Using the Model of Motor Planning in Self for the Purpose of Recognising Motor Action in Other

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Abstract

A subset of the motor neurons in the ventral premotor cortex of our brain forms the mirror neuron system. These neurons have been seen to get activated not only when executing an action but also when observing the same action being performed by another individual.

There is a certain possibility that this architecture has evolved over the course of time to conserve the substrate required for the process of action and that feeling of empathy may just be nothing but a very useful consequence of this architecture

In our research, we attempt to find the validity of the above stated possibility by creating a model for recognising the motor actions of another individual by using the model of action planning in self.

Introduction

In our work the Theory of Mind and the Mirror Neuron System hold special significance.

Theory of mind is refers to the ability of attributing mental states to oneself and others and to understand the other's have states, intentions and perspectives identical or different to their own.
Though opposed, a popular theory proposes theory of mind to be simply an outgrowth of ability of interpretation of other's actions through internal simulations.

The Mirror Neuron System was first found in the 1980s and 90s by *Giacomo Rizzolatti*'s team in the ventral premotor cortex of the macaque monkey.
Since then the MNS emerged to be the most popular and talked about topic of interest in the field of neuroscience.
Widely believed to have emerged as result of associative learning and self-other cognition, the mirror neurons have been widely used to explain the functioning of complex questions of empathy, theory of mind, self-awareness, comprehension of emotion, imitation, and even autism.
V.S. Ramachandran, regards the mirror neuron system to be a cornerstone of the civilized society and compared its possible importance in neuroscience to be similar to that of DNA in Biology.

Hence in our research, we attempt to harmonize both the concepts to understand whether these necessities of comprehending the other's actions, intentions and sentiments resulted from the gradual development and need for efficiency in the process of learning and execution of action.

Status

We have done a very detailed and comparative study of the various research papers, journals, and thesis from the likes of Baron Cohen, Ramachandran and others for in-depth analysis and knowledge of the various aspects and advances in the fields of *mirror neuron system*, *theory of mind, artificial intelligence,* and the aspects of the sensory, perception and simple gesture modules of modern robots.

From that knowledge, we have attempted to observe through self designed computational models whether the demand of fulfilling a predicted action and its continuous comparison with the action self drives some special conspecific subset of the particular neuronal units to inhibit the influence of other neighboring functional units *(fig 1.2).*

Having implemented this we will have a cosine function between transformed coordinates of action to the premotor representation.
Then we want to look into the ways that these transformations can take place between the visual field and the action field.

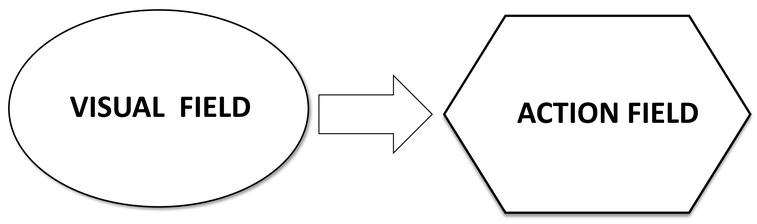

Figure 1.1: The transformation between the visual field and the action field is one of the most important factors of theory of mind and perception and hence one of the most vital component of our study.

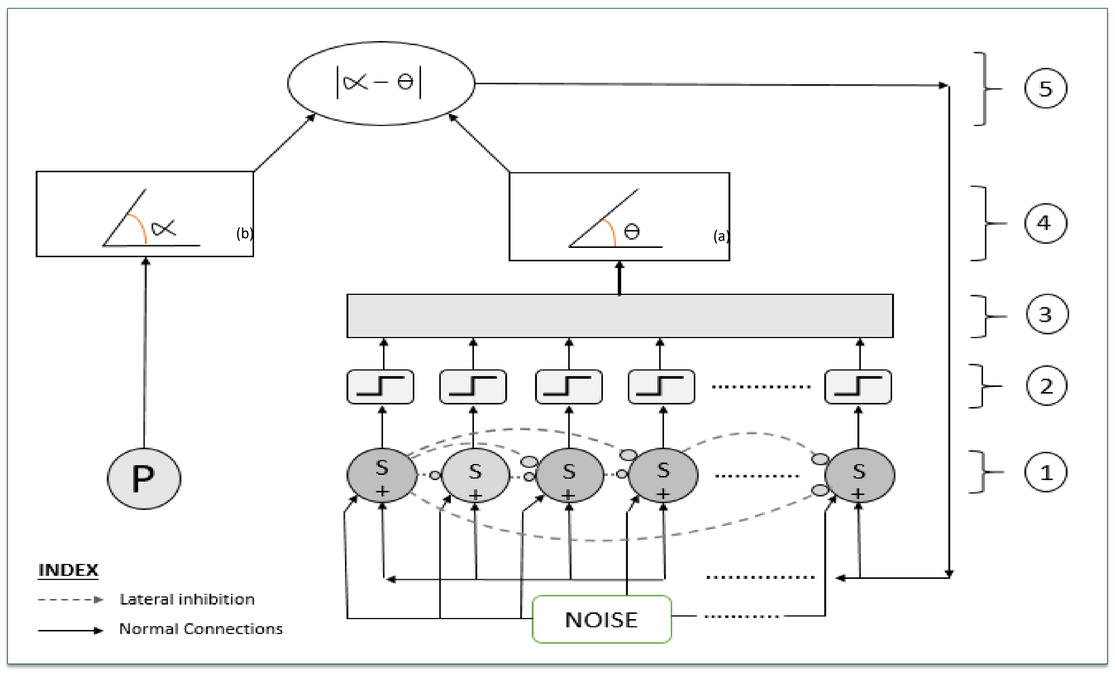

Figure 1.2: A Schematic diagram of our model of neuronal units in continuous comparison between self action with observed action and attempting to converge to match the self action ((**4a**)) predicted action ((**4b**)).
((**1**))- The Inputs: Inputs of the model self. (S) being inputs of model self. (P) being input of observed self.
((**2**))- Threshold Functions which convert input to 0 or 1 depending on action. ((3))- Decoder
((**4**))- Action State where instruction function are fed in resulting in state change, change of angle in this case.
((**5**))- Error Generator where the difference between the angles are calculated and fed back to the input.

Methods and Materials

After detailed studies of the concepts through the materials referenced below, we attempted to design an artificial neural network functioning to move a robot arm at an angle equal to that of an observed arm by measuring the difference in the angles at every iterative steps.

The inputs along with a certain amount of noise are passed through threshold functions and a decoder to convert it into binary instruction string which is fed to action generator. An error calculator which then generates the difference between self and observed and that is fed back to the input.
MS Powerpoint and the Simulink library, the neural network toolbox and programming platform of MATLAB 2015 were used for our purpose.

Remarks

There is one very crucial difference between our research and the actual happenings inside our brain. It is that the isolated activation of a set of mirror neurons have no significance in real perception which happens when these set of neurons upon activation simultaneously and inevitably causes partial activation of some other set of neurons, emotional or linguistics being some of them. This is the key for wholesome perception.

In our research, we are not claiming that through our model we will achieve an autonomous and wholesome perception. But we are attempting to find a module which uses the model of motor planning in the self to recognise the system of planning in others.

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