Neural Circuit Representation Through the Interplay Correlation of Turbulent Fluid Flow and Action Potential from FMRI Mapping

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***Abstract* - Simulation of neural circuits in the brain has been the focus of research from several academic disciplines. In this paper, preliminary comparisons are made between brain activity and turbulent fluid flow. The interplay correlation is drawn from the mathematics of turbulent flow in fluid dynamics, and action potential from FMRI mapping of the brain. The results are drawn from the correlation of the analysis of kinetic energy in the two processes. This work requires heavy analysis of FMRI mapping data, to strengthen the interplay correlation. The results from this study may be able to inform more accurate physical models, and thus more accurate and robust simulations of the brain**

I. INTRODUCTION

Brain simulation is a growing field that involves cutting edge technologies and ideas. Accurate and robust neural simulations require a simulation paradigm which mimics brain-like functions and processes in a way that can project and multiply results. Even though there are paradigms currently used, there is always a need for improvement and innovation. Some brain simulators tend to get more detailed, but they do not get more accurate. There are many ways to simulate aspects of the brain, through machine learning [9], artificial intelligence [1], and computational neuroscience [10], just to name a few.

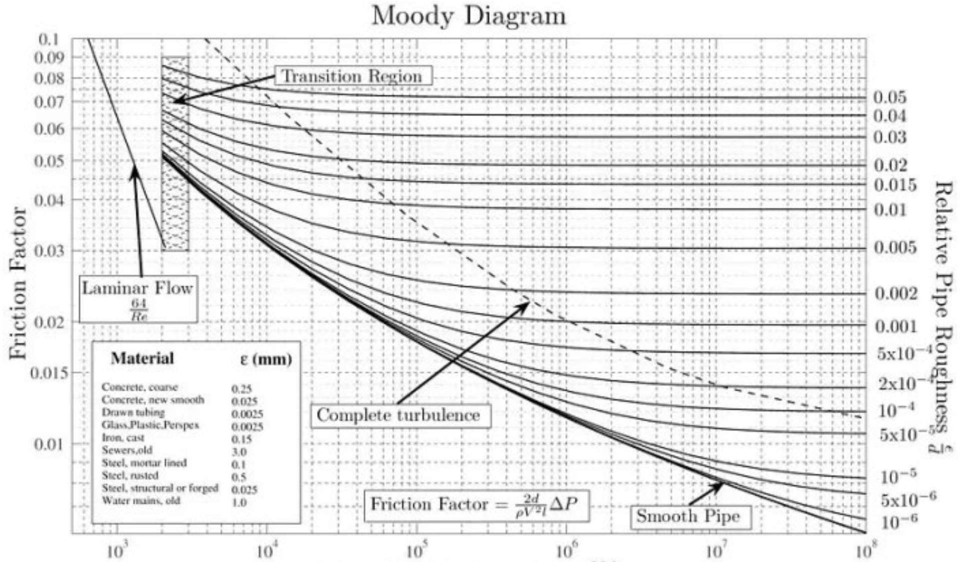
II. METHODS

The focus is on the Reynolds number for fluid flow to determine the flow within the neurons. Reynolds number, Re = VDρ/μ [8]. Velocity, Density, and Viscosity will be based on the characteristics of cerebrospinal fluid [11]. The velocity of cerebrospinal fluid traveling through the cerebral aqueduct is 8 cm/s [6]. The chord width of a neuron is .01cm [3]. The density of the cerebrospinal fluid is based on the average man in the range of 1.00064 +/- 0.00012 g/ ml [7]. The Viscosity of cerebrospinal fluid at 98.6 Fahrenheit is in the range of 0.7-1 mPa [2]. Reynolds number range of 80 -114.

III. RESULTS AND DISCUSSION

Based on these results, if there is fluid flow in the neurons it is laminar based on the Reynolds number range of 80-114 [8].

In this range, the classic moody chart indicates that laminar flow is not dependent on the vessel surface roughness, though the soft matter of the neuron may cause additional kinetic



Material	**ε (mm)**
Concrete, coarse	0.25
Concrete, new smooth	0.025
Drawn tubing	0.0025
Glass,Plastic,Perspex	0.0025
Iron, cast	0.15
Sewers,old	3.0
Steel, mortar lined	0.1
Steel, rusted	0.5
Steel, structural or forged	0.025
Water mains, old	1.0

Moody chart relating relative pipe roughness to Reynolds Number (Re) for Laminar and turbulent fluid flow.[8] The current work estimates a reynolds number between 80-114 for cerebrospinal fluid, well below the transition region, indicating turbulent fluid flow in a neuron is unlikely.

energy losses. With the observation of turbulence in the brain the calculated Reynolds number indicates that.

Mechanical turbulence does not extend to the neurons. There could be a more accurate equation and description to understand the kind of flow through the neurons. The observation of fluid flow in the brain and the effects it has on the neurons can still set a foundation for robust and more accurate brain simulations.

Other forms of turbulence, beyond the standard mechanical variety described above, will be the focus of future efforts. It is likely that these will have an even greater effect on neural processes, as brain activity is largely electro magnetic. The kinds of turbulence include Forced isotropic turbulence, Forced MHD turbulence, Channel flow, and Homogeneous buoyancy driven turbulence. The expansion of the turbulence and neural circuits comparison is done to elaborate on the fluid flow that is already observed in the brain.

If there is a more accurate correlation of fluid flow and neuronal functions, paradigms can be developed, and better simulations can be devised. There is an abstract way that neuron's function and currently with brain simulations there is a missing functional piece to the computations. If that missing abstract piece is conceptualized and implemented it can bridge a gap between simulators that are created to act like people, and simulators that can actually help people.

IV. CONCLUSION

Brain[1] simulators are developing at high rates for commercial and medical use. There is an ever-growing need for innovation and accuracy in them. To create the most robust and accurate paradigm it is worth looking at the actual functions and aspects of human brains. With so much to learn and understand about both simulation and anatomical brain functions there must be heavy analysis to yield impactful results. Turbulence and its correlation to brain function can set the preliminary concepts for simulation. Turbulence and brain function need to be explored more to conceptualize these ideas. While exploring turbulence and brain function, if the results can't contribute to simulation factors now, hopefully it can expand on our perceptions of the brain and understanding.

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