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Silent speech decoding based on brain signals by the Quantum Neural Network

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Abstract

Communication using brain–computer interfaces (BCIs) can be non-intuitive, often requiring the performance of a conversation-irrelevant task such as spoken imagery. In this paper, the reliability of electroencephalography (EEG) signals in discriminating between different covert speech tasks is investigated. Twelve participants, across two sessions each, were asked to perform multiple iterations of three differing mental tasks for ١٠ s each: unconstrained rest or the mental repetition of the words “Hello” , “Food” and "Water" A quantum artificial neural network(QNN) was used to classify all three pairwise combinations of “hello” or “water ” and "food" trials and also for ternary classification. An average accuracy of ٠.٩٥% ± ٤.٦ was reached in the classification of covert speech trials versus rest, with all participants exceeding chance level (٠.٩٧%). The classification of “hello” versus “word” yielded an average accuracy of ٠.٩٣ ± ٠.٦ with ten participants surpassing chance level (٠.٩٧). Finally, the ternary classification yielded an average accuracy of ٠.٩٤% ± ٠.٤. with all participants exceeding chance level (٠.٩٧%). The proposed QNN network provided significantly higher accuracies compared to some of the most common classification techniques in BCI. To our knowledge, this is the first report of using QNN for the classification of EEG covert speech across multiple sessions. Our results support further study of covert speech as a BCI activation task, potentially leading to the development of more intuitive BCIs for communication.

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