Volume 4, Issue 1, January 2014 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Cognitive Computational Neuroscience Aspects for Object Recognition

Mona Singh[1], Sandeep Singh[2]

Dept. of CSE & IT, ITM University,

Gurgaon, India

Abstract:-Object recognition is one of the goals in computational cognitive neuroscience. Vision plays vital role in recognition. Various researches prove that there is some connection between visual stimuli and cortical visual areas. Co-relation is established between retinal and cortical thickness. This helps in image formation that is passed to neurons. Objects compete for neural representation in visual cortex. This paper explains cognition due to bottom-up and top-down approach and some distinctions among feed forward, feedback, view centered and object centered.Information filtering systemis also explored to filter out un-wanted information.

Keywords:-Object Recognition, Cognitive Neuroscience, Visual Stimuli, Neurons, Visual Cortical.

I. INTRODUCTION

Object recognition is a difficult computational problem. If we observe any delegation via camera and we want to focus on a single object then our system should be smart enough to identify that particular object. Itshould categorize or identify in a better way and produce the best result. Recognition can be classified in to two parts i.e. identification and categorization. Categorization means member of a general class or we can say genre whereas identification is to identify a particular individual. With the help of computer system or with some software it is easy to identify whereas difficult to classify or categorize. Psychologist on the other side proves that categorization is easy in comparison to identification. When we see multiple objects or perform multiple tasks at the same time recognition is even more difficult as the capacity of the visual system is limited. Thus competition increases in our neurosystem. Competition can be resolved by salience stimulus [1]. Salience stimulus states that quality by which it stands out relative to itsneighbors. We encounter many things in our day to day life. How we can conclude that this is the information or pattern we were in need of? Best answer to this question is filtration. We filter out the un-wanted information keeping the best information with us which helps in recognizing the object or pattern.Filtration can be possible with the help of bottom-up or top-down approach. When we share a part of information with others or with system then our system is overloaded with the information. So from letting this happen we should find information which is beneficial for us. To make it an easy task we can classify them among information needs and information sources [4] Table 1. There are some assumptions that information need change rate is high in comparison to information source change rate.

Table 1.Comparing information need and information sources by different information behaviors.[4]

Classification	Information needs	Information sources
Information filtering	Stable and specific	Dynamic and unstructured
Information retrieval	Dynamic and specific	Stable and unstructured
Database access	Dynamic and specific	Stable and structured
Information extraction	Specific	Unstructured
Altering	Stable and specific	Dynamic
Browsing	Broad	Unspecified
Entertainment	Unspecified	Unspecified

While choosing important information a person keeps in mind the basic phenomena of keeping the best information while eliminating all other. Two more things are to be carry forwarded i.e. weight keyword method and connection frequency method. While performing filtration adjacent elements are not separated instead they are connected with casual relationships. Prior to all these things vision should be proper with a perfectly working retina.Then only image can be formed i.e. carried to brain formapping of image. Due to age factor some retinal pathology encounter us such as macular degeneration and glaucoma appears which affects the projections at visual cortex. To understand it in a better way it is required to find a relationship between retinal and cortical thickness. If there is some alteration in retinal thickness this can be found if patient is suffering from retinal disease. Whereas cortical thickness helps in diagnosing a neuropathology and it also gives a wide range of information about neurodegenerative and neurodevelopment patterns. Visualization is done in the visual space which is present in the visual cortex. This is a common point in retina and cortex.

II. ORGANISATION of CORTEX LAYER and SENSORY SUPRESSION

How we can find organization of human cortex? Organization is not that difficult job with the help of 'functional brain imaging study' [1] we can find the actual organization of human cortex. Blood flow in brain is mapped –hemodynamic. After achieving the initial path anatomical study is performed and then we got to know human cortex is a combination of many layers. There are visual areas which are organized in two functional pathways. As we precede both the pathways leads to initial layer i.e. v1 or primary visual cortex. Identification of objects is done by occipitotemporal pathway. Neurons which are present in areas V4, TEO, TE of the ventral system respond towards selective stimulus i.e.shape, color and texture. Middle temporal (MT) responds towards speed and direction. Spatial filtering is done with the help of V1 cells. These layers work efficiently and on every possible data. When we study anatomically all connections are reciprocally connected. Competition for neural representation is expressed as sensory suppression interaction among multiple stimuli. If a good neuron has a high firing rate and a poor neuron has less firing rate and the response is compares. As resultant stimuli which are present in the same receptive field (RF) are not processed independently but interact mutually. Stimuli are processed under two conditions i.e. sequentially and simultaneously. In sequentially a single stimulus appeared in one of the four locations then other appeared in different locations. All four stimuli are present at the same time in four locations in the simultaneous.

A. TOP-DOWN and BOTTOM-UP BAISING

Top-down is generated by the cognitive demands of the tasks and not by competing stimuli. They can exert their influence by feedback mechanism from frontoparietal cortex and includes following things such as enhancement of response, biasing of signal by increasing baseline, filtering of information,increment in stimulus salience by neuron's sensitivity.

***1) Neural Response*:**Neural response is directly related to neurons RF. Any animal or human directs their attention towards RF or away from RF to another location. Both these RF's are compared with each other. Layers which are included in the demonstration are v1, v2 and v4. MT which is a dorsal area is also included with them. When we proceed towards functional brain imaging then we encounterfew of the things, identical visual stimuli are presented at corresponding peripheral locations. Neural response is not in favor of stimulus at an attended location but also in favor of attended attribute stimulus. When we attend many of the identical stimuli than the majority of neuron response is towards the stimuli matching the selected feature and other features are attenuated.

2) Baseline:Top down biasing obtained not only by the modulation of visually driven activity but in the absence of any visual simulation. Firing rates are higher in the areas such as v2 and v4. Increased baseline is said as top-down feedbackbiasing represents the attended location and favor the stimuli that appears there at the cost of those appearing at unattended locations.

3) Sensitivity:Role played by attention is to increase the sensitivity. V4 neurons increase the sensitivity when the animal or human directs their attention away from the RF. A high-contrast stimulus dominates the neuron response which is present with the low-contrast stimulus. When attention is towards the low-contrast it indicates that top- down mechanism is counteracting the bottom-up stimulus driven.

B. BOTTOM-UP BIASING

Competition can not only be resolved with the help of top-down biasing but also with the help of bottom-up biasing.

1) Stimulus Salience:It dependson various factors including simple properties such as color stimulus or line orientation. Competition among the multiple lines cannot be easily resolved with salience, but one has to work actively. For such cases we can say that salience is low.

III. RETINAL CORTICAL THICKNESS and MAPPING

For recognizing objects and other things which are surrounding us we should know retinal and cortical thickness. Optical coherence tomography (OCT) [2] is used in measuring the thickness. Thickness is defined as the difference between the internal limiting membrane (ILM) and the retinal pigment epithelium (REP) these are identified with the help of OCT imaging. Cortical thickness can be measured with white and grey matter segmentation and a Laplace method is implemented on it. Software which is used to drive cortical thickness from visual cortex is Brain voyager OX-MPRAGE[2] (magnetization prepared rapid acquisition gradient echo) is used in data acquiring.

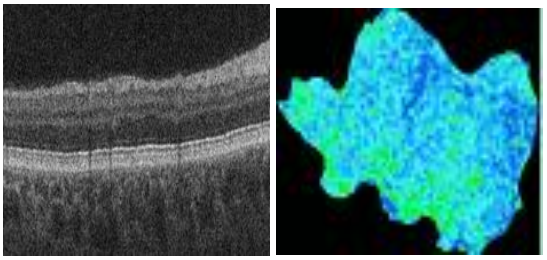

Fig1.B-scan of an original Optical Coherence Tomography volume with two different interfaces inner limiting membrane and retinal pigmented epithelium [2].

Brain Voyager software provide us with two models i.e inflated and the flatened models but flatened model is mostly used as it is two dimensional thus helps in reducing processing time in subsequent stages.Real time computerized imaging is subjected to visual stimuli. Subject is made focused on the fixed target and software is used to gather functional map from the raw data i.e. Siemens Trio ST Scanner and the Brain Voyager OX.

A. Stimulus

Most practiced technique is the travelling wave method or phase encoded retinotopic mapping. In this technique following things are kept important i.e. polar angle [2] (that rotates around fixation target) and eccentricity [2] (expands from the fixation target). Thus helps in visualizing the visual field with the help of polar coordinates i.e. polar angles and eccentricity values.

B. Segmentation Algorithm

This algorithm [2] is used in mapping. Matlab tool is used which is present in the Brain Voyager in addition to this a threshold map is created. For the consideration of relevant vertices threshold map is compared to retinotopic data .Vector field sign (VFS)[2] map can be computed by combining polar angle and eccentricity is done so that direct segmentation can be done of visual areas. Gradient of polar angle can be denoted as ($\nabla\theta$) and eccentricity is denoted by (∇p). Cortical surface can be computed as

$VFS = sign(\det(\partial\Psi))$ **(1)**

det and sign denotes the determinant of matrix. Thus it helps in mapping each point on cortical surface in visual field and the sig num.

$VFS = sign(\det(\nabla\theta, \nabla p, \hat{n}))$ **(2)**

here $\hat{n}$, $\nabla\theta$, ∇p are 3*1 vectors in **eq(2).** $\hat{n}$ is known as the normal vector by using flattened model.

$VFS = sign(\det(\nabla\theta, \nabla p))$ **(3)**

$\nabla\theta$, ∇p are 2*1 vectors

Retinitopic data is used for the segmentation of V1, V2, V3 i.e. visual areas it is also beneficial as visual space between contiguous areas changes its orientation. Thus in the flattened model boundaries between retinotopic visual areas are determined with the help of polar angles and at the same time eccentricity is also needed to know the extent of the visual area. Dorsal and ventral region of visual cortex can be identified with the help of inversion ingradient direction. Polar angle orientation is as

$Orientation = sign(\partial F\,\theta/\partial x)$ **(4)**

Whereas F θ is polar angle function

Eccentricity orientation is

$Orientation = sign(\partial Fp/\partial y)$ **(5)**

Fp eccentricity function

IV. CORRELATION and INTERPOLATION

Correlating links between retinal location and cortical location and vice versa. Few representative lines are obtained i.e. equal eccentricity and equal polar angle. At each time we combine representative lines which have a specific polar angle and eccentricity value. We get all the polar angle and eccentricity values. As the process goes on we encounter some of the branches and label them starting from the initial value till end point. Vectors we have been used to remove all those branches.

V. CONCLUSION

Feed-forward connection is used in immediate recognition tasks. An object which belongs to same class is a sparse population and is not a part of nice class. When representation is among visual stimuli there is competition among multiple stimuli.Multiple stimuli are not processed independently rather they are processed in mutually suppressive way. Suppressive interactions are scaled to RF size within visual cortical .Competition can be biased by bottom-up, top-down feedback mechanism and sensory driven mechanism. In the presence or absence of visual simulation attention modulation activity in visual cortex occurs. Algorithm which we is used have proved efficient and accurate. It can be used in clinical systems where in lessens the work of human expert and more is left to computers. Accuracy is provided in segmentation also.

REFERENCES

[1] Sabine Kaster and Leslie G.Ungerleider.”Mechanism of Visual Attention In The Human Cortex”Annu.Rev.Neurosci 2000.23:315-341.

[2] P.Guimaraes,P.Serranho,M.Castelo-Branco,R.Bernardses,”Segmentation Process and Pattern Recognition in Retina and Brain Imaging”

[3] Maximilian Riesenhuber and TomasoPoggio,”Computational Models of Object Recognition in Cortex: A Review”A.I.Memo No.1695,C.B.C.L. Paper No. 190.

[4] JinwaKim,SeunghumLee,HyeonsuByeon,”An Information Filtering System Using Cognitive Brain Mapping”,Third 2008 International Conference on Convergence and Hybrid Information Technology.

[5] WandellBA,DumoulinSO,BrewerAA,”Visual Field Maps in Human Cortex”Neuron.2007;56(2):366-383

[6] Engel SA,GloverGH,Wandell BA,”RetinotopicOrganisation in Human Visual Cortex and the Spatial Precision of Functional MRI”Cereb.Cortex 7:181-92.

[7] Kaster S, Pinsk MA,DEWeerdP,DesimoneR,UngerleiderLG.”Increased Activity in Human Visual Cortex During Directed Attention in the Absence of Visual Stimulation”Neuron 22:751-61

