

Chapter 49

Spiking Reflective Processing Model for Stress-Inspired Adaptive Robot Partner Applications

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ABSTRACT

In a real-world environment, a social robot is constantly required to make many critical decisions in an ambiguous and demanding (stressful) environment. Hence, a biological stress response system model is a good gauge indicator to judge when the robot should react to such environment and adapt itself towards the environment changes. This work is to implement the Smerek's reflective processing model into human-robot communication application where reflective processing is triggered during such situations where the best action is not known. The authors want to investigate how to address better the human-robot communication problems with the focus on reflective processing model in the perspectives of working memory, Spiking Neural Network (SNN) and stress response system. The authors had applied their proposed Spiking Reflective Processing model for the human-robot communication application in a university population. The initial experimental results showed the positive attitude changes before and after the human-robot interaction experiment.

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INTRODUCTION

The human-robot communication feature is important for many different social robotic applications such as care robot for supporting elderly living, retail robot, health surveillance robot and many more social robot applications. In this work, the robot entity that coexists and interacts with human users is known as “robot partner”. However, such robot partners are operated in a real-world environment where any un-predicted environmental changes will influence the robot partner’s normal operations. For example, if the robot partner detected unknown user input where no definite response is defined. Hence, the robot partner should be able to adapt towards the unknown situations and generate best response behavior in that situation. Therefore, the robot partner can operate in many different human-robot communication situations.

In this work, the research objective is to investigate how to address the human-robot communication ambiguous problems with the focus on Smerek’s reflective processing model (Smerek, 2012) in the perspectives of working memory (Baddeley, 1992), stress response system (Lupien, Maheu, Tu, Fiocco, & Schramek, 2007) and Spiking Neural Network (SNN) (Gerstner, Gerstner, Kistler, & Kistler, 2002). The reflective processing model is the System 2 in dual-process theory (Stanovich & West, 2000) that is slow, low capacity, highly correlated with working memory in cognitive ability. The dual-process approach theory was first introduced by Stanovich (Stanovich & West, 2000).

Reflective processing is a System 2 processing behavior in dual-process approach where the response produced is highly dependent on working memory during ambiguous and demanding situations. For an example, in a misinterpreted user input situation (ambiguity situation that triggered artificial stress in the robot partner), the robot partner has to be vigilant to its surrounding context information (high-working memory utilization for storing context information) and use the context information to determine the user original intended meaning (guessing). Hence, reflective processing or System 2 processing is also the system that processes the robot partner response during ambiguous interaction conditions during human-robot communication scenarios. In this paper, the authors had hypothesized that the robot’s reflective processing behavior can improve the human-robot communication engagement by allowing the robot partner to adapt to the ambiguous situations with the support from context information in the robot partner’s working memory.

LITERATURE REVIEW

Biological Stress Response System and Working Memory

In related cognitive psychology research work, Lupien et al. (Lupien et al., 2002) experimented young male test subjects for working memory on a list of 12 words with different doses of glucocorticoids (cortisol or stress hormone). In her experimental results, a working memory retrieval performance against the level of glucocorticoids had exhibited and discovered the inverted-U-shape phenomenon. Such phenomenon is similar to the phenomenon as described by Yerkes and Dodson (Dodson, 1915).

Dual-Process Theory

In this section, the authors focus on the discussion of the human’s reflective processing behavior during stress-stimulated ambiguous situations. Many of the modern research literature discussions on reflective

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