BT6270 – Computational Neuroscience
Assignment 1

Niraj Kumar Singh
BS13B028

Introduction

Hodgkin-Huxley model is a mathematical model that describes how action potentials in neurons are initiated and propagated. This assignment is aimed at using this model to find the values of external current supplied, for which various forms of neuron firing can be studied.

Method

We were given the basic MATLAB code, which took input from the user for external current and gave the characteristic neuron firing plot. The given code was modified to study the neuron firings for external applied current ranging from 0 to 0.7 microampere/mm^2.

Following assumptions were made to obtain the above mentioned graphs and subsequently the values of I1, I2 and I3 from the modified code.

- Number of iterations = 100000 (increased from 10000 originally given in the code)
- Minimum number of peaks, for considering a wave as AP = 10
- Condition for I1: Number of peaks for an increment of 0.001 uA/mm^2 should be greater than 0
- Condition for I2: Number of peaks for an increment of 0.001 uA/mm^2 should increase by 5
- Condition for I3: Number of peaks for an increment of 0.001 uA/mm^2 should decrease by 5
- Only Na and K channels were considered for this model

Observation

Table 1 contains the values for I1, I2 and I3. I1 represents current at which the first AP was observed. I2 represents the external current at the junction between finite number of APs and when continuous firing starts. Lastly, I3 represents the external current at which distortion in continuous firing is observed, resulting in no more APs.

External Current (I_ext)	Description	Value ($\frac{uA}{mm^2}$)
I1	Single AP	0.0230
I2	Continuous AP	0.0630
I3	No AP	0.4580

Table 1 Threshold Value For I1, I2, I3

Figure 1 shows the graph for firing rate vs external applied current. The parameters that have been used to obtain this plot is shown below.
Figure 2 shows the points I1, I2 and I3.
Figure 3, 4 and 5 shows the voltage vs time graph for I_ext = I1, I2 and I3 respectively.

Graph Depicting the Firing Rate as We Change the Applied External

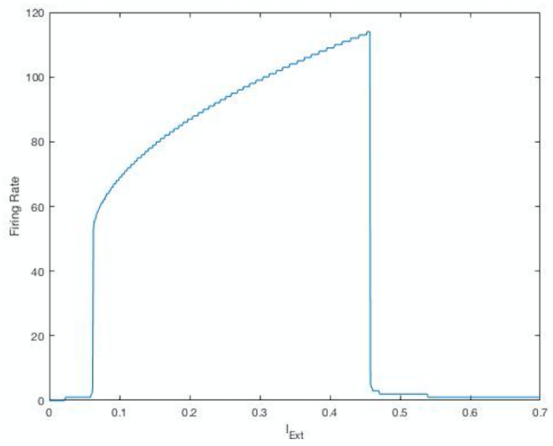

Figure 1

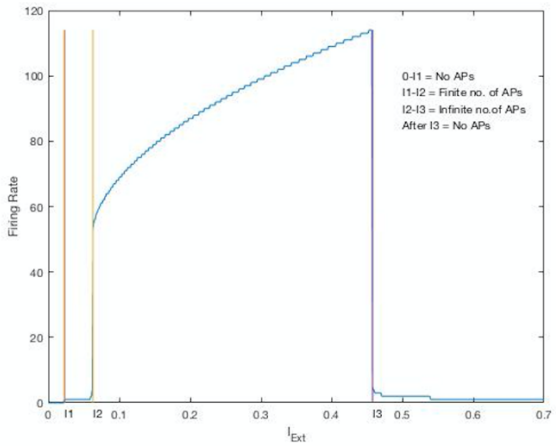

Figure 2

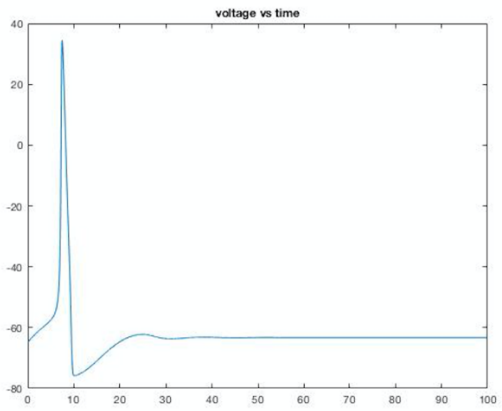

Figure 3: I

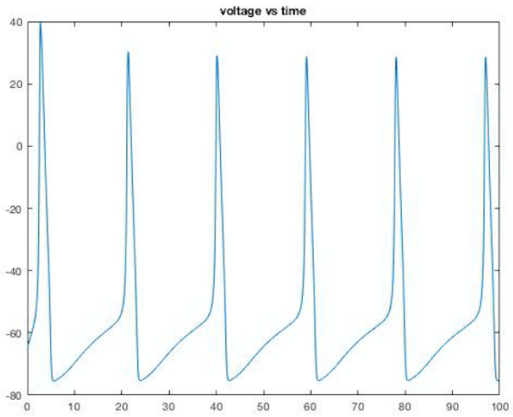

*Figure **4***

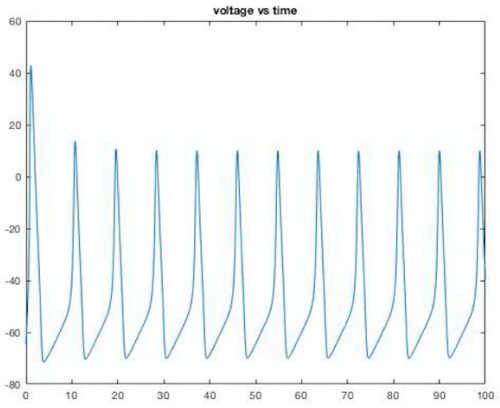

Figure 5

Results

Obtained value of I1 is 0.023 uA/mm^2, I2 is 0.063 uA/mm^2 and I3 is 0.4580 uA/mm^2. Applying current more I3 resulted in almost 0 AP.

Conclusion

Hodgkin-Huxley model is complex yet very useful mathematical model for understanding the dynamics of neuron firing, upon external applied current.