Supporting Information to "Advanced Deep Learning Spectroscopy of Scalogram Infused CNN Classifiers for Robust Identification of Post-Hypoxic Epileptiform EEG Spikes"

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Appendix A

Table S1. Results of the WS-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 13 layers)

Trained and validated on Sheep No.	No. of patterns in the Train and Validation Dataset	Tested on Sheep
2,3,4,5,6,7	4567	1
1,3,4,5,6,7	4751	2
1,2,4,5,6,7	4731	3
1,2,3,5,6,7	3372	4
1,2,3,4,6,7	4088	5
1,2,3,4,5,7	4466	6
1,2,3,4,5,6	4085	7

Overall performance of the 13 layers WS-CNN in the entire 6 hours	**99.03±1.66**

Table S2. Results of the WS-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 9 layers)

Trained and validated on Sheep No.	No. of patterns in the Train and Validation Dataset	Tested on Sheep
2,3,4,5,6,7	4567	1
1,3,4,5,6,7	4751	2
1,2,4,5,6,7	4731	3
1,2,3,5,6,7	3372	4
1,2,3,4,6,7	4088	5
1,2,3,4,5,7	4466	6
1,2,3,4,5,6	4085	7

Overall performance of the 9 layers WS-CNN in the entire 6 hours	**98.54±1.43**

Table S3. Results of the WS-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 5 layers)

Trained and validated on Sheep No.	No. of patterns in the Train and Validation Dataset	Tested on Sheep
2,3,4,5,6,7	4567	1
1,3,4,5,6,7	4751	2
1,2,4,5,6,7	4731	3
1,2,3,5,6,7	3372	4
1,2,3,4,6,7	4088	5
1,2,3,4,5,7	4466	6
1,2,3,4,5,6	4085	7

Overall performance of the 5 layers WS-CNN in the entire 6 hours	**97.70±1.99**

Appendix B

Table S4. Results of the WF-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 11 layers)

Trained and validated on Sheep No.	No. of patterns in the train dataset	Tested on Sheep No.	No. of patt
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638
1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 11 layers WF-CNN in the entire 6 hours	**99.44±0.44**

Table S5. Results of the WF-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 9 layers)

Trained and validated on Sheep No.	No. of patterns in the train dataset	Tested on Sheep No.	No. of patt
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638
1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 9 layers WF-CNN in the entire 6 hours	**99.33±0.36**

Table S6. Results of the WF-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 7 layers)

Trained and validated on Sheep No.	No. of patterns in the train dataset	Tested on Sheep No.	No. of patt
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638

1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 7 layers WF-CNN in the entire 6 hours	**98.07±1.92**

Table S7. Results of the WF-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 5 layers)

Trained and validated on Sheep No.	**No. of patterns in the train dataset**	**Tested on Sheep No.**	**No. of patt**
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638
1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 5 layers WF-CNN in the entire 6 hours	**97.96±1.48**

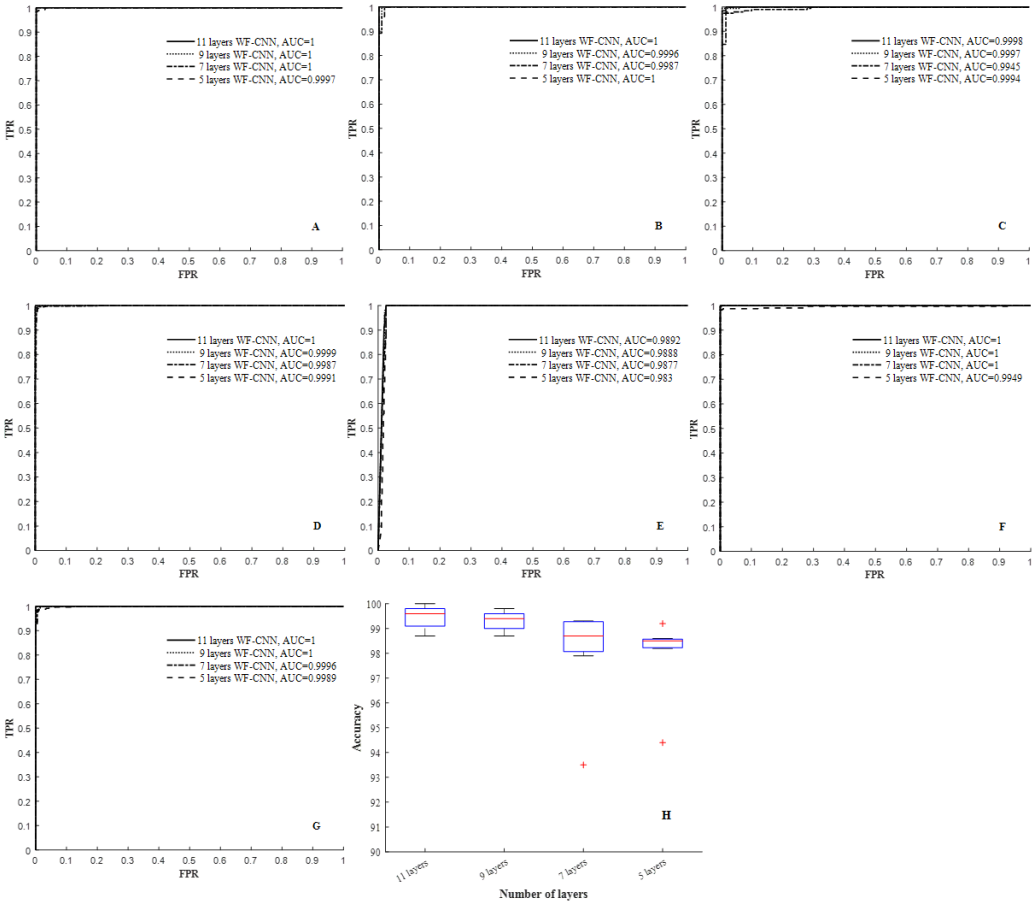

Figure 1: (A) to (G): ROC curves and the corresponding AUC values from 7-fold cross-validation of the results along 6 hours of 1024Hz data across 7 preterm fetal sheep (42 hours total) using 11, 9, 7 and 5 layers in the proposed WF-CNN classifier. The data for each WF-CNN classifier are presented as mean ± SD in the boxplot (H) demonstrating reduced accuracy and increased variability with fewer layers.

Appendix C

Table S8. Results of the 1D-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 11 layers)

Trained and validated on Sheep No.	No. of patterns in the train dataset	Tested on Sheep No.	No. of patt

2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638
1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 11-layers 1D-CNN in the entire 6 hours	**99.27±0.51**

Table S9. Results of the 1D-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 9 layers)

Trained and validated on Sheep No.	**No. of patterns in the train dataset**	**Tested on Sheep No.**	**No. of patt**
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638
1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 9 layers 1D-CNN in the entire 6 hours	**98.07±2.63**

Table S10. Results of the 1D-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 7 layers)

Trained and validated on Sheep No.	**No. of patterns in the train dataset**	**Tested on Sheep No.**	**No. of patt**
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638

1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 7 layers 1D-CNN in the entire 6 hours	**96.83±2.83**

Table S11. Results of the 1D-CNN classifier for post-HI spike transient identification in experimental data (entire 6 hours – 5 layers)

Trained and validated on Sheep No.	**No. of patterns in the train dataset**	**Tested on Sheep No.**	**No. of patt**
2,3,4,5,6,7	4567	1	443
1,3,4,5,6,7	4751	2	259
1,2,4,5,6,7	4731	3	279
1,2,3,5,6,7	3372	4	1638
1,2,3,4,6,7	4088	5	922
1,2,3,4,5,7	4466	6	544
1,2,3,4,5,6	4085	7	925

Overall performance of the 5 layers 1D-CNN in the entire 6 hours	**95.86±3.74**

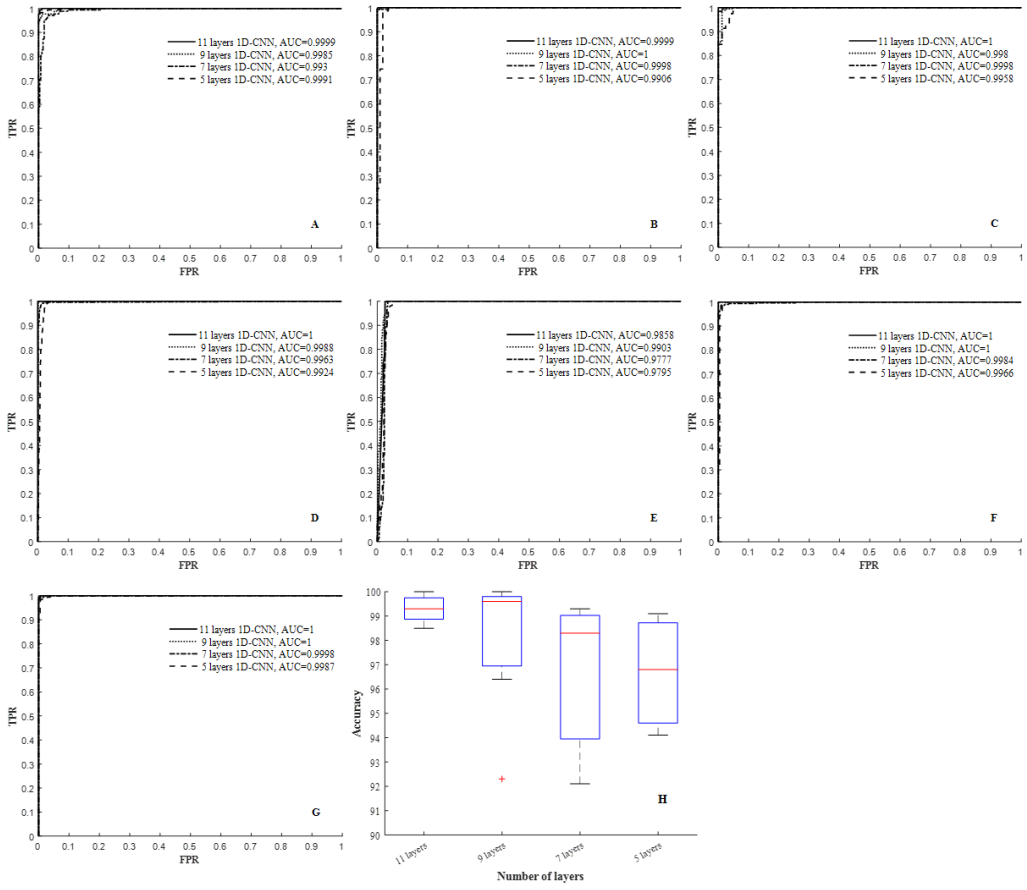

Figure 2: (A) to (G): ROC curves and the corresponding AUC values from 7-fold cross-validation of the results along 6 hours of 1024Hz data across 7 preterm fetal sheep (42 hours total) using 11, 9, 7 and 5 layers in the 1D-CNN classifier. The data for each 1D-CNN classifier are presented as mean ± SD in the boxplot (H) demonstrating reduced accuracy and increased variability with fewer layers.

Appendix D

Table S12. Results of the wavelet-Type-I-Fuzzy classifier for post-HI spike transient identification in experimental data (entire 6 hours)

Tested on Sheep No.	No. of patterns in the Test-set	TP hits	FP hits	FN hits	Sensitivity [%]	Selecti

1	443	441	3	2	99.55	99.32
2	259	258	4	1	99.61	98.47
3	279	275	8	4	98.57	97.17
4	1638	1621	9	17	98.96	99.45
5	922	916	6	6	99.35	99.35
6	544	536	5	8	98.53	99.08
7	925	921	4	4	99.57	99.57

Overall performance of the WT-Type-I-Fuzzy in the entire 6 hours	**99.04±0.53**

Table S13. Results of the FFT-Type-I-Fuzzy classifier for post-HI spike transient identification in experimental data (entire 6 hours)

Tested on Sheep No.	**No. of patterns in the Test-set**	**TP hits**	**FP hits**	**FN hits**	**Sensitivity [%]**	**Selecti**
1	443	438	6	5	98.87	98.65
2	259	254	7	5	98.07	97.32
3	279	272	9	7	97.49	96.80
4	1638	1615	13	23	98.60	99.20
5	922	911	11	11	98.81	98.81
6	544	534	9	10	98.16	98.34
7	925	921	8	4	99.57	99.14

Overall performance of the FFT-Type-I-Fuzzy in the entire 6 hours	**98.42±0.71**

Table S14. The architecture of the proposed deep WF-CNN classifier

Layers	**Type**	**No. of Neurons (Output layer)**	**Kernel size**	**Stride**	**Padding**	**No. of**
0-1	Conv.	72×3	[3 3]	1	1	32
1-2	Max_pool	36×2	[2 1]	2	0	
2-3	Conv.	36×2	[3 3]	1	1	64
3-4	Max_pool	18×1	[2 2]	2	0	
4-5	Conv.	18×1	[3 3]	1	1	128
5-6	Max_pool	9×1	[2 1]	2	0	

6-7	Conv.	9×1	[3 3]	1	1	256
7-8	Max_pool	4×1	[3 1]	2	0	
9-11	Fully_connected	1280				
	Fully_connected	20				
	Fully_connected	2				
Output	Softmax &Classification					

Table S15. The architecture of the proposed deep 1D-CNN classifier

Layers	**Type**	**No. of Neurons (Output layer)**	**Kernel size**	**Stride**	**Padding**	**No. of Filters**
0-1	Conv.	72×1	[3 1]	1	0	4
1-2	Max_pool	70×1	[2 1]	2	0	
2-3	Conv.	35×1	[3 1]	1	0	6
3-4	Max_pool	33×1	[3 1]	2	0	
4-5	Conv.	16×1	[3 1]	1	0	8
5-6	Max_pool	14×1	[2 1]	2	0	
6-7	Conv.	7×1	[3 1]	1	0	10
7-8	Max_pool	5×1	[3 1]	2	0	
9-11	Fully_-connected	40				
	Fully_-connected	10				
	Fully_-connected	2				
Output	Softmax & Classification					

Appendix F

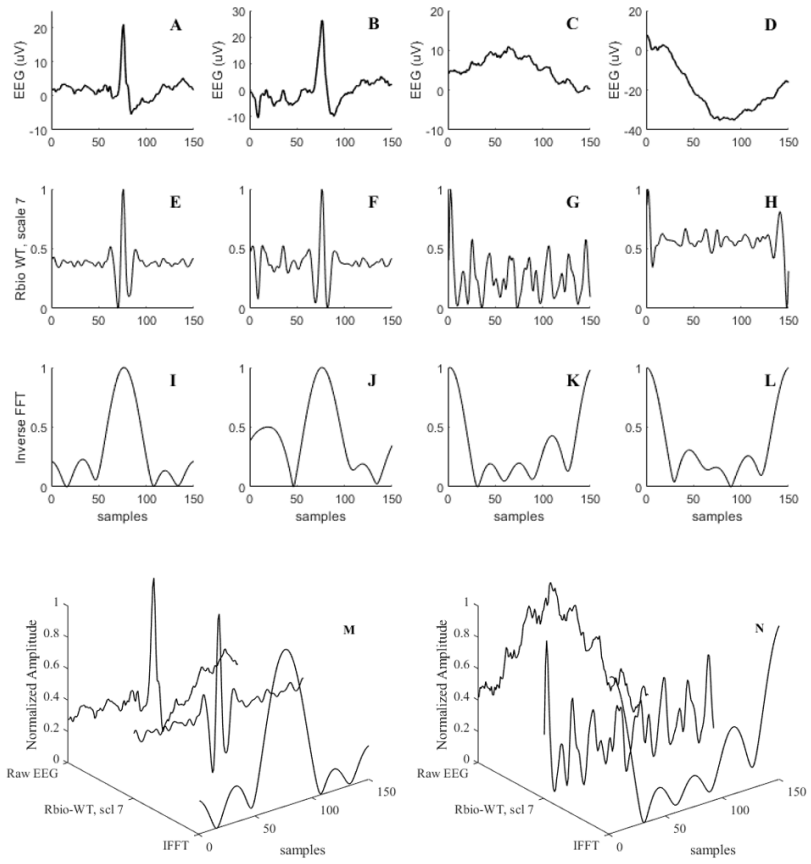

Figure 3: Examples of post-HI micro-scale ECoG spike transients (A, B) and non-spike ECoG background (C, D). The corresponding reverse biorthogonal wavelet transforms (rbio2.8) of the spikes (E, F) and non-spikes (G, H) at scale 7. The corresponding inverse Fourier transforms of the spikes (I, J) and non-spikes (K, L) using band-pass filter 80-120 Hz. The combination of these three time-series (to form a matrix of size 72×1×3) was used for training and validation of the WF-CNN classifier (M, N).

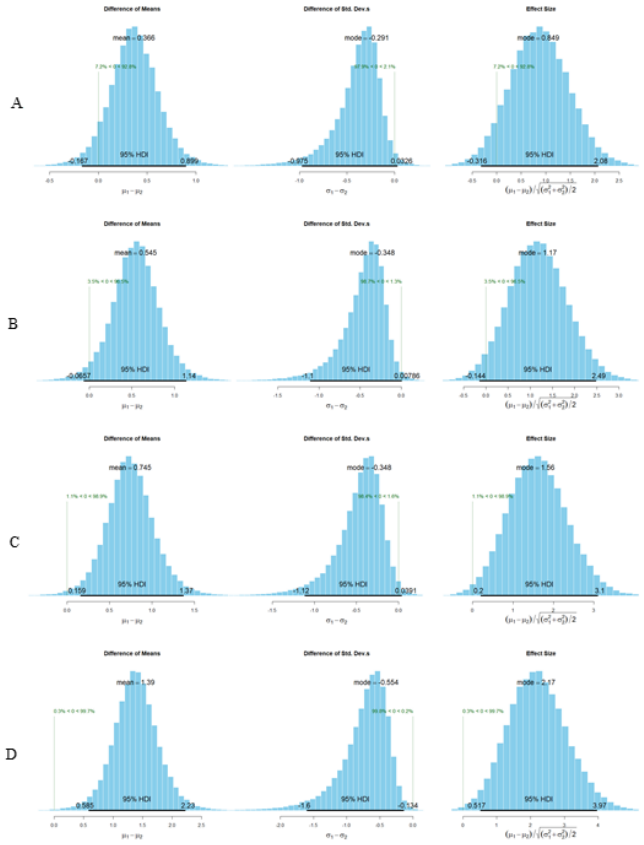

Figure 4: Bayesian estimation analysis for (A) 17-layers WS-CNN vs 11-layers WF-CNN (B) 17-layers WS-CNN vs 11-layers 1D-CNN (C) 17-layers WS-CNN vs WT-Fuzzy (D) 17-layers WS-CNN vs FFT-Fuzzy. Results demonstrate how the deepest WS-CNN could statistically outperform the other classifiers.

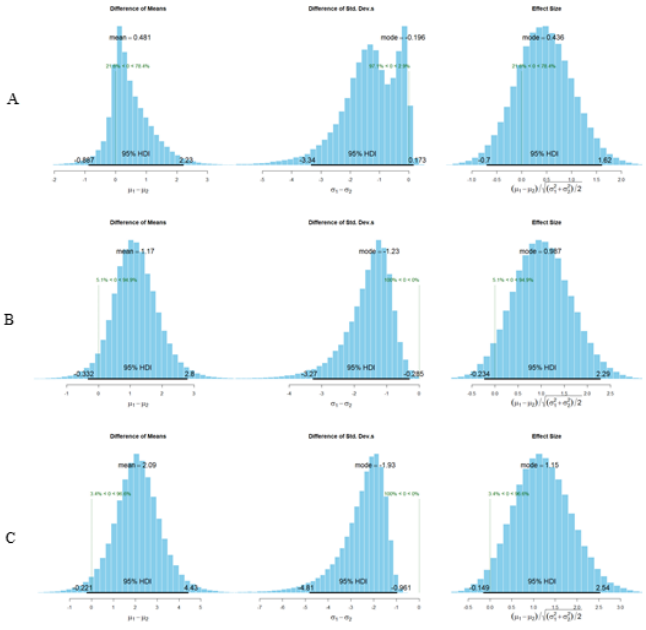

Figure 5: Bayesian estimation analysis for (A) 17-layers WS-CNN vs 13-layers WS-CNN (B) 17-layers WS-CNN vs 9-layers WS-CNN (C) 17-layers WS-CNN vs 5-layers WS-CNN. Results demonstrate how the deepest WS-CNN could statistically outperform other WS-CNN classifiers with shallower structures.