

Evaluation Results

1. Figure 8 is a signal captured during the head-impact experiment. The signal was transformed into a frequency domain, and figure 9 is the result.
2. After the experiment, we can see that the sampling rates should be set higher than 300Hz. The time interval of HIC in the formula has been limited to 15 microseconds. Due to this, I defined the sampling rates of my warning device as 3000Hz.

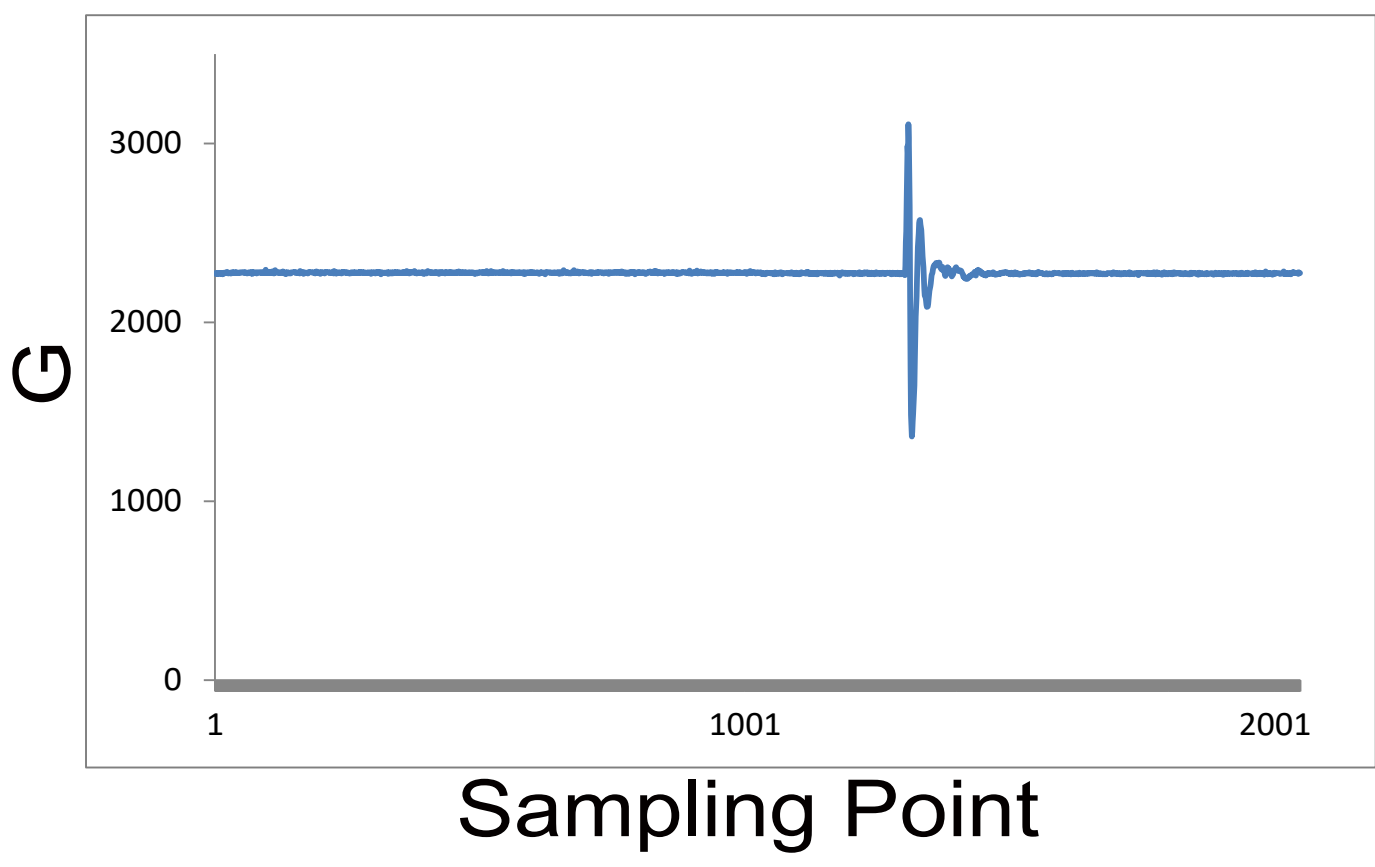


Fig. 8. Signal represented in time domain

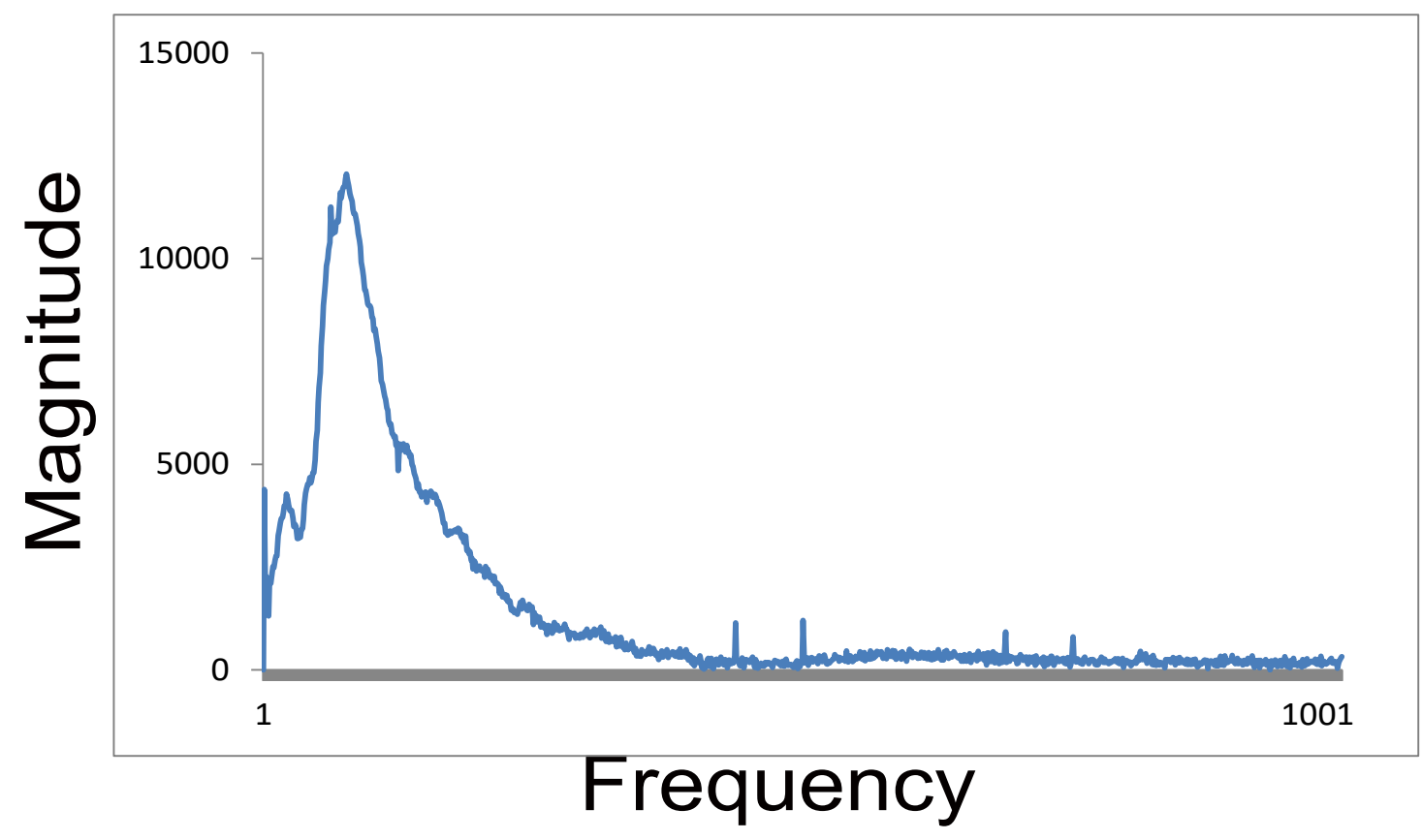


Fig. 9. Signal represented in frequency domain

3. Table 1 is the result of the street dancing experiment. As the highest HIC value for a dance move (movement 4) approaches 39, it shows that street dancing has a high potential for damaging the brain.
4. Table 2 is the result of the amusement ride experiment. The HIC values are lower than those in the dancing experiment, which indicates that the rides have a negligible effect on brain injury.
5. Table 3 shows the results of the dancing experiment which was collected by three sensors. Three sensors were placed in different locations on the head. The result shows HIC values in different locations have apparent differences.

Table 1. Results of dancing experiment

	Duration 1		Duration 2		Duration 3	
	G	HIC	G	HIC	G	HIC
Movement 1	14.2	3.3	11.1	2.9	5.5	0.4
Movement 2	10.1	3.1	8.7	3.2	7.8	2.3
Movement 3	8.5	2.7	5.8	1.0	7.4	2.0
Movement 4	29.8	38.6	16.6	6.4	15.0	3.0
Movement 5	11.6	3.8	9.0	1.7	6.8	3.0
Movement 6	20.6	12.0	13.0	4.1	12.8	3.7
Movement 7	11.8	6.9	11.8	7.1	10.0	4.7
Movement 8	16.5	8.4	16.4	10.2	11.0	4.3
Movement 9	5.8	1.2	5.4	1.0	4.4	0.6
Movement 10	7.4	1.8	6.5	1.4	5.8	1.1
Movement 11	7.1	1.8	4.4	0.6	3.1	0.2
Movement 12	4.0	0.5	3.8	0.3	3.9	0.4
Movement 13	5.4	0.9	4.9	0.8	3.1	0.2

Table 2. Results of amusement ride experiment

	Duration 1		Duration 2		Duration 3	
	G	HIC	G	HIC	G	HIC
Ride 1	11.2	3.3	11.0	3.2	7.8	1.6
Ride 2	11.5	2.0	11.6	1.2	11.6	2.3
Ride 3	5.0	0.6	1.7	0.1	1.7	0.1
Ride 4	3.8	0.1	3.6	0.3	4.0	0.1
Ride 5	3.2	0.2	3.4	0.1	2.6	0.1
Ride 6	4.6	0.5	3.8	0.4	3.6	0.1

Table 3. Result of dancing experiment collected by three sensors

	Movement 4	
	G	HIC
Right (max)	13.7	25.2
Middle (max)	7.5	5.6
Left (max)	6.8	4.4

6. Figure 10 shows the result of the continuous head impact model simulating various head-impacting actions.
7. Figure 11 shows the consistency of the proposed model of CHIMERA in this study.

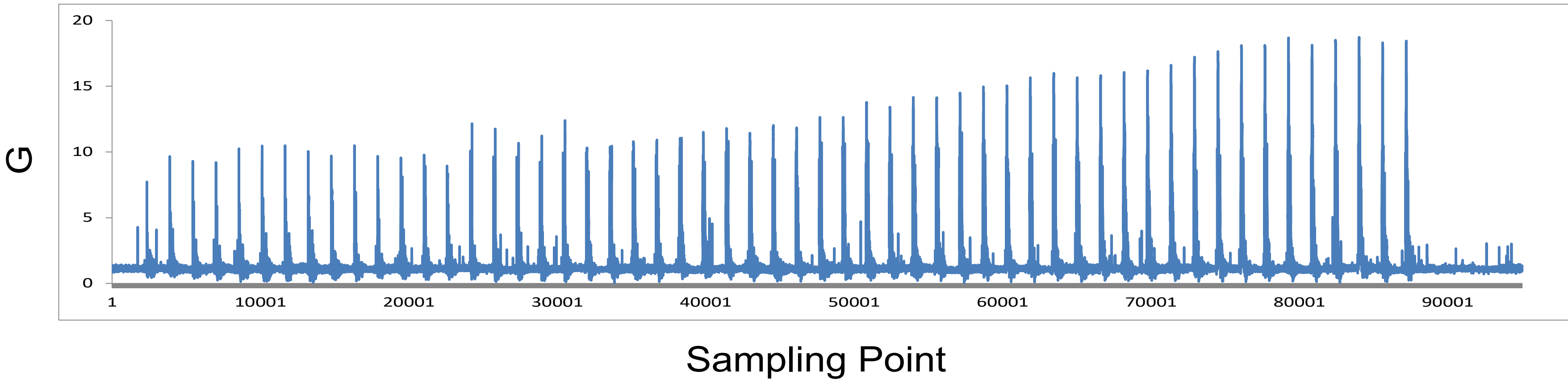
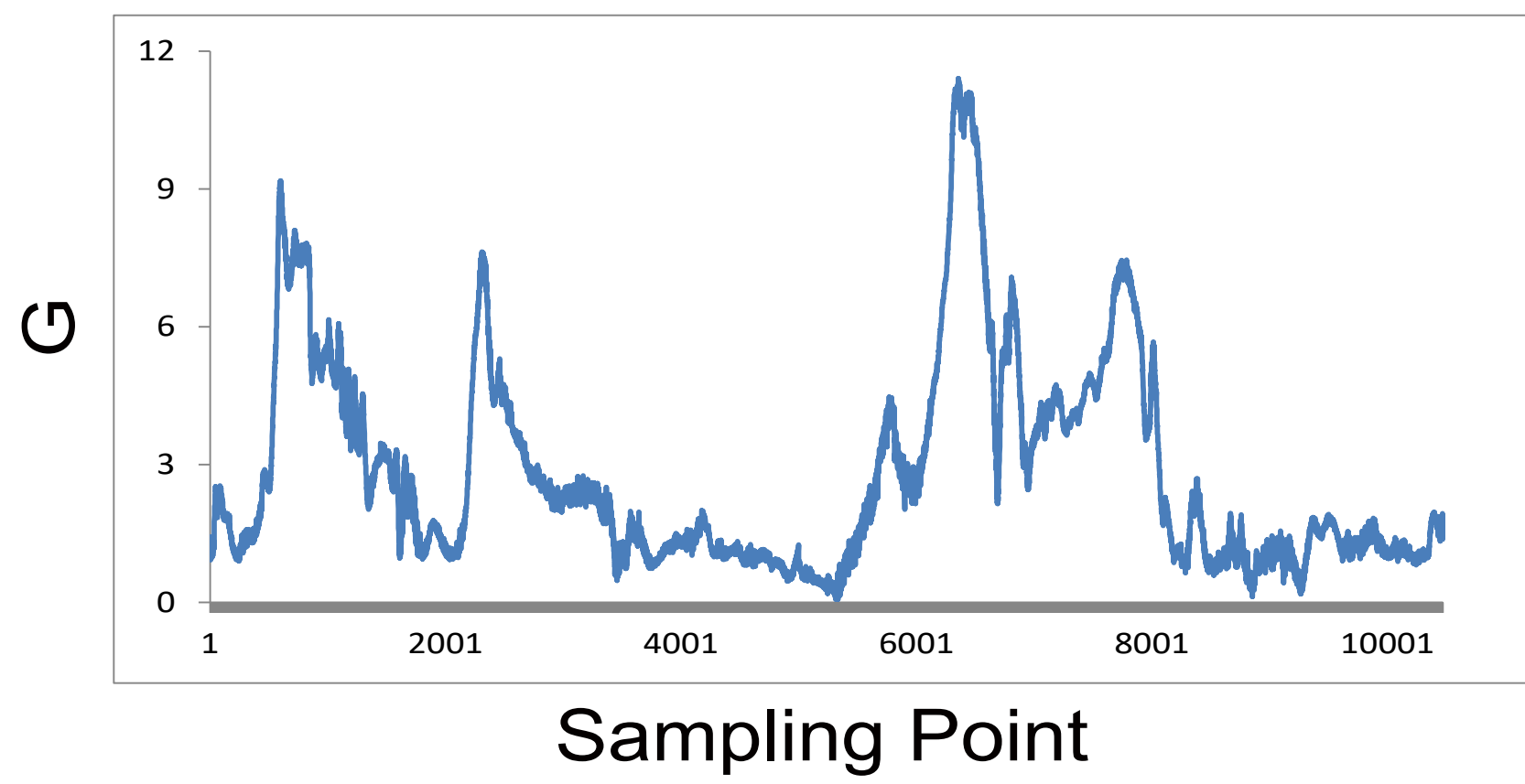
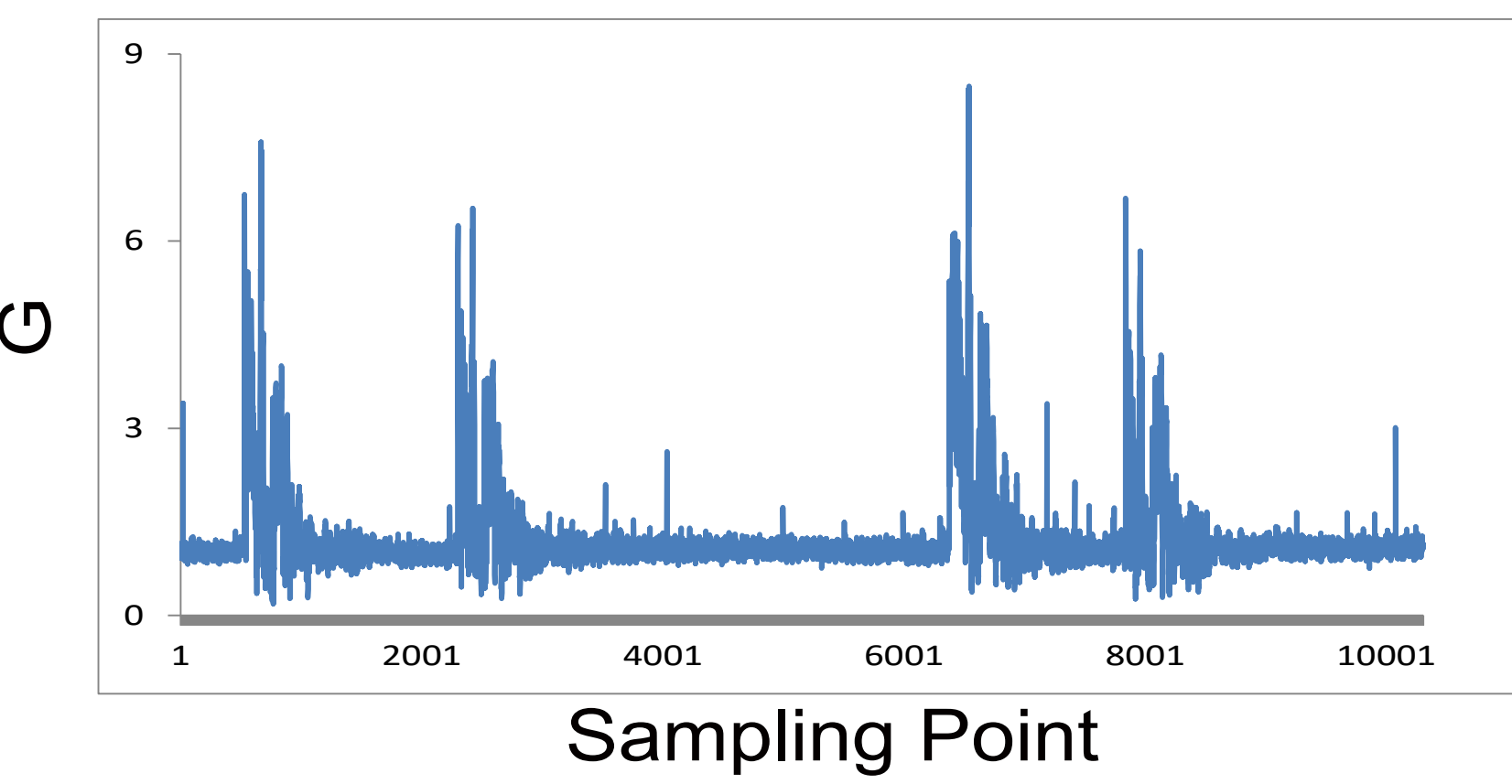


Fig. 10. The result of continuous head impact simulator



(a) Raw data



(b) The output data of simulator

Fig. 11. The consistency of the proposed model of CHIMERA

8. Figure 10 shows the result of the correlation value of figure 11(a) and (b).
9. The higher the correlation value is, the more similar the figures become.
10. The highest point on figure 12 shows that the simulator can accurately simulate the data.

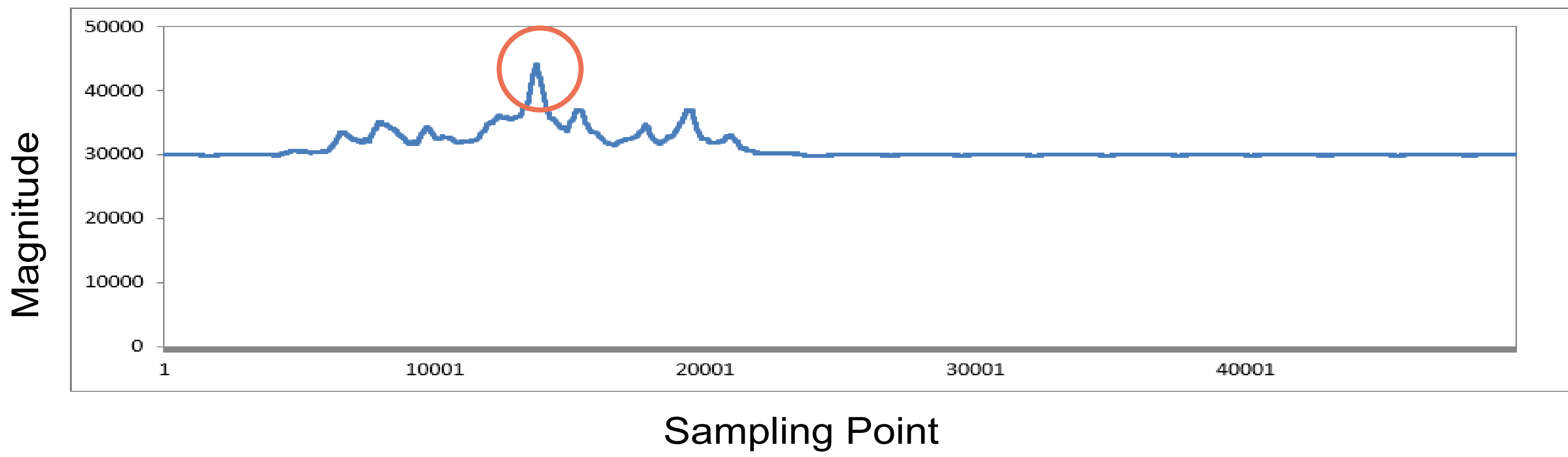


Fig. 12. Correlation value of figure 8(a) and 8(b)

Conclusions and Future Applications

Conclusions

1. With the wearable mTBI warning system, the potential for an activity leading to brain injury can be examined without using sophisticated instruments. Based on medical research, the threshold of the wearable mTBI waring system is set to be HIC = 51.
2. Street dance has potential to lead to brain injury. Its HIC value is 38.6, which is close to the threshold value defined in the study.
3. Even if it's very intense, the amusement rides barely contribute to brain damage. The most significant HIC value measured is 3.3, which is far from the critical value.
4. A continuous impact model of CHIMERA based on electromagnetism was introduced, this eliminate the drawbacks of current pressure-based CHIMERA.

Future Applications

1. Through interdisciplinary research, the effects of multiple impacts on brain damage can be studied through the dissection of the mice's brains.
2. Integrate the wearable device with smartphones and the Cloud to collect more data from people, which can then be used to construct a database of brain injury. Adding more sensors, e.g., gyro sensors, to the wearable device will enhance the accuracy.

References

[1] Dhananjay R Namjoshi, Wai Hang Cheng , Kurt McInnes , Kristina M Martens , Peter A Crompton , Cheryl L Wellington. (n.d.). CHIMERA (Closed Head Injury Model of Engineered Rotational Acceleration) Is a Novel and Clinically Relevant Traumatic Brain Injury Model in Rodents.

[2] Namjoshi DR, Cheng WH, Bashir A, Wilkinson A, Stukas S, Martens KM, Whyte T, Abebe ZA, McInnes KA, Crompton PA, Wellington CL. (2017). Defining the biomechanical and biological threshold of murine mild traumatic brain injury using CHIMERA (Closed Head Impact Model of Engineered Rotational Acceleration). Experimental Neurology, 292, 80-91.

[3] McHenry, B. G. (n.d.). Head Injury Criterion and the ATB.

[4] Dhananjay R Namjoshi, Wai Hang Cheng , Kurt McInnes , Kristina M Martens , Peter A Crompton , Cheryl L Wellington. (n.d.). CHIMERA (Closed Head Injury Model of Engineered Rotational Acceleration) Is a Novel and Clinically Relevant Traumatic Brain Injury Model in Rodents. Retrieved from http://ibrc.osu.edu/wp-content/uploads/2015/05/Cheng_Manuscript_2016.pdf

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