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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

May 2024

RESEARCH ▪ AWARDS ▪ NEWS ▪ EVENTS ▪ STAFF UPDATE ▪ DEFENDED PHD ▪ PUBLICATIONS

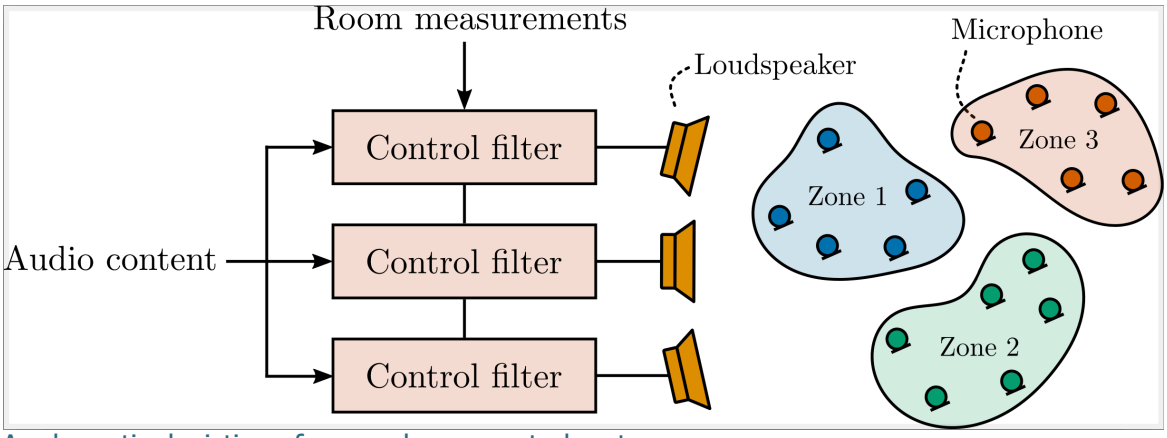
Research of the month by Jesper Brunnström

"Signal-to-interference-plus-noise ratio based optimization for sound zone control"

Work under the supervision of Marc Moonen and Toon van Waterschoot

Sound zone control is the reproduction of different audio content in different zones of the same space using a loudspeaker array. This allows multiple listeners to enjoy individual audio content while still being present together. Examples where this could be beneficial include hospital environments, where patients often share the same space, automotive environments, where riders and drivers would not need to listen to the same content, and home environments where music and film could be enjoyed at the same time.

Many environments where such technology could be used have a non-negligible level of noise from external sources. The level of the external noise could be beneficial to take into account, to ensure that the sound is audible in all zones despite the noise. This have not previously been investigated, and is the topic of this work.



A schematic depiction of a sound zone control system.

The reproduction system, as shown in Figure 1, takes a monophonic audio signal and filters it through one filter per loudspeaker. The filters should be designed according to some well chosen criteria. In this work, the criteria is stated as an optimization problem of minimizing loudspeaker power subject to a constraint on the signal-to-interference-plus-noise ratio (SINR) in each zone. A low loudspeaker power is beneficial for robustness, as well as being less disturbing to people outside the considered zones. Considering the SINR as a measure of audibility, the SINR constraint ensures that a certain level of audibility is obtained despite the noise. The optimal solution can be found using semi-definite programming. However, solving the problem in this way results in an immensely costly optimization procedure.

In the process of developing a less costly algorithm, the key insight was a close resemblence between sound zone control and transmit beamforming in digital communications. There is a duality between transmit and receive beamforming commonly exploited in digital communications, commonly referred to as uplink-downlink duality. It is particularly useful for transmit beamforming problems, as they rae difficult than the corresponding receive beamforming problems. An analogous duality exists in sound reproduction, but is seldom used. In this work, the transmit and receive duality for sound reproduction is exploited to produce an algorithm that finds the optimal solution at much lower computational cost compared to the direct solution, reducing the cost to compute all filters in an example scenario from close to 29 minutes to 300 ms.

Link: https://doi.org/10.1109/OJSP.2023.3246398

News



FWO-SBO approved

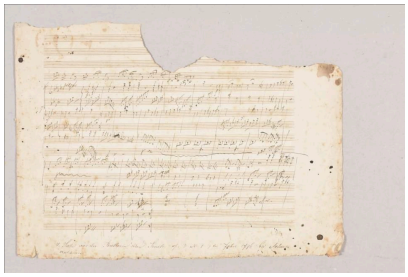
We are thrilled to announce the approval of a new FWO SBO project "New Perspectives on Medieval and Renaissance Courtly Song", with a substantial budget of over 2 million Euros. The project is coordinated by David Burn from Alamire Foundation (**Bart De Moor** being a chairman), and is prepared in collaboration with ESAT-STADIUS (**Toon van Waterschoot**), Department of Literature, the Department of Musicology, and the Leiden University Centre for the Arts in Society.
The project focuses on the Franco-Flemish polyphony preserved in the recently discovered Leuven Chansonnier, a fifteenth-century manuscript that is a significant part of European heritage.

Over the next 4 years the project will investigate the **architecture and acoustics of historical performance venues** and apply these insights to contemporary contexts.
Congratulations!



Presentation of Vesalius's 'De Fabrica'

In February, KU Leuven announced an acquisition of a copy of Andreas Vesalius's De Fabrica, annotated by Vesalius himself. This rare and exceptional piece was secured with the generous support of the Government of Flanders and several other benefactors from KU Leuven. In May, this remarkable book was presented to a limited circle of people, offering an exclusive glimpse into the history of anatomy and the groundbreaking work of Vesalius.



The Alamire Foundation welcomes unique sketch by Beethoven

The Alamire Foundation proudly adds a unique sketch by Ludwig van Beethoven to its collection. This draft of the fourth movement from Beethoven's first sonata (Op. 2, No. 1), in the composer's original handwriting, was handed over by Flemish Minister-President Jan Jambon to general director Bart Demuyt during the meeting of the European Ministers for Culture.

Awards



Bart Vanrumste - elected as EAMBES Fellow

We are proud to announce that Bart Vanrumste was elected as a Fellow of European Alliance of Medical and Biological Engineering and Science (EAMBES).
The certificate was presented to Bart at EAMBES annual General Council and General Assembly meeting in April in Rome.

Events @ STADIUS

For more information about STADIUS events

please visit the STADIUS Event webpages.

Don't forget to check the website of VAIA for a wide choice of courses on (aspects of) AI: www.vaia.be

ERC Back to the Roots Seminar: The Moment-SOS hierarchy
When: **11/06/2024, 17:00**
Where: **Aula van de Tweede Hoofdwet** - Thermotechnisch Instituut
By: **Guillaume Mercère**

Meet-the-Jury Symposium: "From Lab to Clinic: AI-Driven Musculoskeletal Image"
When: **12/06/2024, 16:00**
Where: **Aula van de Tweede Hoofdwet** - Thermotechnisch Instituut
By: **Claudia Lindner**

PhD defense - Adriaan Lambrechts: "Automation of preoperative planning for total knee arthroplasty using machine learning"
When: **12/06/2024, 17:30**
Where: **Aula van de Tweede Hoofdwet** - Thermotechnisch Instituut
By: **Adriaan Lambrechts**

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New colleagues

A warm welcome to new personnel at STADIUS!



Hi everyone,

My name is **Marta Bono**. I recently completed my BSc and MSc in Biomedical Engineering from the Polytechnic of Turin, Italy. I'm excited to start my PhD here at KU Leuven under the supervision of Prof. Maarten Van De Bossche and Prof. **Maarten De Vos**.
My research focuses on identifying markers and triggers of agitation in people with severe dementia, using signal analysis and Machine Learning techniques.
In my free time, I enjoy cooking, playing board games, and spending time outdoors, such as visiting new places or horse riding. I am looking forward to meeting you all in the lab and working together!

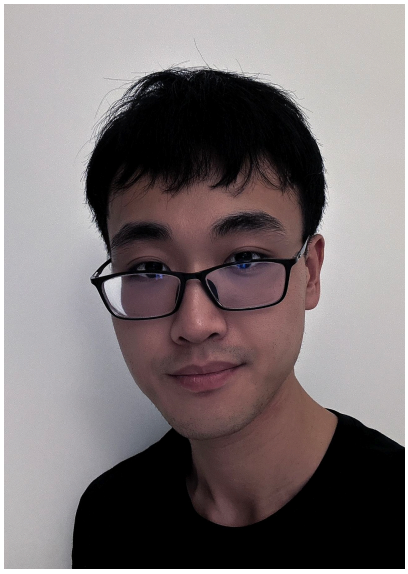
Marta

Hi everyone,

My name is **Sofie Buyckx**
After a career of nearly 25 years in the cargo business, I decided it was time for something new so in 2022 I ended up at KU Leuven Department of Civil Engineering. After



some time, I thought I missed that business, and I got the opportunity to go and work for a grower and importer of tropical plants. However, I wasn't used to the way of working in the cargo business anymore and I missed some structure. So, after a short break from KU Leuven, I came back and ended up at Stadius, where I will be working together with Elsy as financial co-worker.
My hobbies are walking and baking.



Hi everyone,

My name is **Tianyi Li.** I completed my BSc at the University of Electronic Science and Technology of China and my MSc at TU Delft. Now, I'm pursuing a PhD under the supervision of Prof. **Alexander Bertrand,** focusing on signal processing algorithms for auditory attention decoding. It's great to join STADIUS for this research.

In my free time, I enjoy fitness, meditation, and playing video games. I look forward to getting to know all of you.

Kind regards,
Tianyi



Hello,

I am **Zander Op de Beeck**, professor **Johan Suykens**' new PhD student, and will be working on disentanglement, deep kernel machines and tensor-based methods. I have a background in mathematical engineering (master's) and physics (bachelor's) as well as some miscellanous engineering courses, all at the KUL. Outside of research, I enjoy literature, languages, and learning various things, often using a spaced repetition system. I try to make sure to keep (somewhat) in shape by rowing.

Kindest regards,
Zander

Hello everyone,

My name is **Georgios Rousis**. In December 2023, I acquired my Diploma of Electrical and Computer Engineering from Aristotle University of Thessaloniki, Greece. I am now pursuing a PhD under the co-



supervision of Prof. **Maarten De Vos** and Prof. Bart Boets from the Center of Developmental Psychiatry. My research will mainly focus on the multimodal integration of physiological body and brain signals in real-life dyadic interactions, aiming to unravel and quantify synchrony. In my free time, I listen to a lot of music and occasionally write my own tunes. I am looking forward to meeting you all in the lab!

Georgios

Recently started projects

- 01/05/2024 Interactive Explainable AI - FAIR Enrichment Project
  - Maarten De Vos (coordinator)
  - Duration: 6months

Congratulations!

Recently defended PhD theses

- 21/05/2024 Yingyi Chen: Deep Learning Models : Duality, Robustness and Generalization Properties, supervised by Johan Suykens
- 13/05/2024 Coppens Peter: Provable safe learning-based control of uncertain systems, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), May 2024 Lirias number: 4141342.
- 08/03/2024 Martin Jalmby: Low-rank modeling in room acoustics, supervised by Toon van Waterschoot.

Congratulations!

Publication Digest

Here's the monthly STADIUS Publications Digest, including new reports that have been added to the publications database.

Please remember to have your own reports added in the publications database and make sure your entries are kept up to date (status submitted/accepted/published) at all times.

Contact Ida for new additions and updates, do not add/update database content yourself.

24-60

Didier P., ``Topology-independent GEVD-based distributed adaptive node-specific signal estimation in ad-hoc wireless acoustic sensor networks'', Technical Report 24-60, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-61

Tao Q., Tonin F., Lambert A., Chen Y., Patrinos P., Suykens J.A.K., ``Learning in Feature Spaces via Coupled Covariances: Asymmetric Kernel SVD and Nystrom method'', Technical Report 24-61, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024. Accepted for publication in *The 41st International Conference on Machine Learning (ICML)*, pp. 1-17.
Lirias number: 4157924.

24-62

Lagauw S., Vermeersch C., De Moor B., ``Solving Applications from Systems Theory Via Efficient Numerical Linear Algebra Root-Finding Algorithms'', *Presentation at the SIAM Conference on Applied Linear Algebra (LA24)*, Paris, France, May 2024.
Lirias number: 4159355.

24-63

He F., He M., Shi L., Huang X., Suykens J.A.K., ``Enhancing Kernel Flexibility via Learning Asymmetric Locally-Adaptive Kernels'', Technical Report 24-63, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-64

Zeng X., Tao Q., Suykens J.A.K., ``Feature Learning using Multi-view Kernel Partial Least Squares'', Technical Report 24-64, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-65

Filtjens B., Vanrumste B., Slaets P., ``Skeleton-based action segmentation with multi-stage spatial-temporal graph convolutional neural networks'', *IEEE Transactions on Emerging Topics in Computing*, vol. 12, no. 1, 2024, pp. 202-212.
Lirias number: 4009741.

24-66

Brunnstrom J., Moller M. B., Ostergaard J., Moonen M., ``Bayesian sound field estimation using uncertain data'', Technical Report 24-66, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-67

Achten S., Tonin F., Cevher V., Suykens J. A. K., ``HeNCler: Node Clustering in Heterophilous Graphs through Learned Asymmetric Similarity'', Technical Report 24-67, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-68

Chen Y., *Deep Learning Models : Duality, Robustness and Generalization Properties*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), May 2024
Lirias number: 4154483.

24-69

Coppens P., *Provable safe learning-based control of uncertain systems*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), May 2024
Lirias number: 4141342.

24-70

Seeuws N., *Detection of disturbances and events in biomedical signals with deep learning*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Mar. 2024
Lirias number: 4137665.

24-71

Tonin F., Lambert A., Suykens J.A.K., Cevher V., ``An Augmented Lagrangian Method for Faster Spectral Clustering with Fairness Constraints'', Technical Report 24-71, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-72

Sajjadifar Z., De Moor B., ``Deep Learning Forecasting Model for Kidney Function Post-Transplant Exploiting Missing Values'', *The 44th International Symposium on Forecasting (ISF)*, Dijon, France, Jul. 2024.
Lirias number: 4159951.

24-73

Rinaldi G., Botman L., Agudelo O. M., De Moor B., ``A Decision Support System for Evaluating Smart Plug Forecasting Pipelines'', *The 44th International Symposium On Forecasting (ISF)*, Dijon, France, Jul. 2024.
Lirias number: 4159952.

24-74

Green R W., Heremans R., Fischerova D., Yan. J., Eriksson L., Mascilini F., Testa A. C., Franchi D., Sladkevicius P., Valentin L., Opolskiene G., Haak L. A., Fruscio R., Chiappa V., Van Holsbeke C., Alcazar J., Cibula D., Guerriero S., Fruehauf F., Carlson J., Mestdagh W., Bourne T., Timmerman D., Van den Bosch T., Epstein E., ``Prediction of outcome in endometrial cancer improved by combining traditional with sonographic and demographic parameters: IETA4 cohort follow-up'', *Ultrasound in Obstetrics & Gynecology*, vol. 62, no. 0960-7692, Oct. 2023, pp. 43-44.
Lirias number: 4146283.

24-75

Cao Z., Seeuws N., De Vos M., Bertrand A., ``A Multi-view Extension for Change Point Detection via Time-invariant Representations'', in *Proc. of the 32nd European Signal Processing Conference (EUSIPCO 2024)*, Lyon, France, Aug. 2024.
Lirias number: 4159986.

24-76

Cakmak B., Dietzen T., Ali R., Naylor P., van Waterschoot T., ``Microphone Pair Selection for Sound Source Localization in Massive Arrays of Spatially Distributed Microphones'', Technical Report 24-76, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024. Accepted for publication in *EUSIPCO 2024*.
Lirias number: 4160089.

24-77

Hendrikx D., Caicedo Dorado A., Van Huffel S., Naulaers G., Wolfsberger C., Urlesberger B., Pichler G., ``Coupling between Regional Oxygn Saturation of the Brain and Vital Signs during Immediate Transition after Birth'', *Neonatology*, Apr. 2024, pp. 1-10.
Lirias number: 4152950.

24-78

Van den Bulcke L., Peeters A.M., Davidoff H., Vaessens R., Vansteelandt K., Van den Stock J., De Vos M., Testelmans D., Vandenbulcke M., Van Den Bossche M., ``Aggression Severity as a Predictor of Mortality in Dementia'', *JAMDA*, vol. 25, 2024, pp. 764-768.
Lirias number: 4113973.

24-79

De Brabandere A., Chatzichristos C., Van Paesschen W., De Vos M., Davis J., ``Detecting Epileptic Seizures Using Hand-Crafted and Automatically Constructed EEg Features'', *IEEE Transactions on Biomedical Engineering*, vol. 71, no. 1, Jan. 2024, pp. 318-325.
Lirias number: 4128185.

24-80

Zhang J., Swinnen L., Chatzichristos C., Broux V., Proost R., Jansen K., Mahler B., Zabler N., Epitashvilli N., Dumpelmann M., Schulze-Bonhage A., Schriewer E., Ermis U., Wolking S., Linke F., Weber Y., Symmonds M., Sen A., Biondi A., Richardson M.P., Sulaiman A., Silva A.I., Sales F., Vertes G., Van Paesschen W., De Vos M., ``Multimodal wearable EEG, EMG and Accelerometry measurements improve the accuracy of tonic-clonic seizure detection'', *Physiological Measurement*, 2024, pp. 1-16.
Lirias number: 4159378.

24-81

Proost R., Heremans E., Lagae L., Van Paesschen W., De Vos M., Jansen K., ``Automated sleep staging on reduced channels in children with epilepsy'', *Frontiers in Neurology*, May 2024, pp. 01-08.
Lirias number: 4159609.

24-82

Deferm W., Singh B., Wass S., De Vos M., van den berg B., De Bruyn S., Wouters E., Ponnet K., Boets B., ``Objectively quantifying self- and co-regulation problems in a biobehavioral synchrony framework'', *Proc. of the European society for cognitive and affective neuroscience (ESCAN)*, Gent, Belgium, May 2024.
Lirias number: 41600500.

24-83

Kempen B., Klein S., De Sloovere V., De Vos M., Depreitere B., ``Reconstruction based anomaly detection for cerebrovascular autoregulation state monitoring from ABP and ICP signals: a proof-of-concept study using experimental data'', *Proc. of the BrainIT Meeting*, Glasgow, Scotland, May 2024.
Lirias number: 4159944.

24-84

Davidoff H., Van Kraaij A., Van den Bulcke L., Lutin E., Vandenbulcke M., Van Helleputte N., De Vos M., Van Hoof C., Van Den Bossche M., ``Physiological Profiling of Agitation in Dementia: Insights from Wearable Sensor Data'', Technical Report 24-84, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024. Accepted for publication in *Innovation in Aging*.
Lirias number: 4159841.

24-85

Desbordes P., Maes J., Van Orshoven K., De Vos M., Steinwender M., Helfenstein E., Marginean C., Henzi N., Cerkl P., Heeb P., Keusch S., Calderari G., Boetticher P., Baumgartner B., Stolz D., Simon M., Gompelmann D., Janssens W., Topalovic M., ``Late Breaking Abstract - AI-powered decision support helps pulmonologists to diagnose ILD more accurately'', *Proc. of the Annual congress of the European-Respiratory-Society (ERS)*, Milan, Italy, Sep. 2023.
Lirias number: 4137716.

24-86

De Vos M., Maes J., Van Orshoven K., Desbordes P., Vanheule V., Quataert C., Fovel I., Topalovic M., Topalovic M., ``Insights into spirometry usage and the potential for AI-based decision support software in Belgian primary care'', in *Proc. of the Annual congress of the European-Respiratory-Society (ERS)*, Milan, Italy, Sep. 2023, pp. 1-2.
Lirias number: 4137721.

24-87

Desbordes P., Maes J., Stachowicz N., Kaspers J., Arfoosh R., Hegewald M., De Vos M., Topalovic M., ``How many lung function interpretations can an expert make in one hour based on the 2021 ERS/ATS standards?'', in *Proc. of the Annual congress of the European-Respiratory-Society (ERS)*, Milan, Italy, Sep. 2023, pp. 1-2.
Lirias number: 4137720.

24-88

Elmahy A., Maes J., Desbordes P., De Vos M., Topalovic M., ``AI models for respiratory diseases from spirometry alone: validation based on UK Biobank'', *Proc. of the Annual congress of the European-Respiratory-Society (ERS)*, Milan, Italy, Sep. 2023.
Lirias number: 4137719.

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