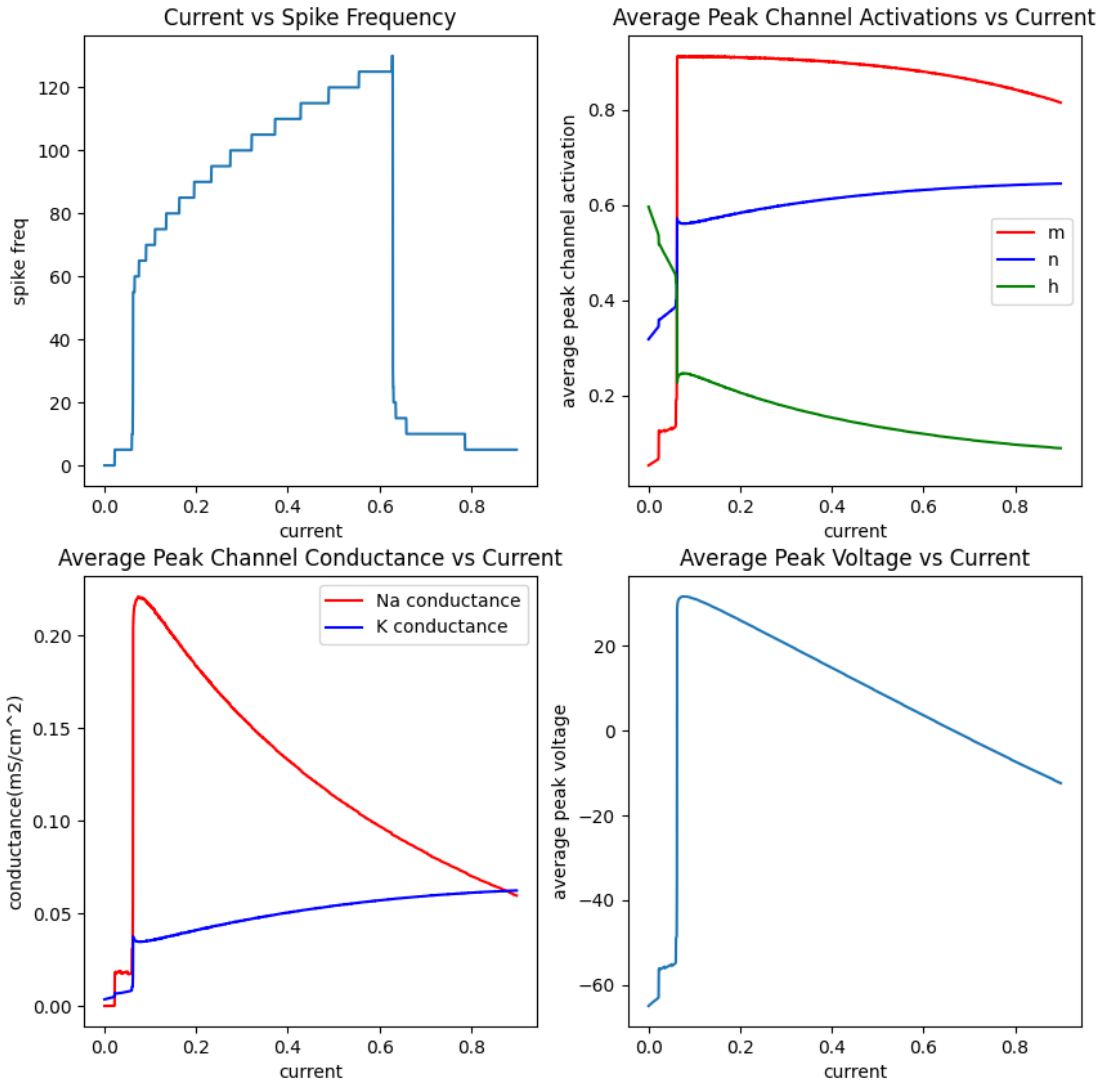
Hodgkin Huxley Neuron Model Simulation Results



The following is the Spiking Frequency vs Current plot obtained for a constant current input-

The following curve shows bifurcations at currents of 0.023 μA, 0.062 μA and 0.601 μA respectively.

$I_1 = 0.023\mu A$

$I_2 = 0.062\mu A$

$I_1 = 0.601\mu A$

The frequency was calculated by computed the number of peaks observed over 10000 iterations (100s) of HH model ie

$$dt = 0.01$$

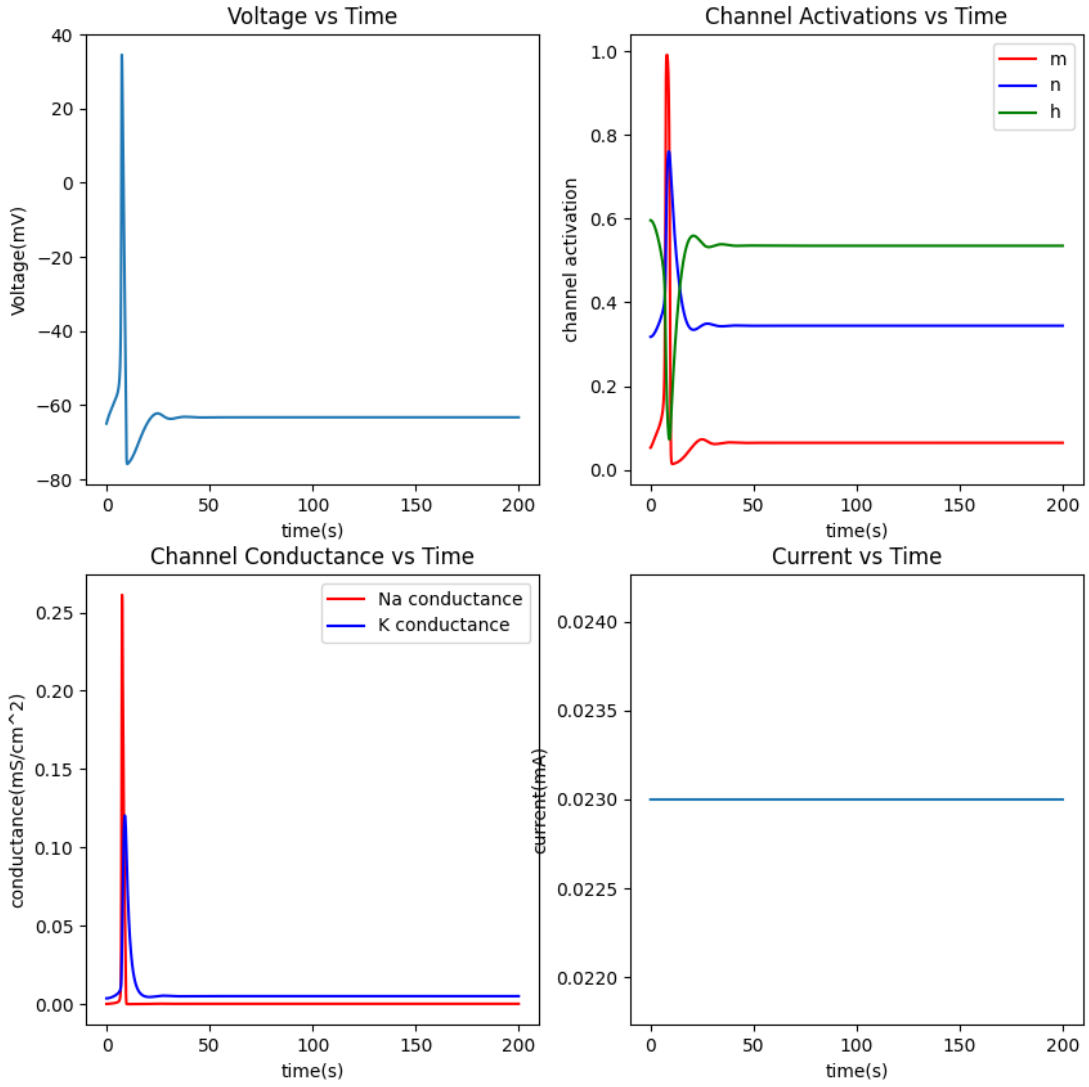
$$n_{iter} = 10000$$

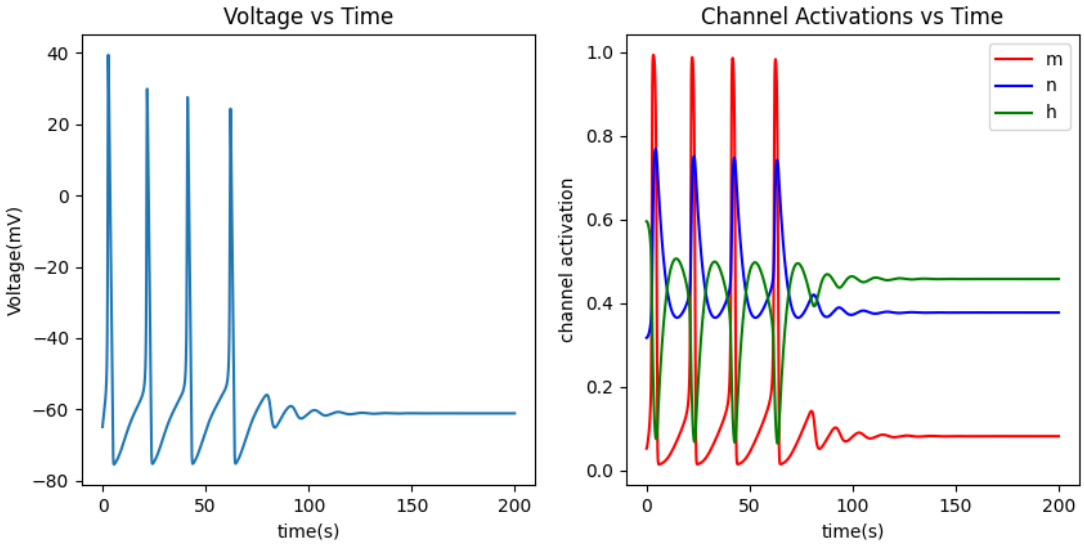
$$threshold = 0mV$$

A resolution of 0.0005 μA was used to calculate the the Spiking Frequency vs Current curve.

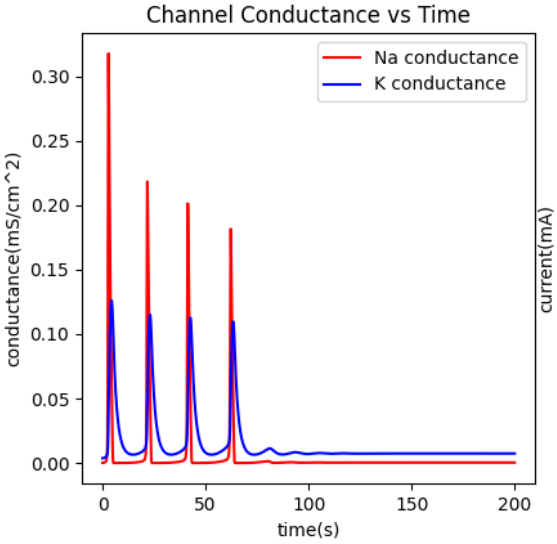
A spike in conductance is observed when an action potential id generated. There is a fall in the magnitude from the first to the second action potential when the limit cycle behaviour is exhibited. Beyond a certain current threshold(0.6 mA) there are periodic perturbations from the the rest potential, but these perturbation are not of sufficient magnitude to be called Action Potential. As expected, after the bifurcation into continuous spiking mode, the average peak voltage decreases continuously while the frequency increases. Also average peak sodium conductance decreases with current while average peak potassium conductance increases. This may seem counterintuitive, but due to the smaller magnitude of the potassium conductance, as the number of peaks increase the average value tends to approximately the same or increase slightly.

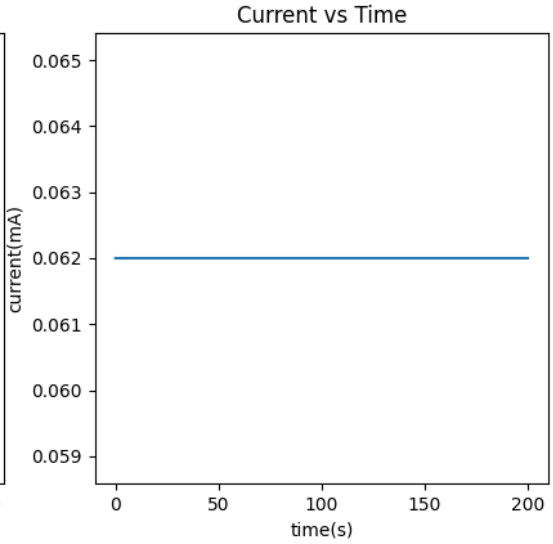
The following are the plots for I_1, I_2 and I_3 respectively.

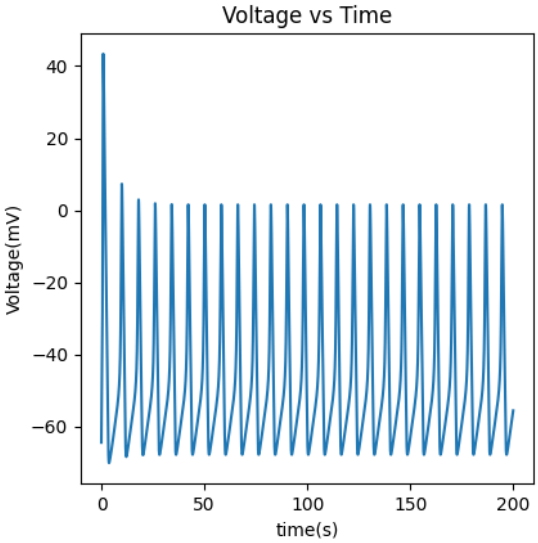


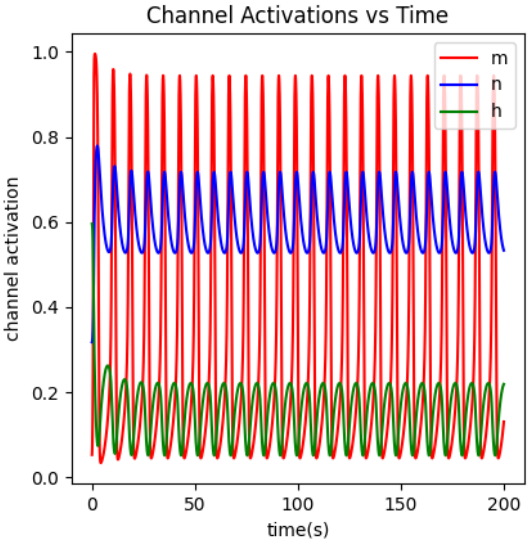

Voltage vs Time
Voltage(mV)
time(s)

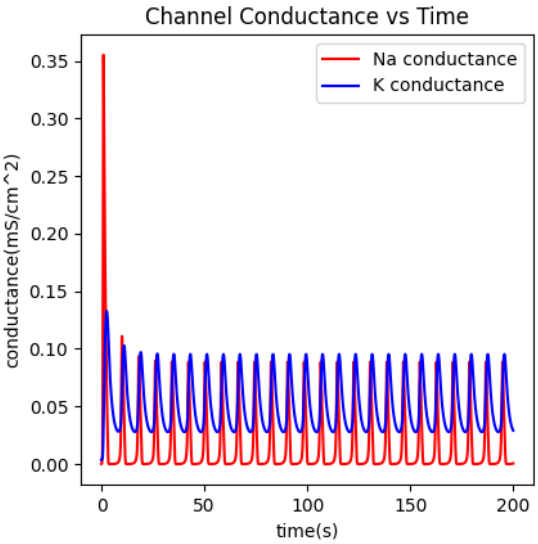
Channel Activations vs Time
channel activation
time(s)
m
n
h

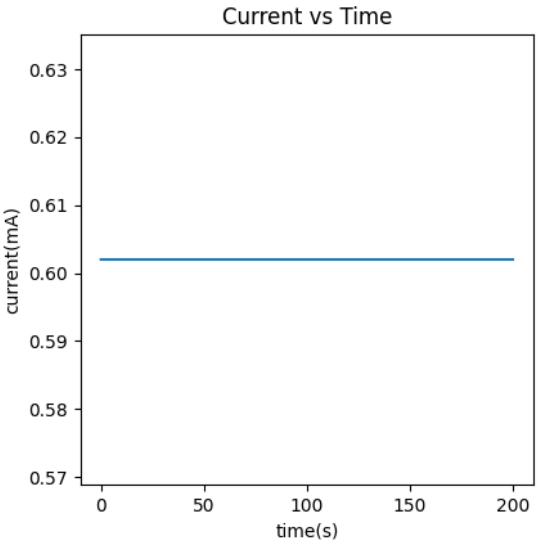

Channel Conductance vs Time
conductance(mS/cm^2)
time(s)
Na conductance
K conductance


Current vs Time
current(mA)
time(s)


Voltage vs Time
Voltage(mV)
time(s)


Channel Activations vs Time
channel activation
time(s)
m
n
h


Channel Conductance vs Time
conductance(mS/cm^2)
time(s)
Na conductance
K conductance


Current vs Time
current(mA)
time(s)

Run the module main.py to run replicate the results.

Refer to the following link for a more detailed analysis of the HH model using different pattens of input currents- https://github.com/shandilya1998/HodgkinHuxleyNeuralModel