quiet and active sleep using deep learning CNN technique. Noninvasive electrocardiogram signals were recorded from 109 healthy fetuses with a Gestation Age (GA) range of 20–40 weeks for a duration of 10 min. After computing the Heart Rate (HR) from the R-R interval, each recording was then segmented into a 3 min window in order to obtain 279 samples, which ensured that all recordings were representative of one HR pattern. This article proposes a 1D Convolution Neural Network (CNN)-based approach to classify FBSes. Besides the input and output layers, the proposed CNN model consists of six layers (namely: three convolution layers, two down sampling layers, and one full connection layer) resulting in the automatic extraction and classification of features from the original data. The training and validation datasets are split into a 70:30 ratio. A hidden test set of 39 samples was also used, where the Doppler signal was used to label these samples. This preliminary study achieves a promising classification accuracy of 80%. We anticipate that the study will pave the way for implementing deep learning models to determine the health status of the fetal ANS in clinics at every stage of gestation.