A Small Network with Huge Artificially Grown Pyramidal Cells

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Introduction

Application Area :

Validation of -

- Spike Detection Algorithms
- Spike Sorting Algorithms
- Independent Component Analysis

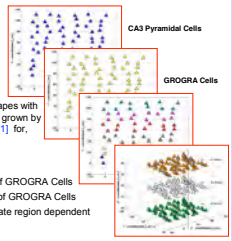
❖ Goal :

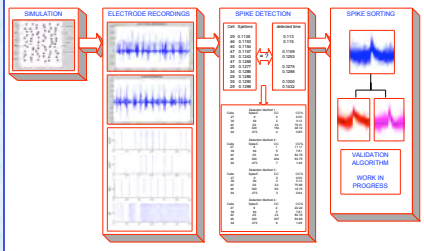
To generate different classes of Spikeshapes with Grogra cells. (Grogra cells are artificially grown by using Lindenmayer's growth grammar) [1] for,

- Validation of Spike sorting Algorithms

❖ Approach:

- Replace CA3 Cells with only one type of GROGRA Cells
- Replace CA3 Cells with different types of GROGRA Cells
- Finally build different Networks to simulate region dependent spike patterns





Simulation Set-up

Old Network : [2]

- 72 Pyramidal cells [6 x 12] (Consisting of 66 Compartments & 645 ion channels)
- 18 Interneurons [3 x 3] (Consisting of 48 Compartments)
- 16 Afferent Inputs [4 x 4]
- O/p - Biologically realistic data with single spike class

New Network :

- 72 Pyramidal cells [6 x 12] (Consisting of 397 Compartments & 3955 ion channels)
- 18 Interneurons [3 x 3] (Consisting of 48 Compartments)
- 16 Afferent Inputs [4 x 4]
- O/p - Biologically realistic data with more number of classes expected !

Parallel Simulation Setup

Current Approach:

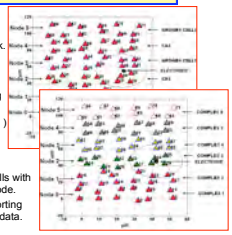
- Replace Some CA3 cells with GROGRA cells in the same network.

Simulator used:

- MPGENESIS [3] (Parallel GENESIS using Message Passing Interface (MPI) protocol).
- On SUNFIRE E15K (64 SMP M/c)
- Network simulated on 6 nodes

Work in Progress:

- To completely replace the CA3 cells with different GROGRA cells on each node.
- Writing Validation programs for Sorting Algorithms based on the simulated data.



MPGENESIS & SMP

Why ?

❖ Mpgenesis is based on MPI protocol which is supposed to do fast simulation on a Symmetrical Multi-Processor Machine (SMP).

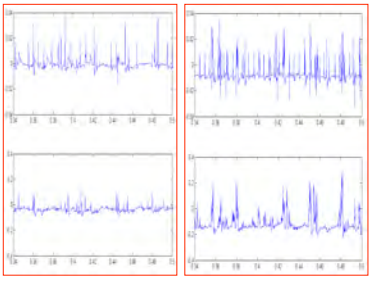
Advantage :-

❖ Installation procedure not so complicated
❖ One time setup !
❖ The distribution of the network is done automatically over the nodes.

Problems faced during simulation on SUNFIRE E15K SMP :-

❖ If all the nodes are already been used by some other, The cpu's gets shared by the users and the simulations gets slower.
❖ We used the if exists command to know which cells are on which node, as the getelementlist@{othernode} returns only one element.
❖ The mpgenesis processes are assigned lower priority on the SMP with respect to processes from other users, which makes the simulation slow.
❖ 6 nodes seemed to be optimum for the small network as more nodes increases the burden of message communication on the already slowed machine.

Results



CA3 CELLS
Electrode & soma recordings

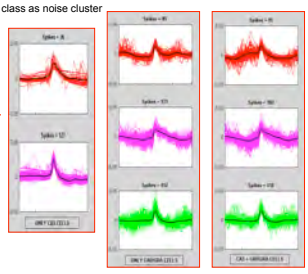
GROGRA CELLS
Electrode & soma recordings

Results

Results:

- N/w with CA3 cells gives only one class of Spike shapes.
- GROGRA cells in the same network gives two classes.
- Considering one class as noise cluster

Sorting done using kmeans



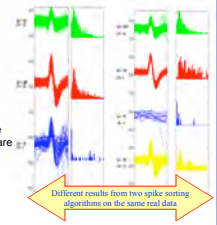
Spike Sorting Validation

Why ?

❖ Different Spike sorting Algorithms give different results using real data.
❖ No ground truth to compare such Algorithms.
❖ Are the sorted spikes really from separate neurons ?

How ?

❖ Simulated Electrode Recordings give realistic data with ground truth to compare such Algorithms.
❖ Writing Validation algorithm can be tough as the electrode recordings are summation of the activities of neighboring cells, but not Impossible !



X-Box Cluster

Why ?

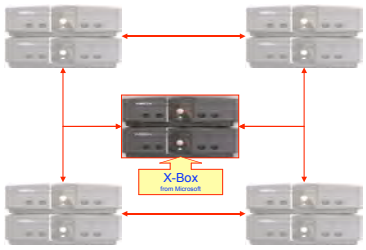
❖ Money is something everybody is always short of.
❖ SMP's and MPP Machines at prices beyond reason.
❖ Unbeatable performance to price ratio.
❖ Built-in Hard-drive.

Cons :-

❖ Need to modify the X-box in some way to run Linux on it.

Current Status :-

❖ X-Boxes, running with Xebian, (GNU Debian Linux Distribution).
❖ GENESIS is running without any Problems on the X-Box.
❖ PVM is running without any problems.
❖ Set up of PGENESIS on XBOX cluster is in Progress !



Conclusions & Outlook

Conclusion:

- We have shown that the GROGRA cells can gives more realistic results.
- To get more classes we may need to put different GROGRA cells in another network of same type, in layers.
- MPGENSIS can distribute the cells automatically over the nodes making the task of writing parallel scripts easier.
- The X- box cluster can help simulation run faster as we will be the only users on it.

References :-

[1] GROGRA (GROwth GRAmmar interpreter): http://www.grogra.de

[2] Menne KML, Folkers A, Malina T, Maex R, Hofmann UG, Test of spike sorting algorithms on the basis of simulated network data, Neurocomputing 44-46, 1119-1126, Elsevier

[3] /BABEL/babeldirs/contrib/MPI-PGENESIS, MPI based Parallel Genesis contributed by Christo Panchev (University of Sunderland, UK).