PLOS | ONE

RESEARCH ARTICLE

View-Invariant Visuomotor Processing in Computational Mirror Neuron System for Humanoid

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Abstract

Mirror neurons are visuo-motor neurons found in primates and thought to be significant for imitation learning. The proposition that mirror neurons result from associative learning while the neonate observes his own actions has received noteworthy empirical support. Self-exploration is regarded as a procedure by which infants become perceptually observant to their own body and engage in a perceptual communication with themselves. We assume that crude sense of self is the prerequisite for social interaction. However, the contribution of mirror neurons in encoding the perspective from which the motor acts of others are seen have not been addressed in relation to humanoid robots. In this paper we present a computational model for development of mirror neuron system for humanoid based on the hypothesis that infants acquire MNS by sensorimotor associative learning through self-exploration capable of sustaining early imitation skills. The purpose of our proposed model is to take into account the view-dependency of neurons as a probable outcome of the associative connectivity between motor and visual information. In our experiment, a humanoid robot stands in front of a mirror (represented through self-image using camera) in order to obtain the associative relationship between his own motor generated actions and his own visual body-image. In the learning process the network first forms mapping from each motor representation onto visual representation from the self-exploratory perspective. Afterwards, the representation of the motor commands is learned to be associated with all possible visual perspectives. The complete architecture was evaluated by simulation experiments performed on DARwIn-OP humanoid robot.

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Citation: Dawood F, Loo CK (2016) View-Invariant Visuomotor Processing in Computational Mirror Neuron System for Humanoid. PLoS ONE 11(3): e0152003. doi:10.1371/journal.pone.0152003

Editor: Thomas Wennekers, Plymouth University, UNITED KINGDOM

Received: August 30, 2015

Accepted: March 6, 2016

Published: March 21, 2016

Data Availability Statement: All relevant data are within the paper.

Funding: This research is supported by High Impact Research MoE Grant UM.C/625/1/HIR/MOHE/FCSIT/10 from the Ministry of Education Malaysia.

Competing Interests: The authors have declared that no competing interests exist.

Introduction

Mirror Neurons belongs to the family of visuomotor neurons which were originally discovered in the F5 area located in the premotor cortex of the macaque monkey brain [1]. Mirror neurons not only activate when the primates observes an action (e.g., grasping) performed by demonstrator (human or monkey) and also activate when the primates try to execute the same observed action [2–4]. These neurons are an example of a motor resonance system in which