

Automated seizure detection for remote monitoring

Citation for published version (APA):

Raghu, R. (2020). *Automated seizure detection for remote monitoring*. [Doctoral Thesis, Maastricht University]. Maastricht University. <https://doi.org/10.26481/dis.20201207rr>

Document status and date:

Published: 01/01/2020

DOI:

[10.26481/dis.20201207rr](https://doi.org/10.26481/dis.20201207rr)

Document Version:

Publisher's PDF, also known as Version of record

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy

If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

CHAPTER 12

Summary

In this thesis, we focused on database-independent, cross-database evaluation of classification of seizure for remote monitoring of epilepsy patients along with the multi-class classification of epileptic seizures. In this thesis, we contribute novel features and the FBC method to the scientific community.

Chapter 1 gives the general introduction about the thesis including problem statement, objective, and outline of the thesis. In Chapters 2 and 3, we showed that the MD and SDI features are computationally efficient against state-of-the-art methods and suitable for seizure detection. Wavelet-based entropies were studied and optimal sub-bands using different mother wavelets were identified for seizure detection in Chapters 4 and 5. Following the previous results of SDI and MD, in Chapter 6, we proposed AM-FBC to overcome the inter-subject variability in feature distribution. Finally, a cross-database evaluation was performed in Chapter 7 using five EEG databases collected from different centers. We used AM-FBC to overcome the inter-databases variability in feature distribution, smoothing of train and test data and post-processing to achieve significant results. The cross-database model was used to build a mobile-based EEG analysis for seizure monitoring. Chapter 9 describes transfer learning and CNN based multi-class classification of seizure types. Overall, extract the image features approach outperformed the transfer learning approach. Finally, this thesis is concluded with the feasibility of a mobile-based app for remote monitoring of epilepsy patients using the database-independent optimized algorithm in Chapter 10.

The results of this thesis contribute towards the clinical aspect in terms of reducing the neurologist burden in reviewing long-term EEG, speed up the treatment procedure and monitor epilepsy patients using a mobile app.

Samenvatting

In dit proefschrift hebben we ons gericht op database-onafhankelijke, databaseoverschrijdende evaluatie ten behoeve van classificatie van epileptische aanvallen voor remote monitoring bij epilepsiepatiënten.

Hoofdstuk 1 geeft de algemene inleiding over de scriptie inclusief probleemstelling, doelstelling en overzicht van de scriptie. In de Hoofdstukken 2 en 3 hebben we aangetoond dat de MD- en SDI-functies rekenkundig efficiënt zijn en geschikt voor automatische aanvals detectie. Op wavelet gebaseerde entropieën werden bestudeerd en geoptimaliseerde subbanden met behulp van verschillende moederwavelets werden geïdentificeerd voor aanvalssdetectie in Hoofdstukken 4 en 5. In navolging van de eerdere resultaten van SDI en MD, in Hoofdstuk 6, stelden we AM-FBC voor om de variabiliteit tussen de onderwerpen in de distributie van functies te ondervangen. Ten slotte werd een databaseoverschrijdende evaluatie uitgevoerd in Hoofdstuk 7 met behulp van vijf EEG-databases verzameld uit verschillende centra. We hebben AM-FBC gebruikt om de interdatabase-variabiliteit bij de distributie van functies, en het trainen en testen van gegevens en nabewerking te verbeteren om significante resultaten te bereiken. Het cross-database model werd gebruikt om een mobiele toepassing voor EEG-analyse te bouwen. Hoofdstuk 9 beschrijft transfer learning en CNN-gebaseerde multi-class classificatie of aanvals types. Ten slotte wordt dit proefschrift afgesloten met de haalbaarheid van een mobiele app voor monitoring op afstand in epilepsiepatiënten met behulp van het database-onafhankelijke geoptimaliseerde algoritme in Hoofdstuk 10.