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A Neurocomputational Model Implemented on Humanoid Robot for Learning Action Selection

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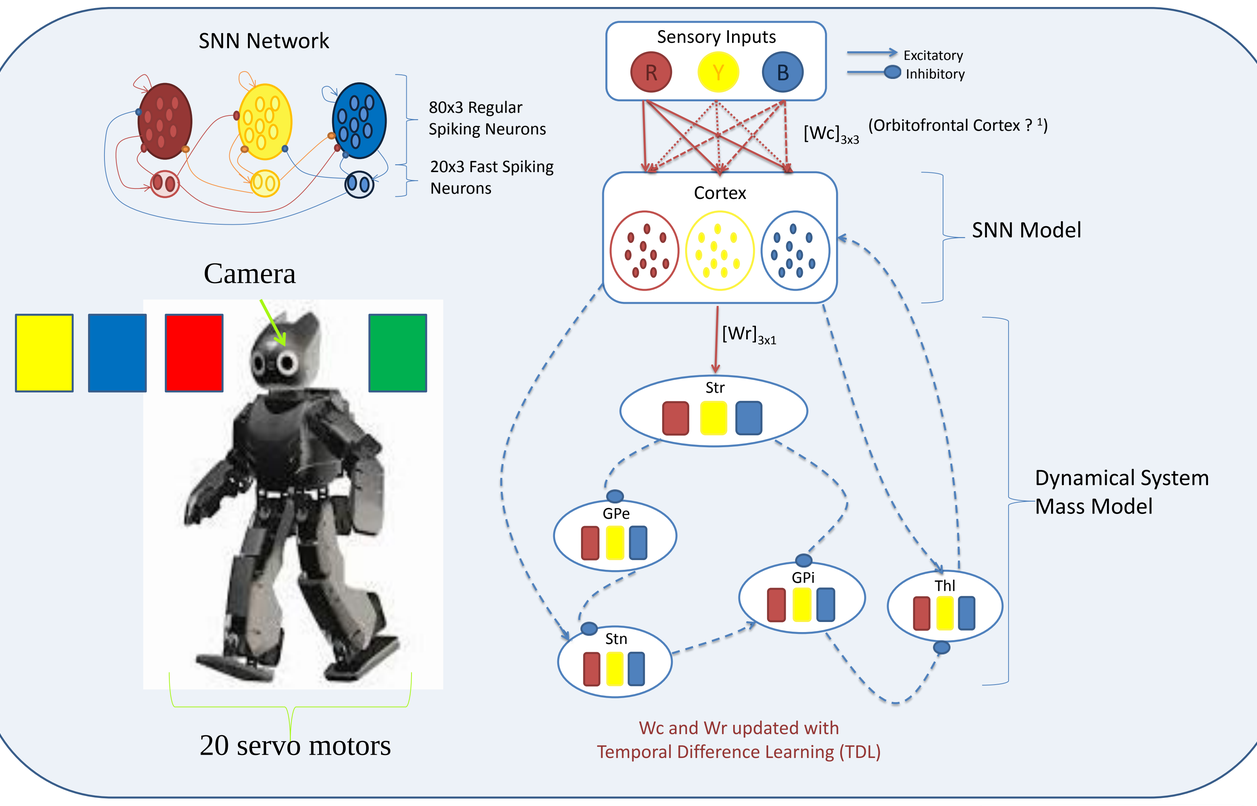
Abstract

Based on a computational model of Basal ganglia-Thalamus-Cortex (BTC) circuit proposed for action selection, the task of associating a sensory stimulus with a desired action is realized on a humonoid robot. The computational model of BTC circuit, incorporates two different levels of modeling: point neuorns and mass models. With the point neuron it is aimed to obtain a more realistic method to investigate the model in real time, while mass model provides realizability of the task on humanoid robot platform, Darwin-Op. Point neurons are used in modeling cortex which consists of channels for each action to be elected. The plastic all-to-all connections from the sensory stimuli to the basal ganglia structures are modulated with reward.

In the task, the sensory inputs, namely colors, are presented to the humanoid robot and it is expected that these sensory inputs would be associated with the predefined actions by modulating the connections.

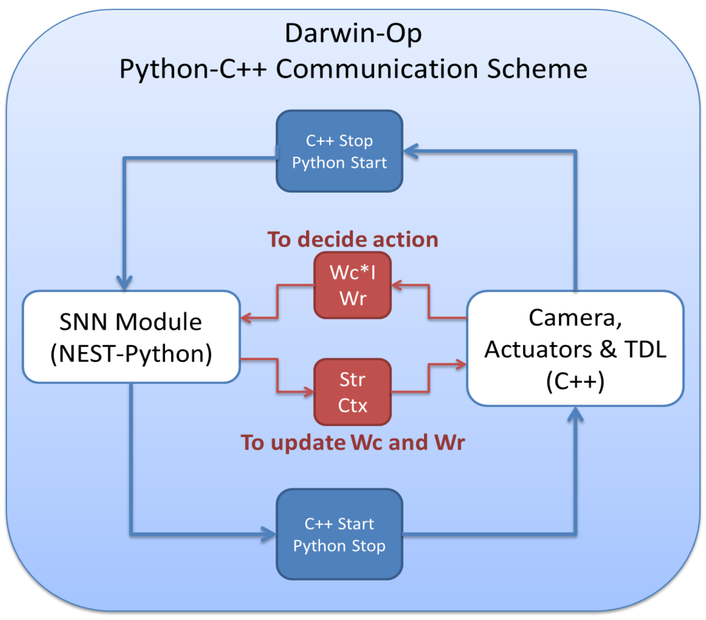
Despite the model lack the reality and detail computational models of basal ganglia, thalamus and cortex loop for action selection, its simple approach is sufficient from modeling aspect to show the action selection behavior on cortex in real time applications.

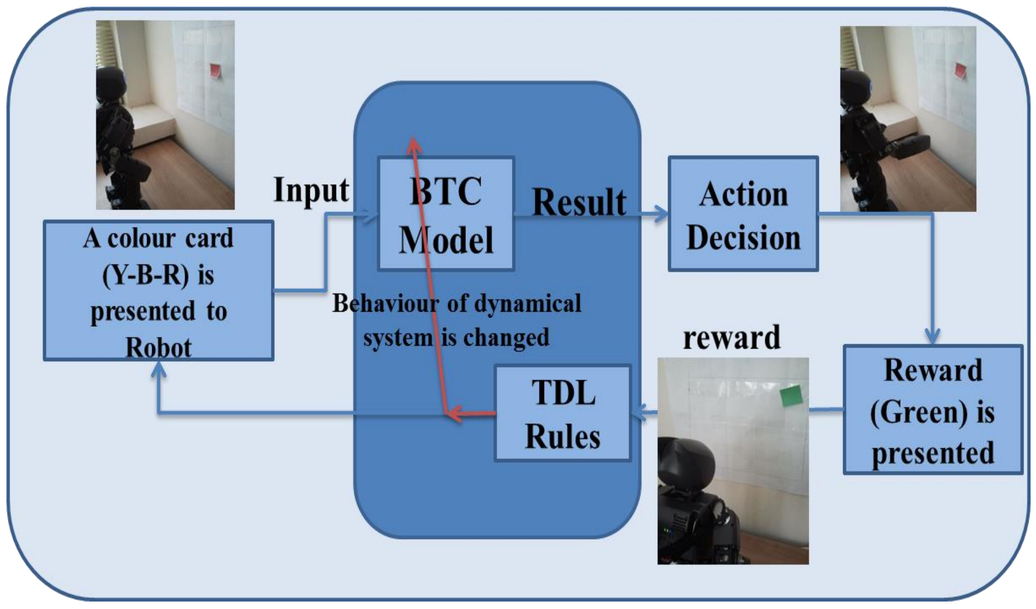


The Model

The model consists of two parts, one is Cortex that is modeled using İzhikevich neurons[4] and the other is BTC which is modeled using mass model given in [1,2]. The BTC model is coded in Python and the Cortex is simulated in NEST[6]. There are three channels each for a different action and the winning channel in Cortex is considered as the selected action.

The camera information is get from the C++ coded part and sent to the model, and the BTC model determines the action to be selected. The output of cortex is determined by firing rates of three channels and this information is sent to the Basal ganglia-Thalamus loop in a normalized form to manage the calculations. Basal ganglia Thalamus loop employs the action selected to cortex and this information with striatum information is used in reinforcement learning to update the model parameters using temporal difference learning in C++ coded part.

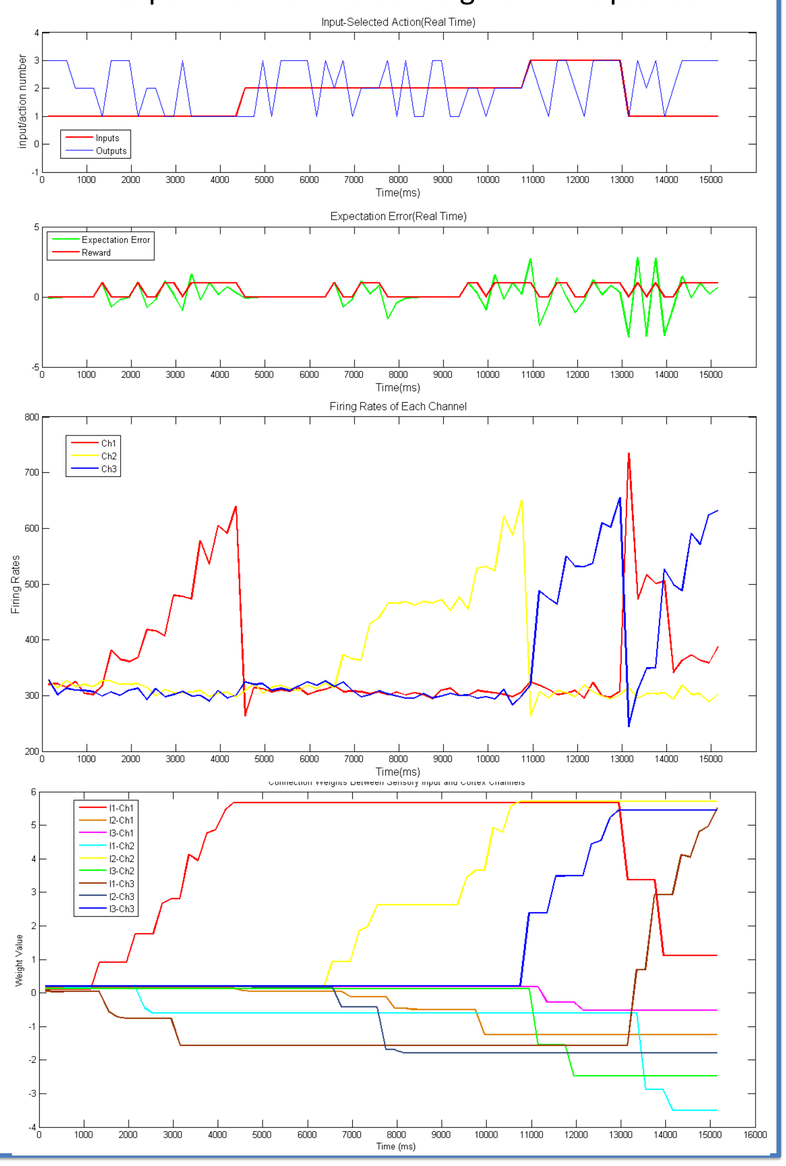




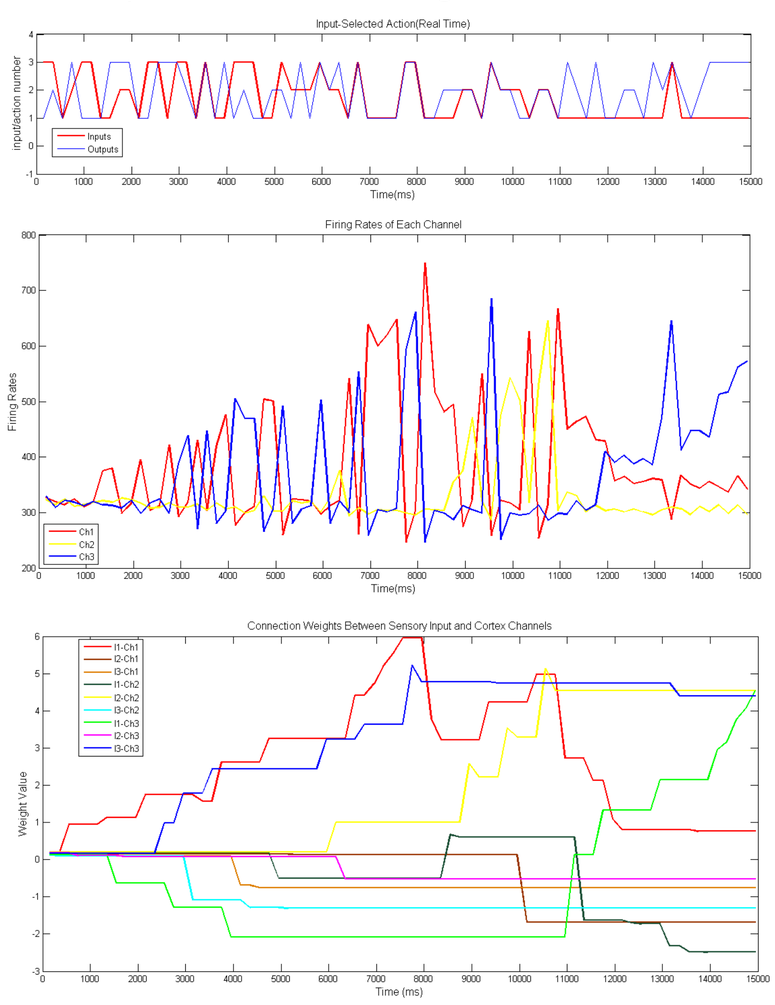
The Task

When a color is presented to robot, it tries to decide on an action, at first randomly, and gets reward according to its decision. The reward given, causes an **expectation error,** as the robot was **expecting nothing** as a result of its choice. This urges robot to **reinforce the desired stimulus-action pair**. Once robot is rewarded due to its right choice, expectation error **updates the parameters** of BTC model in charge of action selection. When update is completed, robot manages to select the desired action related with the given stimulus. In case, when **an expected reward is not given** to the selected action associated with a stimulus, this also causes an expectation error and urges robot to **rearrange** the previously built association between a stimulus and action.

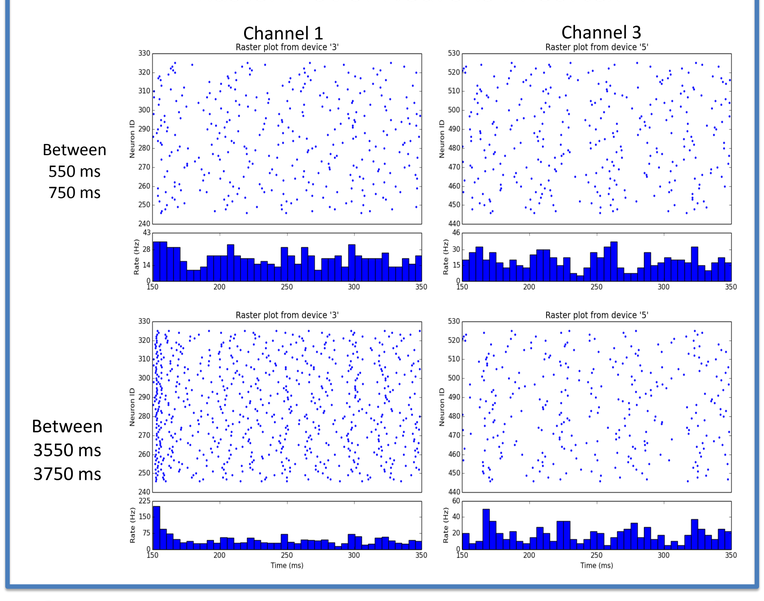
1st experiment: Stimulus are given in sequence



2nd experiment: Stimulus are given in random order



Raster Plot of Neurons in Cortex



Referances

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Acknowledgements

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