Seizure Type Classification Using EEG Based on Gramian Angular Field Transformation and Deep Learning

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Citations: 25

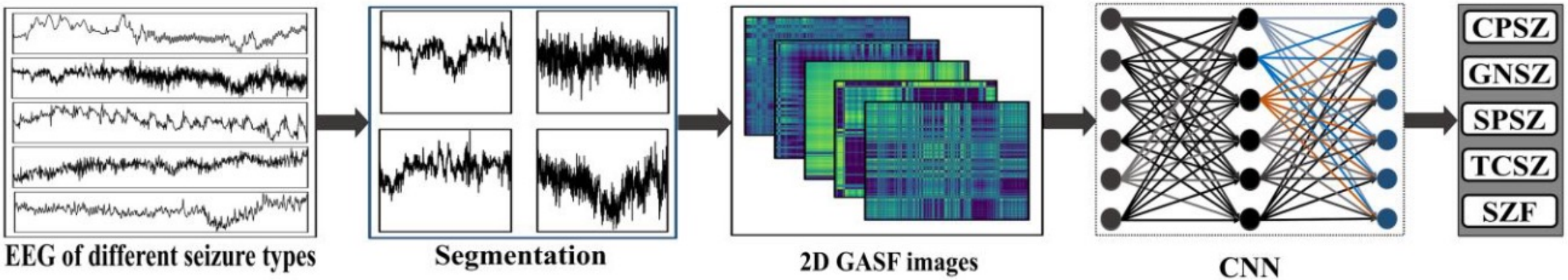
Motivation

- Classification of seizure types plays a crucial role in diagnosis and prognosis of epileptic patients.
- Most of the works are concerned with seizure detection only (i.e. vs. normal)
- This study presents a novel approach based on DL
- Used to classify four types of seizures:
  - ❑complex partial seizure,
  - ❑generalized non-specific seizure,
  - ❑simple partial seizure,
  - ❑tonic-clonic seizure,
  - ❑**and seizure-free**

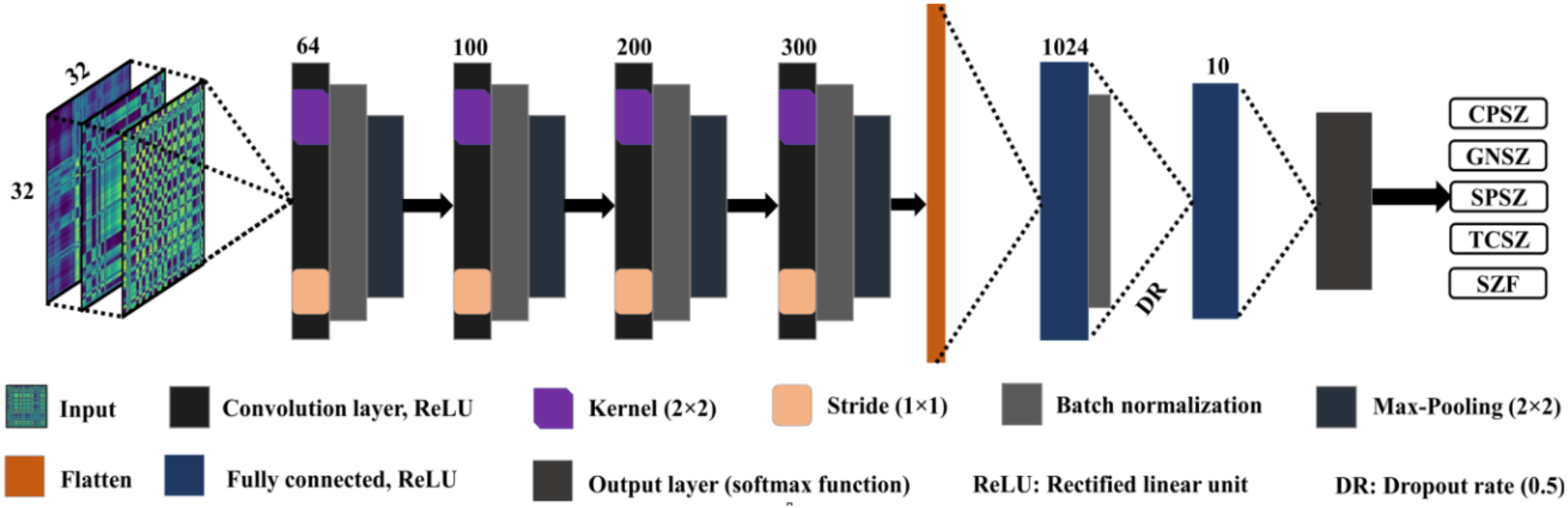
Proposed method

- CNN has been employed to perform both automatic feature extraction and classification.
- 2D images generated from 1D EEG using gramian angular summation field.
- Images fed into CNN to perform binary and multi-class classification tasks.

Outline of proposed framework

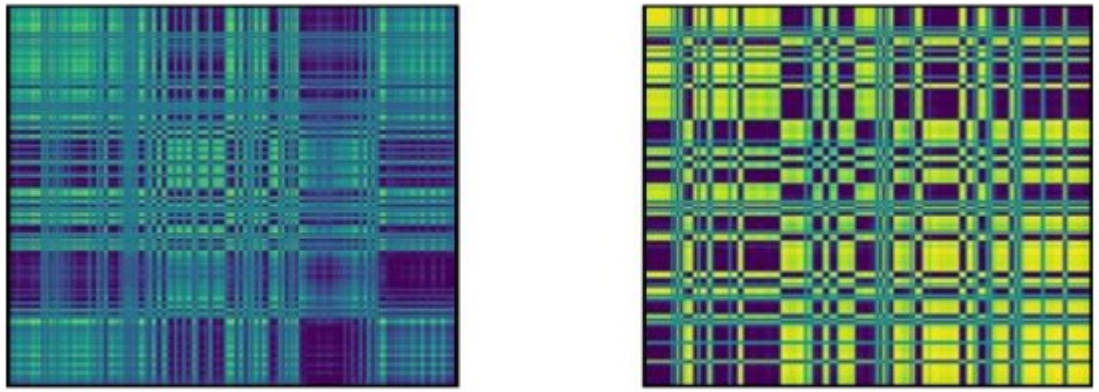


CNN architecture



GASF image of two seizure types

- (a) CPSZ vs. (b) GNSZ
- Images resized to 32 * 32
- Model trained by Adam (β1= 0.9, β2 =0.99,decay rate =10-6) optimizer and categorical cross-entropy as loss function.



(a) (b)

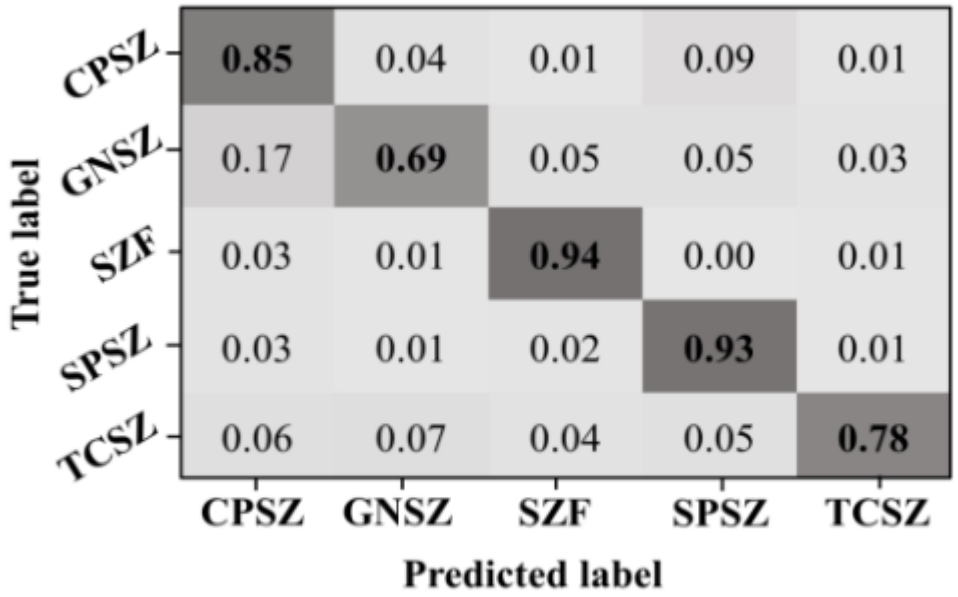
Dataset Description

- Seizure subtypes: EEG dataset of Temple University Hospital.
- Unipolar montages of 19 common channels: C3, C4, Cz, F3,F4, F7, F8, FP1, FP2, Fz, O1, O2, P3, P4, Pz, T3, T4, T5, and T6.
- Sampling rate of 250Hz.
- The EEG recording of each channel has been segmented in the length of 10s with 50% over

TABLE I
DATASET DESCRIPTION

Seizure types	Duration (*s*)
Complex partial seizure (CPSZ)	1448.48
Generalized non-specific seizure (GNSZ)	1606.16
Simple partial seizure (SPSZ)	1328.50
Tonic clonic seizure (TCSZ)*	517.17
Seizure-free (SZF)	1386.11

Results



The normalized confusion matrix obtained in classification of CPSZ, GNSZ, SPSZ, TCSZ, and SZF.

Binary classification

TABLE II: PM OF BINARY CLASSIFICATION

Seizure types		PM (%)	
		A_{cc}	$F1$
CPSZ	GNSZ	84.51	85.0
	SZF	92.51	93.0
	SPSZ	92.85	93.0
	TCSZ	92.49	90.0
GNSZ	SZF	90.04	90.0
	SPSZ	95.00	95.0
	TCSZ	85.76	85.0
SPSZ	SZF	96.01	96.0
	TCSZ	92.15	92.0
TCSZ	SZF	91.08	92.0

3-class problem

TABLE III: PM OF CLASSIFICATION OF 3 SEIZURE TYPES

Seizure types			PM (%)	
			A_{cc}	$F1$
CPSZ	GNSZ	SZF	76.87	77.0
		SPSZ	81.35	82.0
		TCSZ	79.87	80.0
	SPSZ	TCSZ	89.91	90.0
	SZF	SPSZ	88.47	88.0
		TCSZ	78.50	78.0
GNSZ	SZF	SPSZ	88.10	88.0
		TCSZ	82.50	82.0
	SPSZ	TCSZ	87.71	88.0
SPSZ	SZF	TCSZ	86.88	87.0

4- and 5-class problem

TABLE IV: PM FOR CLASSIFICATION OF 4 AND 5 SEIZURE TYPES

Seizure types					PM (%)	
					A_{cc}	$F1$
4–class						
CPSZ	GNSZ	SZF	SPSZ		79.62	80.0
		SZF	TCSZ		79.05	79.0
		SPSZ	TCSZ		79.67	80.0
	SZF	SPSZ	TCSZ		84.18	84.0
GNSZ	SPSZ	SZF	TCSZ		84.19	84.0
5–class						
CPSZ	GNSZ	SPSZ	SZF	TCSZ	84.20	84.0

Comparison with prior work

TABLE V: A COMPARATIVE ANALYSIS

Works	**Methods**	**PM (%)**	
		A_{cc}	$F1$
[5]	EEG, basic CNN	82.14	-
	EEG, AlexNet	84.06	-
[6]	EEG, FFT, CNN	72.20	-
	EEG, FFT, k-NN	88.40	-
This work	**EEG, GASF, CNN**	**96.01**[a]	**96.0**[a]
		89.91[b]	**90.0**[b]
		84.19[c]	**84.0**[c]
		84.20[d]	**84.0**[d]

Note: [a]: binary, [b]: 3– types, [c]: 4– types, [d]: 5– types of seizure