Abstract Title:

Human-Robot Shared Perception for Categorizing Object via Deep Canonical Correlation Analysis

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Abstract:

Human vision and robotic vision share the same goals such as object categorization. They can complement with each other. For example, human vision is able to understand object located in unstructured environment less than several hundred milliseconds, and therefore accelerates perception speed without needing any training data that is used in robotic vision. On the other hand, robotic vision is able to sense environment all day and all night without interruptions, which enables human to have rest or focus on other tasks. For this reason, shared visual perception between human and robot may enhance performance of human-robot collaboration tasks in continuous and natural environment. In this work, an integration strategy of human and robotic vision perceptions is proposed to improve object categorization performance. Under the shared perception framework, one object is viewed by two vision systems, respectively. Perception response of human visual system is recorded by neurophysiological signal electroencephalography (EEG), and robotic vision on object perception is characterized by speeded up robust features (SURF). To overcome nonstationary problem, periodogram analysis is used to model EEG signal for identifying robust visual representation. A complex nonlinear transformation of two views of data is learned by deep canonical correlation analysis (DCCA) to make two vision representations highly correlated. Maximizing correlation with highly correlated representations are used to classify natural objects. A six-category object dataset, recorded by both of EEG headset electrodes and visual cameras, is used to evaluate the proposed method. Reliability of the proposed method is evaluated on EEG data acquisitions across different time periods. Experimental results show that the shared perception between human and robot visual systems is able to increase object categorization accuracy, in compared to a single modality-based object classification in human visual perception. Reliability of object categorization is also improved by integrating analysis of both human vision and robotic vision.