Emerging Trends of Biomedical Circuits and Systems

Other titles in Foundations and Trends® in Integrated Circuits and Systems

Revisiting the Frontiers of Analog and Mixed-Signal Integrated Circuits Architectures and Techniques towards the future Internet of Everything (IoE) Applications
Rui P. Martins, Pui-In Mak, Sai-Weng Sin, Man-Kay Law, Yan Zhu, Yan Lu, Jun Yin, Chi-Hang Chan, Yong Chen, Ka-Fai Un, Mo Huang, Minglei Zhang, Yang Jiang and Wei-Han Yu
ISBN: 978-1-68083-892-3

Welcome to the World of Single-Slope Column-Level Analog-to-Digital Converters for CMOS Image Sensors
Albert Theuwissen and Guy Meynants
ISBN: 978-1-68083-812-1

Emerging Trends of Biomedical Circuits and Systems

Mohamad Sawan

Jie Yang

Mahdi Tarkhan

Jinbo Chen

Minqing Wang

Chuanqing Wang

Fen Xia

Yun-Hsuan Chen

Westlake University, China

now
the essence of knowledge
Boston — Delft

Full text available at: http://dx.doi.org/10.1561/3500000005

Foundations and Trends® in Integrated Circuits and Systems

Published, sold and distributed by:
now Publishers Inc.
PO Box 1024
Hanover, MA 02339
United States
Tel. +1-781-985-4510
www.nowpublishers.com
sales@nowpublishers.com

Outside North America:
now Publishers Inc.
PO Box 179
2600 AD Delft
The Netherlands
Tel. +31-6-51115274

The preferred citation for this publication is

Mohamad Sawan, Jie Yang, Mahdi Tarkhan, Jinbo Chen, Minqing Wang, Chuanqing Wang, Fen Xia and Yun-Hsuan Chen. *Emerging Trends of Biomedical Circuits and Systems*. Foundations and Trends® in Integrated Circuits and Systems, vol. 1, no. 4, pp. 217–411, 2021.

ISBN: 978-1-68083-907-4
© 2021 Mohamad Sawan, Jie Yang, Mahdi Tarkhan, Jinbo Chen, Minqing Wang, Chuanqing Wang, Fen Xia and Yun-Hsuan Chen

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, mechanical, photocopying, recording or otherwise, without prior written permission of the publishers.

Photocopying. In the USA: This journal is registered at the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by now Publishers Inc for users registered with the Copyright Clearance Center (CCC). The 'services' for users can be found on the internet at: www.copyright.com

For those organizations that have been granted a photocopy license, a separate system of payment has been arranged. Authorization does not extend to other kinds of copying, such as that for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale. In the rest of the world: Permission to photocopy must be obtained from the copyright owner. Please apply to now Publishers Inc., PO Box 1024, Hanover, MA 02339, USA; Tel. +1 781 871 0245; www.nowpublishers.com; sales@nowpublishers.com

now Publishers Inc. has an exclusive license to publish this material worldwide. Permission to use this content must be obtained from the copyright license holder. Please apply to now Publishers, PO Box 179, 2600 AD Delft, The Netherlands, www.nowpublishers.com; e-mail: sales@nowpublishers.com

Foundations and Trends® in Integrated Circuits and Systems

Volume 1, Issue 4, 2021

Editorial Board

Editorial Scope

Topics

Foundations and Trends® in Integrated Circuits and Systems survey and tutorial articles in the following topics:

- Analog, digital and mixed-signal circuits and systems
- RF and mm-wave integrated circuits and systems
- Wireless and wireline communication circuits and systems
- Data converters and frequency generation
- Power electronics and power management circuits
- Biomedical circuits and systems
- Sensor and imager circuits and cyber physical systems
- Security and resilient circuits and systems
- Circuits and systems in emerging non-CMOS technologies
- Circuit theory, modeling, analysis and design methods

Information for Librarians

Foundations and Trends® in Integrated Circuits and Systems, 2021, Volume 1, 4 issues. ISSN paper version 2693-9347. ISSN online version 2693-9355. Also available as a combined paper and online subscription.

Contents

Emerging Trends of Biomedical Circuits and Systems

Mohamad Sawan, Jie Yang, Mahdi Tarkhan, Jinbo Chen, Minqing Wang, Chuanqing Wang, Fen Xia and Yun-Hsuan Chen*

CenBRAIN Lab., School of Engineering, Westlake University, Hangzhou, Zhejiang 310024, China; sawan@westlake.edu.cn

---

ABSTRACT

Biomedical circuits and systems are heading toward a multidisciplinary race in two main directions. On the one hand, advanced smart medical devices must be built to improve human healthcare conditions. On the other hand, breakthroughs are required in mimicking the brain when designing learning algorithms and corresponding hardware implementations for numerous applications. In this monograph, we review the main emerging trends and report the trends of biomedical circuits and systems. We report most related circuits and systems activities for biosignal recording and processing, advanced imaging techniques and corresponding circuits and systems, power harvesting and wireless data communications, as well as body area networks, biosensors, and neural prostheses. The research direction in each one of these circuits and systems occupies a large place in several international conferences and prestigious journals, not only in many IEEE societies but also in several other publications.

---

*Mohamad Sawan, Jie Yang and Mahdi Tarkhan are equal contributors.

Mohamad Sawan, Jie Yang, Mahdi Tarkhan, Jinbo Chen, Minqing Wang, Chuanqing Wang, Fen Xia and Yun-Hsuan Chen (2021), “Emerging Trends of Biomedical Circuits and Systems”, Foundations and Trends® in Integrated Circuits and Systems: Vol. 1, No. 4, pp 217–411. DOI: 10.1561/3500000005.

Keywords: Biomedical circuits and systems, Smart medical devices, Neurotechnology, Neurorecording, Neuroprostheses, Biotelemetry, Biosensors, Biosignal Processing, Imaging, Implantable devices, Wearable systems, Power harvesting.

1

Introduction

With the development of fields of biomedical circuits and systems (BioCAS), challenging directions are also emerging. The challenges are related to several technological and medical limits, such as understanding biomedical applications requiring the development of efficient diagnostic tools and grasping the addressed mechanisms of involved medical organs and functions to be enhanced or recovered. Over the past 5–10 years, several topics have been addressed by BioCAS, and many research and review papers [1]–[7] reporting the latest contributions to these biomedical fields have been published.

More recently, machine and deep-learning techniques have begun to occupy parts of emerging chipsets [8]–[10]. The latter are analog and mixed-signal circuits intended to run complex neural-network-based architectures. However, smart medical devices intended for the diagnosis, treatment, and prediction of neurodegenerative diseases remain among the most challenging goals when multiple dimensions, such as large complexity due to the number of channels, reliability, and sensitivity, must be met. In addition, numerous tests, and validations, such as monitoring bioelectronics interface conditions, are required for enhanced safety, and in vitro, ex vivo and in vivo tests are necessary before any translation to the product can occur. In short, to achieve breakthrough innovation in

Full text available at: http://dx.doi.org/10.1561/3500000005

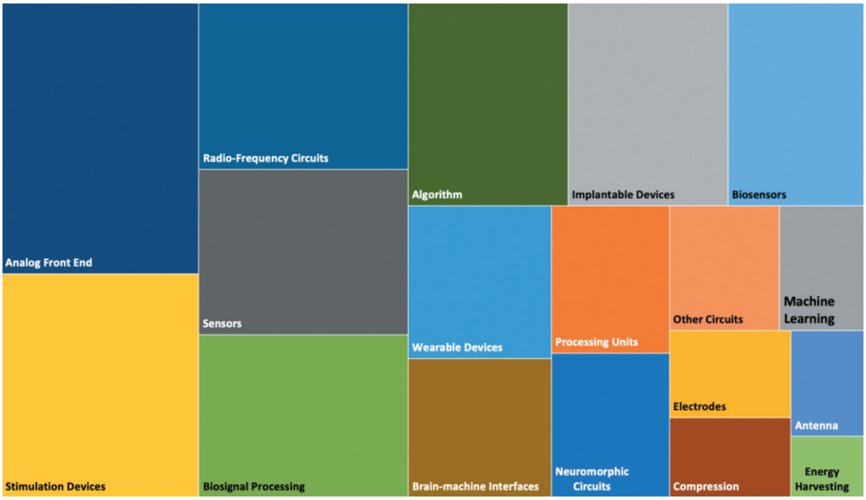

Figure 1.1: Distribution of main BioCAS research interests.

BioCAS, researchers must deal with multidimensional design challenges such as power management, low-power high-data-rate wireless communication, reliable harvesting energy methods and application-specific system architectures. In addition to common BioCAS, case studies will be described, which include epileptic seizure foci localization, detection, and prediction and optogenetic retinal protheses [11]–[14]. For the contents of this study, we scanned publications in main IEEE journals and, more particularly, the Transactions on BioCAS, then sorted out the occurrence of BioCAS topics, and built the diagram shown in Figure 1.1.

The distribution of various research fields in this figure includes the analog front ends (AFEs), which are among the most popular research works. The latter includes building blocks to acquire numerous types of biomedical signals such as electroencephalogram (EEG), intracortical EEG (IcEEG), electrocorticogram (ECoG), local field potential (LFP), single cell spikes, and electrocardiogram (ECG). This AFE includes a low-noise amplifier (LNA) and subsequent signal processing functions to adapt to the next circuit blocks. Filtering, amplification, power reduction, and noise canceling are the main functions. Stimulation devices come second, where the heart parts are analog back-end stages to deliver, in most cases, constant-current biphasic stimulation or light-tuned stimuli [1], [15]–[18]. Third, sensors, radio-frequency building structures, biosignal processing, and algorithm architectures are the four topics that share the same importance. Implantable devices and biosensors, including Lab-on-CMOS-chip, are next, followed by brain-machine interfaces and wearable devices. In addition, many other topics are emerging, such as neuromorphic, machine learning, and electrode–tissue interfaces and harvesting energy. Finally, most of the above summarized research topics are interconnected or integrated in system-on-chip (SoC), system-in-package, and other flexible 2D and 3D structures [19]–[23].

In this review, we focus on the most currently conducted research activities in circuits and systems, including their assembly and validation. Consequently, the remaining parts of this review include in Section 2 biosignal recording circuits and systems, AFE for electrical readout, architecture based on time-division and frequency-division multiplexing, AC- and DC-coupled AFE, and direct-digital readout AFE. Section 3 concerns biosignal processing, which includes compression techniques, compressive sensing, principal component analysis, feature extraction such as time-domain, frequency features, and time-frequency features, and biosignal classification such as regression, SVM, and neural networks. In Sections 4 and 5, we describe radio-frequency transmission and power management, which include photovoltaic, motion-driven, thermoelectric, and biofuel cell-based energy harvesting, power conditioning circuits and wireless power transmission, such as inductive, capacitive, and ultrasonic links, as well as wireless body area network.

In Section 6 dedicated to neuroimaging, we describe functional near-infrared spectroscopy (fNIRS) and ultrasound, photoacoustic, electromagnetic, and electrical impedance tomography, which are considered among the main brain imaging methods where innovative circuit techniques are required. In Section 7, chemical and molecular biosensors such as amperometric, potentiometric, and ion-specific, and other biotransistors, such as ISFET devices are described. Case studies such as neural prostheses intended to enhance or recover vision are reported in Section 8. In Section 9, the criteria and characterizations of electrode–tissue interfaces are discussed. Last, the conclusions are detailed in Section 10.

References

[1] M. Sawan, Y. Hu, and J. Coulombe, "Wireless smart implants dedicated to multichannel monitoring and microstimulation," pp. 21–39, *IEEE Circuits and systems magazine*, vol. 5, no. 1, 2005.

[2] E. McGlynn, *et al.*, "The future of neuroscience: Flexible and wireless implantable neural electronics," *Advanced Science*, vol. 8, no. 10, 2021.

[3] F. H. Noshahr, M. Nabavi, and M. Sawan, "Multi-channel neural recording implants: A review," *Sensors (Basel)*, vol. 20, no. 3, 2020. DOI: 10.3390/s20030904.

[4] J. Yang and M. Sawan, "Towards smart and fully embedded sseizure prediction engine: A review," pp. 1–1, *IEEE Transactions on Biomedical Circuits and Systems*, 2020. DOI: 10.1109/tbcas.2020.3018465.

[5] Q. Lin, *et al.*, "Wearable multiple modality bio-signal recording and processing on chip: A review," pp. 1–1, *IEEE Sensors Journal*, 2020. DOI: 10.1109/jsen.2020.3016115.

[6] Y.-W. Chong, W. Ismail, K. Ko, and C.-Y. Lee, "Energy harvesting for wearable devices: A review," pp. 9047–9062, *IEEE Sensors Journal*, vol. 19, no. 20, 2019. DOI: 10.1109/jsen.2019.2925638.

[7] H.-J. Kim, H. Hirayama, S. Kim, K. J. Han, R. Zhang, and J.-W. Choi, "Review of near-field wireless power and communication for biomedical applications," pp. 21 264–21 285, *IEEE Access*, vol. 5, 2017.

[8] S. Yin, *et al.*, "A 1.06-μw smart ecg processor in 65-nm cmos for real-time biometric authentication and personal cardiac monitoring," pp. 2316–2326, *IEEE Journal of Solid-State Circuits*, vol. 54, no. 8, 2019.

[9] E. Donati, M. Payvand, N. Risi, R. Krause, and G. Indiveri, "Discrimination of emg signals using a neuromorphic implementation of a spiking neural network," pp. 795–803, *IEEE transactions on biomedical circuits and systems*, vol. 13, no. 5, 2019.

[10] I. Kiral-Kornek, *et al.*, "Epileptic seizure prediction using big data and deep learning: Toward a mobile system," pp. 103–111, *EBioMedicine*, vol. 27, 2018. DOI: 10.1016/j.ebiom.2017.11.032.

[11] P.-O. Champagne, N. T. Sanon, L. Carmant, P. Pouliot, A. Bouthillier, and M. Sawan, "Feasibility of implantable iron oxide nanoparticles in detecting brain activity-proof of concept in a rat model," p. 106 585, *Epilepsy Research*, vol. 172, 2021.

[12] M. Safi-Harb, M. T. Salam, D. K. Nguyen, and M. Sawan, "An implantable seizure-onset detector based on a dual-path single-window count-based technique for closed-loop applications," pp. 603–612, *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, vol. 1, no. 4, 2011.

[13] Y. Zheng, G. Wang, K. Li, G. Bao, and J. Wang, "Epileptic seizure prediction using phase synchronization based on bivariate empirical mode decomposition," pp. 1104–1111, *Clinical Neurophysiology*, vol. 125, no. 6, 2014.

[14] L. Montazeri, N. El Zarif, S. Trenholm, and M. Sawan, "Optogenetic stimulation for restoring vision to patients suffering from retinal degenerative diseases: Current strategies and future directions," pp. 1792–1807, *IEEE transactions on biomedical circuits and systems*, vol. 13, no. 6, 2019.

[15] G. O'Leary, D. M. Groppe, T. A. Valiante, N. Verma, and R. Genov, "Nurip: Neural interface processor for brain-state classification and programmable-waveform neurostimulation," pp. 3150–3162, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 11, 2018. DOI: 10.1109/jssc.2018.2869579.

[16] S.-Y. Lee, *et al.*, "A programmable implantable microstimulator soc with wireless telemetry: Application in closed-loop endocardial stimulation for cardiac pacemaker," pp. 511–522, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 5, no. 6, 2011.

[17] L. Yue, J. D. Weiland, B. Roska, and M. S. Humayun, "Retinal stimulation strategies to restore vision: Fundamentals and systems," pp. 21–47, *Progress in retinal and eye research*, vol. 53, 2016.

[18] A. Soltan, *et al.*, "High density, high radiance μled matrix for optogenetic retinal prostheses and planar neural stimulation," pp. 347–359, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 11, no. 2, 2017.

[19] S. Saha, Y. Lu, S. Weyers, F. Lesage, and M. Sawan, "Compact optical probe for time-resolved nirs-imaging," pp. 6101–6113, *IEEE Sensors Journal*, vol. 20, no. 11, 2020.

[20] B. Liu, *et al.*, "A 13-channel 1.53-mw 11.28-mm 2 electrical impedance tomography soc based on frequency division multiplexing for lung physiological imaging," pp. 938–949, *IEEE transactions on biomedical circuits and systems*, vol. 13, no. 5, 2019.

[21] U. Ha, J. Lee, M. Kim, T. Roh, S. Choi, and H.-J. Yoo, "An eeg-nirs multimodal soc for accurate anesthesia depth monitoring," pp. 1830–1843, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 6, 2018. DOI: 10.1109/jssc.2018.2810213.

[22] C.-H. Cheng, *et al.*, "A fully integrated 16-channel closed-loop neural-prosthetic cmos soc with wireless power and bidirectional data telemetry for real-time efficient human epileptic seizure control," pp. 3314–3326, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 11, 2018. DOI: 10.1109/jssc.2018.2867293.

[23] C.-Y. Wu, C.-H. Cheng, and Z.-X. Chen, “A 16-channel cmos chopper-stabilized analog front-end ecog acquisition circuit for a closed-loop epileptic seizure control system,” pp. 543–553, *IEEE transactions on biomedical circuits and systems*, vol. 12, no. 3, 2018.

[24] B. Gosselin, *et al.*, “A mixed-signal multichip neural recording interface with bandwidth reduction,” pp. 129–41, *IEEE Trans Biomed Circuits Syst*, vol. 3, no. 3, Jun 2009. DOI: 10.1109/TBCAS.2009.2013718.

[25] R. Muller, *et al.*, “A minimally invasive 64-channel wireless μecog implant,” pp. 344–359, *IEEE Journal of Solid-State Circuits*, vol. 50, no. 1, 2015. DOI: 10.1109/jssc.2014.2364824.

[26] A. Bagheri, M. T. Salam, J. L. P. Velazquez, and R. Genov, “Low-frequency noise and offset rejection in dc-coupled neural amplifiers: A review and digitally-assisted design tutorial,” pp. 161–176, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 11, no. 1, 2017. DOI: 10.1109/tbcas.2016.2539518.

[27] J. Xu, S. Mitra, C. Van Hoof, R. F. Yazicioglu, and K. A. A. Makinwa, “Active electrodes for wearable eeg acquisition: Review and electronics design methodology,” pp. 187–198, *IEEE Rev Biomed Eng*, vol. 10, 2017. DOI: 10.1109/RBME.2017.2656388.

[28] M. Sharma, A. T. Gardner, H. J. Strathman, D. J. Warren, J. Silver, and R. M. Walker, “Acquisition of neural action potentials using rapid multiplexing directly at the electrodes,” *Micromachines (Basel)*, vol. 9, no. 10, Sep 20 2018. DOI: 10.3390/mi9100477.

[29] W. Smith, J. Uehlin, S. Perlmutter, J. Rudell, and V. Sathe, “A scalable, highly-multiplexed delta-encoded digital feedback ecog recording amplifier with common and differential-mode artifact suppression,” in *2017 Symposium on VLSI Circuits*, pp. C172–C173, IEEE, 2017.

[30] J. Warchall, P. Theilmann, Y. Ouyang, H. Garudadri, and P. P. Mercier, “Robust biopotential acquisition via a distributed multichannel fm-adc,” pp. 1229–1242, *IEEE Trans Biomed Circuits Syst*, vol. 13, no. 6, FM modulated neural recording system, 2019. DOI: 10.1109/TBCAS.2019.2941846.

[31] K. A. Ng and Y. P. Xu, "A compact, low input capacitance neural recording amplifier with c in/gain of 20ff. v/v," in *2012 IEEE Biomedical Circuits and Systems Conference (BioCAS)*, pp. 328–331, IEEE, 2012.

[32] R. F. Yazicioglu, P. Merken, R. Puers, and C. Van Hoof, "A 60 μw 60 nv/$\sqrt{\text{hz}}$ readout front-end for portable biopotential acquisition systems," pp. 1100–1110, *IEEE Journal of Solid-State Circuits*, vol. 42, no. 5, 2007. DOI: 10.1109/jssc.2007.894804.

[33] T. Denison, K. Consoer, W. Santa, A.-T. Avestruz, J. Cooley, and A. Kelly, "A 2 μw 100 nv/rthz chopper-stabilized instrumentation amplifier for chronic measurement of neural field potentials," pp. 2934–2945, *IEEE Journal of Solid-State Circuits*, vol. 42, no. 12, 2007. DOI: 10.1109/jssc.2007.908664.

[34] N. Verma, A. Shoeb, J. Bohorquez, J. Dawson, J. Guttag, and A. P. Chandrakasan, "A micro-power eeg acquisition soc with integrated feature extraction processor for a chronic seizure detection system," pp. 804–816, *IEEE Journal of Solid-State Circuits*, vol. 45, no. 4, 2010. DOI: 10.1109/jssc.2010.2042245.

[35] J. Xu, R. F. Yazicioglu, B. Grundlehner, P. Harpe, K. A. A. Makinwa, and C. Van Hoof, "A 160μw 8-channel active electrode system for eeg monitoring," pp. 555–567, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 5, no. 6, 2011. DOI: 10.1109/tbcas.2011.2170985.

[36] Y. Liu, S. Luan, I. Williams, A. Rapeaux, and T. G. Constandinou, "A 64-channel versatile neural recording soc with activity-dependent data throughput," pp. 1344–1355, *IEEE Trans Biomed Circuits Syst*, vol. 11, no. 6, 2017. DOI: 10.1109/TBCAS.2017.2759339.

[37] T. Tang, *et al.*, "34.6 eeg dust: A bcc-based wireless concurrent recording/transmitting concentric electrode," in *2020 IEEE International Solid-State Circuits Conference-(ISSCC)*, pp. 516–518, IEEE, 2020.

[38] B. Gosselin, M. Sawan, and C. A. Chapman, "A low-power integrated bioamplifier with active low-frequency suppression," pp. 184–192, *IEEE Trans Biomed Circuits Syst*, vol. 1, no. 3, 2007. DOI: 10.1109/TBCAS.2007.914490.

[39] K. A. Ng and P. K. Chan, "A cmos analog front-end ic for portable eeg/ecg monitoring applications," pp. 2335–2347, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 52, no. 11, 2005.

[40] R. Muller, S. Gambini, and J. M. Rabaey, "A 0.013 mmp, 5 w, dc-coupled neural signal acquisition ic with 0.5 v supply," pp. 232–243, *IEEE Journal of Solid-State Circuits*, vol. 47, no. 1, 2012. DOI: 10.1109/jssc.2011.2163552.

[41] H. Kassiri, *et al.*, "Battery-less tri-band-radio neuro-monitor and responsive neurostimulator for diagnostics and treatment of neurological disorders," pp. 1274–1289, *IEEE Journal of Solid-State Circuits*, vol. 51, no. 5, 2016. DOI: 10.1109/jssc.2016.2528999.

[42] J. Xu, B. Busze, C. Van Hoof, K. A. A. Makinwa, and R. F. Yazicioglu, "A 15-channel digital active electrode system for multi-parameter biopotential measurement," pp. 2090–2100, *IEEE Journal of Solid-State Circuits*, vol. 50, no. 9, 2015. DOI: 10.1109/jssc.2015.2422798.

[43] Y. Zhao, Z. Shang, and Y. Lian, "A 2.55 nef 76 db cmrr dc-coupled fully differential difference amplifier based analog front end for wearable biomedical sensors," pp. 918–926, *IEEE Trans Biomed Circuits Syst*, vol. 13, no. 5, 2019. DOI: 10.1109/TBCAS.2019.2924416.

[44] E. Greenwald *et al.*, "A bidirectional neural interface ic with chopper stabilized bioadc array and charge balanced stimulator," pp. 990–1002, *IEEE Trans Biomed Circuits Syst*, vol. 10, no. 5, 2016. DOI: 10.1109/TBCAS.2016.2614845.

[45] H. Kassiri *et al.*, "Rail-to-rail-input dual-radio 64-channel closed-loop neurostimulator," pp. 1–18, *IEEE Journal of Solid-State Circuits*, 2017. DOI: 10.1109/jssc.2017.2749426.

[46] C. Kim, S. Joshi, H. Courellis, J. Wang, C. Miller, and G. Cauwenberghs, "Sub-μvrms-noise sub-μw/channel adc-direct neural recording with 200-mv/ms transient recovery through predictive digital autoranging," pp. 3101–3110, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 11, 2018. DOI: 10.1109/jssc.2018.2870555.

[47] X. Yang *et al.*, "A 108db dr hybrid-ctdt direct-digitalization $\Delta\Sigma$-Σm front-end with 720 mv pp input range and <300 mv offset removal for wearable bio-signal recording," pp. C296–C297, 2019.

[48] W. Jiang, V. Hokhikyan, H. Chandrakumar, V. Karkare, and D. Markovic, "A ±50-mv linear-input-range vco-based neural-recording front-end with digital nonlinearity correction," pp. 173–184, *IEEE Journal of Solid-State Circuits*, vol. 52, no. 1, 2017. DOI: 10.1109/jssc.2016.2624989.

[49] R. Fiorelli, M. Delgado-Restituto, and A. Rodriguez-Vazquez, "Charge-redistribution based quadratic operators for neural feature extraction," pp. 606–619, *IEEE Trans Biomed Circuits Syst*, vol. 14, no. 3, 2020. DOI: 10.1109/TBCAS.2020.2987389.

[50] P. Harpe, "A compact 10-b sar adc with unit-length capacitors and a passive fir filter," pp. 636–645, *IEEE Journal of Solid-State Circuits*, vol. 54, no. 3, 2019. DOI: 10.1109/jssc.2018.2878830.

[51] K. Abdelhalim, H. M. Jafari, L. Kokarovtseva, J. L. P. Velazquez, and R. Genov, "64-channel uwb wireless neural vector analyzer soc with a closed-loop phase synchrony-triggered neurostimulator," pp. 2494–2510, *IEEE Journal of Solid-State Circuits*, vol. 48, no. 10, 2013.

[52] S. Porrazzo, *et al.*, "A 155 mu w 88-db dr discrete-time sigma modulator for digital hearing aids exploiting a summing sar adc quantizer," pp. 573–82, *IEEE Trans Biomed Circuits Syst*, vol. 7, no. 5, 2013. DOI: 10.1109/TBCAS.2013.2280694.

[53] L. B. Leene and T. G. Constandinou, "A 0.006 mm 2 1.2μw analog-to-time converter for asynchronous bio-sensors," pp. 2604–2613, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 9, 2018.

[54] J. J. Jun, *et al.*, "Fully integrated silicon probes for high-density recording of neural activity," pp. 232–236, *Nature*, vol. 551, no. 7679, 2017. DOI: 10.1038/nature24636.

[55] J. Putzeys, *et al.*, "Neuropixels data-acquisition system: A scalable platform for parallel recording of 10 000+ electrophysiological signals," pp. 1635–1644, *IEEE Trans Biomed Circuits Syst*, vol. 13, no. 6, 2019. DOI: 10.1109/TBCAS.2019.2943077.

[56] N. A. Steinmetz, *et al.*, "Neuropixels 2.0: A miniaturized high-density probe for stable, long-term brain recordings," *Science*, vol. 372, no. 6539, 2021.

[57] T. Lee, M. K. Kim, H. J. Lee, and M. Je, *A 5.7 μw/channel folded-current-mirror-based reconfigurable multimodal neural recording ic with improved hardware availability, presented at the 2021 ieee international symposium on circuits and systems (iscas)*, 2021.

[58] Y. Luo and C.-H. Heng, "An 8.2 μw 0.14 mm 2 16-channel cdma-like period modulation capacitance-to-digital converter with reduced data throughput," in *2018 IEEE Symposium on VLSI Circuits*, pp. 165–166, IEEE, 2018.

[59] K. Hu, C. E. Arcadia, and J. K. Rosenstein, "A large-scale multimodal cmos biosensor array with 131,072 pixels and code-division multiplexed readout," pp. 48–51, *IEEE Solid-State Circuits Letters*, vol. 4, 2021. DOI: 10.1109/lssc.2021.3056515.

[60] J. H. Park, *et al.*, "A 15-channel orthogonal code chopping instrumentation amplifier for area-efficient, low-mismatch bio-signal acquisition," pp. 2771–2780, *IEEE Journal of Solid-State Circuits*, vol. 55, no. 10, 2020. DOI: 10.1109/jssc.2020.2991542.

[61] B. Murmann, M. Verhelst, and Y. Manoli, "Analog-to-information conversion," in *Nano-Chips 2030, (The Frontiers Collection)*, ch. 17, pp. 275–292, 2020.

[62] J. Van Assche and G. Gielen, "Power efficiency comparison of event-driven and fixed-rate signal conversion and compression for biomedical applications," pp. 746–756, *IEEE Trans Biomed Circuits Syst*, vol. 14, no. 4, Aug 2020. DOI: 10.1109/TBCAS.2020.3009027.

[63] R. G. Baraniuk, "Compressive sensing [lecture notes]," pp. 118–121, *IEEE signal processing magazine*, vol. 24, no. 4, 2007.

[64] E. J. Candes, Y. C. Eldar, D. Needell, and P. Randall, "Compressed sensing with coherent and redundant dictionaries," pp. 59–73, *Applied and Computational Harmonic Analysis*, vol. 31, no. 1, 2011.

[65] D. Gangopadhyay, E. G. Allstot, A. M. Dixon, K. Natarajan, S. Gupta, and D. J. Allstot, "Compressed sensing analog front-end for bio-sensor applications," pp. 426–438, *IEEE Journal of Solid-State Circuits*, vol. 49, no. 2, 2014.

[66] X. Liu *et al.*, "A fully integrated wireless compressed sensing neural signal acquisition system for chronic recording and brain machine interface," pp. 874–883, *IEEE Transactions on biomedical circuits and systems*, vol. 10, no. 4, 2016.

[67] M. Shoaran, M. H. Kamal, C. Pollo, P. Vandergheynst, and A. Schmid, "Compact low-power cortical recording architecture for compressive multichannel data acquisition," pp. 857–870, *IEEE transactions on biomedical circuits and systems*, vol. 8, no. 6, 2014.

[68] T.-S. Chen, H.-C. Kuo, and A.-Y. Wu, "A 232–1996-ks/s robust compressive sensing reconstruction engine for real-time physiological signals monitoring," pp. 307–317, *IEEE Journal of Solid-State Circuits*, vol. 54, no. 1, 2018.

[69] Y.-C. Cheng, P.-Y. Tsai, and M.-H. Huang, "Matrix-inversion-free compressed sensing with variable orthogonal multi-matching pursuit based on prior information for ecg signals," pp. 864–873, *IEEE Transactions on biomedical circuits and systems*, vol. 10, no. 4, 2016.

[70] V. R. Pamula, *et al.*, "A 172 μw compressively sampled photoplethysmographic (ppg) readout asic with heart rate estimation directly from compressively sampled data," pp. 487–496, *IEEE transactions on biomedical circuits and systems*, vol. 11, no. 3, 2017.

[71] F. Pareschi, P. Albertini, G. Frattini, M. Mangia, R. Rovatti, and G. Setti, "Hardware-algorithms co-design and implementation of an analog-to-information converter for biosignals based on compressed sensing," pp. 149–162, *IEEE transactions on biomedical circuits and systems*, vol. 10, no. 1, 2015.

[72] Z. Chen, *et al.*, "An energy-efficient ecg processor with weak-strong hybrid classifier for arrhythmia detection," pp. 948–952, *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 65, no. 7, 2017.

[73] T. Wu, W. Zhao, H. Guo, H. H. Lim, and Z. Yang, "A streaming pca vlsi chip for neural data compression," pp. 1290–1302, *IEEE transactions on biomedical circuits and systems*, vol. 11, no. 6, 2017.

[74] M. Wess, P. S. Manoj, and A. Jantsch, "Neural network based ecg anomaly detection on fpga and trade-off analysis," in *2017 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1–4, IEEE, 2017.

[75] A. Gogna, A. Majumdar, and R. Ward, "Semi-supervised stacked label consistent autoencoder for reconstruction and analysis of biomedical signals," pp. 2196–2205, *IEEE Transactions on Biomedical Engineering*, vol. 64, no. 9, 2016.

[76] O. Yildirim, R. San Tan, and U. R. Acharya, "An efficient compression of ecg signals using deep convolutional autoencoders," pp. 198–211, *Cognitive Systems Research*, vol. 52, 2018.

[77] S.-A. Huang, K.-C. Chang, H.-H. Liou, and C.-H. Yang, "A 1.9-mw svm processor with on-chip active learning for epileptic seizure control," pp. 452–464, *IEEE Journal of Solid-State Circuits*, vol. 55, no. 2, 2019.

[78] K. H. Lee and N. Verma, "A low-power processor with configurable embedded machine-learning accelerators for high-order and adaptive analysis of medical-sensor signals," pp. 1625–1637, *IEEE Journal of Solid-State Circuits*, vol. 48, no. 7, 2013.

[79] W.-M. Chen *et al.*, "A fully integrated 8-channel closed-loop neural-prosthetic cmos soc for real-time epileptic seizure control," pp. 232–247, *IEEE Journal of Solid-State Circuits*, vol. 49, no. 1, 2013.

[80] J. Kwong and A. P. Chandrakasan, "An energy-efficient biomedical signal processing platform," pp. 1742–1753, *IEEE Journal of Solid-State Circuits*, vol. 46, no. 7, 2011.

[81] S. R. Sridhara, *et al.*, "Microwatt embedded processor platform for medical system-on-chip applications," pp. 721–730, *IEEE Journal of Solid-State Circuits*, vol. 46, no. 4, 2011.

[82] J. Yoo, L. Yan, D. El-Damak, M. A. B. Altaf, A. H. Shoeb, and A. P. Chandrakasan, "An 8-channel scalable eeg acquisition soc with patient-specific seizure classification and recording processor," pp. 214–228, *IEEE journal of solid-state circuits*, vol. 48, no. 1, 2012.

[83] S.-Y. Hsu, Y. Ho, P.-Y. Chang, C. Su, and C.-Y. Lee, "A 48.6-to-105.2 μw machine learning assisted cardiac sensor soc for mobile healthcare applications," pp. 801–811, *IEEE Journal of Solid-State Circuits*, vol. 49, no. 4, 2014.

[84] X. He, R. A. Goubran, and X. P. Liu, "Secondary peak detection of ppg signal for continuous cuffless arterial blood pressure measurement," pp. 1431–1439, *IEEE Transactions on Instrumentation and Measurement*, vol. 63, no. 6, 2014.

[85] M. Kachuee, M. M. Kiani, H. Mohammadzade, and M. Shabany, "Cuffless blood pressure estimation algorithms for continuous health-care monitoring," pp. 859–869, *IEEE Transactions on Biomedical Engineering*, vol. 64, no. 4, 2016.

[86] K. Abdelhalim, V. Smolyakov, and R. Genov, "Phase-synchronization early epileptic seizure detector vlsi architecture," pp. 430–438, *IEEE transactions on biomedical circuits and systems*, vol. 5, no. 5, 2011.

[87] A. Page, C. Sagedy, E. Smith, N. Attaran, T. Oates, and T. Mohsenin, "A flexible multichannel eeg feature extractor and classifier for seizure detection," pp. 109–113, *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 62, no. 2, 2014.

[88] F. Samie, S. Paul, L. Bauer, and J. Henkel, "Highly efficient and accurate seizure prediction on constrained iot devices," in *2018 Design, Automation & Test in Europe Conference & Exhibition (DATE)*, pp. 955–960, IEEE, 2018.

[89] R. Genov and G. Cauwenberghs, "Kerneltron: Support vector "machine" in silicon," pp. 1426–1434, *IEEE Transactions on Neural Networks*, vol. 14, no. 5, 2003.

[90] K. Kang and T. Shibata, "An on-chip-trainable gaussian-kernel analog support vector machine," pp. 1513–1524, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 57, no. 7, 2009.

[91] M. Shoaib, K. H. Lee, N. K. Jha, and N. Verma, "A 0.6–107 μw energy-scalable processor for directly analyzing compressively-sensed eeg," pp. 1105–1118, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 61, no. 4, 2014.

[92] M. A. B. Altaf, C. Zhang, and J. Yoo, "A 16-channel patient-specific seizure onset and termination detection soc with impedance-adaptive transcranial electrical stimulator," pp. 2728–2740, *IEEE Journal of Solid-State Circuits*, vol. 50, no. 11, 2015.

[93] M. A. B. Altaf and J. Yoo, "A 1.83 μj/classification, 8-channel, patient-specific epileptic seizure classification soc using a non-linear support vector machine," pp. 49–60, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 10, no. 1, 2015.

[94] L. Feng, Z. Li, and Y. Wang, "Vlsi design of svm-based seizure detection system with on-chip learning capability," pp. 171–181, *IEEE transactions on biomedical circuits and systems*, vol. 12, no. 1, 2017.

[95] S. Benatti *et al.*, "A versatile embedded platform for emg acquisition and gesture recognition," pp. 620–630, *IEEE transactions on biomedical circuits and systems*, vol. 9, no. 5, 2015.

[96] G. Surrel, A. Aminifar, F. Rincón, S. Murali, and D. Atienza, "Online obstructive sleep apnea detection on medical wearable sensors," pp. 762–773, *IEEE transactions on biomedical circuits and systems*, vol. 12, no. 4, 2018.

[97] M. Hügle, *et al.*, "Early seizure detection with an energy-efficient convolutional neural network on an implantable microcontroller," in *2018 International Joint Conference on Neural Networks (IJCNN)*, pp. 1–7, IEEE, 2018.

[98] M.-P. Hosseini, H. Soltanian-Zadeh, K. Elisevich, and D. Pompili, "Cloud-based deep learning of big eeg data for epileptic seizure prediction," in *2016 IEEE global conference on signal and information processing (GlobalSIP)*, pp. 1151–1155, IEEE, 2016.

[99] P. A. Merolla, *et al.*, "A million spiking-neuron integrated circuit with a scalable communication network and interface," pp. 668–673, *Science*, vol. 345, no. 6197, 2014.

[100] S. M. Kueh and T. J. Kazmierski, "Low-power and low-cost dedicated bit-serial hardware neural network for epileptic seizure prediction system," pp. 1–9, *IEEE journal of translational engineering in health and medicine*, vol. 6, 2018.

[101] Y. Park, S.-H. Han, W. Byun, J.-H. Kim, H.-C. Lee, and S.-J. Kim, "A real-time depth of anesthesia monitoring system based on deep neural network with large edo tolerant eeg analog front-end," pp. 825–837, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 14, no. 4, 2020.

[102] J. P. Dominguez-Morales, A. F. Jimenez-Fernandez, M. J. Dominguez-Morales, and G. Jimenez-Moreno, "Deep neural networks for the recognition and classification of heart murmurs using neuromorphic auditory sensors," pp. 24–34, *IEEE transactions on biomedical circuits and systems*, vol. 12, no. 1, 2017.

[103] J. Deng, W. Dong, R. Socher, L.-J. Li, K. Li, and L. Fei-Fei, "Imagenet: A large-scale hierarchical image database," in *2009 IEEE conference on computer vision and pattern recognition*, pp. 248–255, IEEE, 2009.

[104] X. Zhang, X. Zhou, M. Lin, and J. Sun, "Shufflenet: An extremely efficient convolutional neural network for mobile devices," in *Proceedings of the IEEE conference on computer vision and pattern recognition*, pp. 6848–6856, 2018.

[105] R. J. Wang, X. Li, and C. X. Ling, "Pelee: A real-time object detection system on mobile devices," *arXiv preprint arXiv:1804.06882*, 2018.

[106] M. Sandler, A. Howard, M. Zhu, A. Zhmoginov, and L.-C. Chen, "Mobilenetv2: Inverted residuals and linear bottlenecks," in *Proceedings of the IEEE conference on computer vision and pattern recognition*, pp. 4510–4520, 2018.

[107] F. N. Iandola, S. Han, M. W. Moskewicz, K. Ashraf, W. J. Dally, and K. Keutzer, "Squeezenet: Alexnet-level accuracy with 50x fewer parameters and <0.5 mb model size," *arXiv preprint arXiv:1602.07360*, 2016.

[108] A. G. Howard, *et al.*, "Mobilenets: Efficient convolutional neural networks for mobile vision applications," *arXiv preprint arXiv:1704.04861*, 2017.

[109] S. Zhao, J. Yang, Y. Xu, and M. Sawan, "Binary single-dimensional convolutional neural network for seizure prediction," in *2020 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1–5, 2020.

[110] S. Zhao, J. Yang, and M. Sawan, "Energy-efficient neural network for epileptic seizure prediction," *IEEE Transactions on Biomedical Engineering*, 2021.

[111] Z. Wang, J. Yang, and M. Sawan, "A novel multi-scale dilated 3d cnn for epileptic seizure prediction," in *2021 IEEE 3rd International Conference on Artificial Intelligence Circuits and Systems (AICAS)*, pp. 1–4, IEEE, 2021.

[112] V. J. Lawhern, A. J. Solon, N. R. Waytowich, S. M. Gordon, C. P. Hung, and B. J. Lance, "Eegnet: A compact convolutional neural network for eeg-based brain–computer interfaces," p. 056 013, *Journal of neural engineering*, vol. 15, no. 5, 2018.

[113] Z. Liu *et al.*, "Neural signal analysis with memristor arrays towards high-efficiency brain–machine interfaces," pp. 1–9, *Nature communications*, vol. 11, no. 1, 2020.

[114] Z. Liu, *et al.*, "Multichannel parallel processing of neural signals in memristor arrays," *Science advances*, vol. 6, 2020.

[115] J. Lee, C. Kim, S. Kang, D. Shin, S. Kim, and H.-J. Yoo, "Unpu: A 50.6 tops/w unified deep neural network accelerator with 1b-to-16b fully-variable weight bit-precision," in *2018 IEEE International Solid-State Circuits Conference-(ISSCC)*, pp. 218–220, IEEE, 2018.

[116] D. Bankman, L. Yang, B. Moons, M. Verhelst, and B. Murmann, "An always-on 3.8 $\mu/86\%$ cifar-10 mixed-signal binary cnn processor with all memory on chip in 28-nm cmos," pp. 158–172, *IEEE Journal of Solid-State Circuits*, vol. 54, no. 1, 2018.

[117] M. Kishi, *et al.*, "Micro thermoelectric modules and their application to wristwatches as an energy source," in *Eighteenth International Conference on Thermoelectrics. Proceedings, ICT'99 (Cat. No.99TH8407)*, pp. 301–307, 1999. DOI: 10.1109/ICT.1999.843389.

[118] T. Ghomian and S. Mehraeen, "Survey of energy scavenging for wearable and implantable devices," pp. 33–49, *Energy*, vol. 178, 2019. DOI: 10.1016/j.energy.2019.04.088.

[119] M. Rasouli and L. S. J. Phee, "Energy sources and their development for application in medical devices," pp. 693–709, *Expert Review of Medical Devices*, vol. 7, no. 5, 2010. DOI: 10.1586/erd.10.20.

[120] G. Rong, Y. Zheng, and M. Sawan, "Energy solutions for wearable sensors: A review," p. 3806, *Sensors*, vol. 21, no. 11, 2021. DOI: 10.3390/s21113806.

[121] S. P. Beeby, M. J. Tudor, and N. M. White, "Energy harvesting vibration sources for microsystems applications," *Measurement Science and Technology*, vol. 17, no. 12, 2006. DOI: 10.1088/0957-0233/17/12/R01.

[122] S. Priya and D. J. Inman, *Energy harvesting technologies*. Springer, 2009.

[123] P. D. Mitcheson, E. M. Yeatman, G. K. Rao, A. S. Holmes, and T. C. Green, "Energy harvesting from human and machine motion for wireless electronic devices," pp. 1457–1486, *Proceedings of the IEEE*, vol. 96, no. 9, 2008. DOI: 10.1109/JPROC.2008.927494.

[124] C. Wei and X. Jing, "A comprehensive review on vibration energy harvesting: Modelling and realization," pp. 1–18, *Renewable and Sustainable Energy Reviews*, vol. 74, 2017. DOI: 10.1016/j.rser.2017.01.073.

[125] T. Ghomian, O. Kizilkaya, and J.-W. Choi, "Lead sulfide colloidal quantum dot photovoltaic cell for energy harvesting from human body thermal radiation," pp. 761–768, *Applied Energy*, vol. 230, 2018. DOI: 10.1016/j.apenergy.2018.09.004.

[126] T. Wu, F. Wu, J. Redouté, and M. R. Yuce, "An autonomous wireless body area network implementation towards iot connected healthcare applications," pp. 11 413–11 422, *IEEE Access*, vol. 5, 2017. DOI: 10.1109/ACCESS.2017.2716344.

[127] W. Y. Toh, Y. K. Tan, W. S. Koh, and L. Siek, "Autonomous wearable sensor nodes with flexible energy harvesting," pp. 2299–2306, *IEEE Sensors Journal*, vol. 14, no. 7, 2014. DOI: 10.1109/JSEN.2014.2309900.

[128] W. Zeng, L. Shu, Q. Li, S. Chen, F. Wang, and X. M. Tao, "Fiber-based wearable electronics: A review of materials, fabrication, devices, and applications," pp. 5310–5336, *Advanced materials*, vol. 26, no. 31, 2014.

[129] A. E. Ostfeld, A. M. Gaikwad, Y. Khan, and A. C. Arias, "High-performance flexible energy storage and harvesting system for wearable electronics," pp. 1–10, *Scientific reports*, vol. 6, no. 1, 2016.

[130] V. Kartsch, S. Benatti, M. Mancini, M. Magno, and L. Benini, "Smart wearable wristband for emg based gesture recognition powered by solar energy harvester," in *2018 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1–5, 2008. DOI: 10.1109/ISCAS.2018.8351727.

[131] J. P. Dieffenderfer, *et al.*, "Solar powered wrist worn acquisition system for continuous photoplethysmogram monitoring," in *2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, pp. 3142–3145, Aug., 2014. DOI: 10.1109/EMBC.2014.6944289.

[132] Y. Zhu, S. O. R. Moheimani, and M. R. Yuce, "A 2-dof wideband electrostatic transducer for energy harvesting and implantable applications," pp. 1542–1545, *Proceedings of IEEE Sensors*, 2009. DOI: 10.1109/ICSENS.2009.5398476.

[133] S. Ahmed and V. Kakkar, "A novel angular sio2 electret-based electrostatic energy harvester for cardiac and neural implants," pp. 1523–1526, *Biomedical Research*, vol. 29, no. 8, 2018.

[134] L. Bu, H. Xu, and B. Xu, "A novel electrostatic vibration energy harvester array using sidewall electric field," pp. 1–3, 2014. DOI: 10.1109/ICSICT.2014.7021222.

[135] A. G. Fowler, S. O. R. Moheimani, and S. Behrens, "An omnidirectional mems ultrasonic energy harvester for implanted devices," pp. 1454–1462, *Journal of Microelectromechanical Systems*, vol. 23, no. 6, 2014. DOI: 10.1109/JMEMS.2014.2315199.

[136] A. G. Fowler, S. O. R. Moheimani, and S. Behrens, "Design and characterization of a 2-dof mems ultrasonic energy harvester with triangular electrostatic electrodes," pp. 1421–1423, *IEEE Electron Device Letters*, vol. 34, no. 11, 2013. DOI: 10.1109/LED.2013.2282815.

[137] S. Risquez, M. Woytasik, J. Wei, F. Parrain, and E. Lefeuvre, "Design of a 3d multilayer out-of-plane overlap electrostatic energy harvesting mems for medical implant applications," pp. 1–5, *Symposium on Design, Test, Integration and Packaging of MEMS/MOEMS, DTIP 2015*, 2015. DOI: 10.1109/DTIP.2015.7160963.

[138] R. Tashiro, N. Kabei, K. Katayama, Y. Ishizuka, F. Tsuboi, and K. Tsuchiya, "Development of an electrostatic generator that harnesses the motion of a living body: Use of a resonant phenomenon," pp. 916–922, *JSME International Journal Series C*, vol. 43, no. 4, 2000. DOI: 10.1299/jsmec.43.916.

[139] U. Jamil and R. I. Shakoor, "Electrostatic energy harvester design using in-plane gap closing and in-plane overlap varying mechanisms," pp. 3–7, *2019 International Conference on Robotics and Automation in Industry, ICRAI 2019*, 2019. DOI: 10.1109/ICRAI47710.2019.8967362.

[140] L. Zhou, A. C. Abraham, S. Y. Tang, and S. Chakrabartty, "A 5 nw quasi-linear cmos hot-electron injector for self-powered monitoring of biomechanical strain variations," pp. 1143–1151, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 10, no. 6, 2016. DOI: 10.1109/TBCAS.2016.2523992.

[141] E. E. Aktakka, R. L. Peterson, and K. Najafi, "A self-supplied inertial piezoelectric energy harvester with power-management ic," pp. 120–121, 2011. DOI: 10.1109/ISSCC.2011.5746246.

[142] S. H. Kondapalli, Y. Alazzawi, M. Malinowski, T. Timek, and S. Chakrabartty, "Feasibility of self-powering and energy harvesting using cardiac valvular perturbations," pp. 1392–1400, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 12, no. 6, 2018. DOI: 10.1109/TBCAS.2018.2865405.

[143] P. Sarkar, C. Huang, and S. Chakrabartty, "An ultra-linear piezo-floating-gate strain-gauge for self-powered measurement of quasi-static-strain," pp. 437–450, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 7, no. 4, 2013. DOI: 10.1109/TBCAS.2012.2220764.

[144] N. Lajnef, N. G. Elvin, and S. Chakrabartty, "A piezo-powered floating-gate sensor array for long-term fatigue monitoring in biomechanical implants," pp. 164–172, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 2, no. 3, 2008. DOI: 10.1109/TBCAS.2008.2001473.

[145] W. J. Li, T. C. H. Ho, G. M. H. Chan, P. H. W. Leong, and W. H. Yung, "Infrared signal transmission by a laser-micromachined, vibration-induced power generator," in *Proceedings of the 43rd IEEE Midwest Symposium on Circuits and Systems (Cat. No. CH37144)*, vol. 1, pp. 236–239, 2000. DOI: 10.1109/MWSCAS.2000.951628.

[146] M. El-hami *et al.*, "Design and fabrication of a new vibration-based electromechanical power generator," pp. 335–342, *Sensors and Actuators A: Physical*, vol. 92, no. 1, 2001. DOI: 10.1016/S0924-4247(01)00569-6.

[147] C. C. Enger, "Implantable biotelemetry transmitter and method of using same," 1979.

[148] J. Kymissis, C. Kendall, J. Paradiso, and N. Gershenfeld, "Parasitic power harvesting in shoes," in *Digest of Papers. Second International Symposium on Wearable Computers (Cat. No.98EX215)*, pp. 132–139, 1998. DOI: 10.1109/ISWC.1998.729539.

[149] S. Wang, Y. Xie, S. Niu, L. Lin, and Z. L. Wang, "Freestanding triboelectric-layer-based nanogenerators for harvesting energy from a moving object or human motion in contact and non-contact modes," pp. 2818–2824, *Advanced materials*, vol. 26, no. 18, 2014.

[150] Y. Xie, *et al.*, "Grating-structured freestanding triboelectric-layer nanogenerator for harvesting mechanical energy at 85% total conversion efficiency," pp. 6599–6607, *Advanced materials*, vol. 26, no. 38, 2014.

[151] W. Yang, *et al.*, “Harvesting energy from the natural vibration of human walking,” pp. 11 317–11 324, *ACS nano*, vol. 7, no. 12, 2013.

[152] W. Seung, *et al.*, “Nanopatterned textile-based wearable triboelectric nanogenerator,” pp. 3501–3509, *ACS nano*, vol. 9, no. 4, 2015.

[153] S. Bose, B. Shen, and M. L. Johnston, “26.5 a 20 µw heartbeat detection system-on-chip powered by human body heat for self-sustaining wearable healthcare,” pp. 408–410, 2020. DOI: 10.1109/ISSCC19947.2020.9063071.

[154] Y. Zhang *et al.*, “A batteryless 19 μw mics/ism-band energy harvesting body sensor node soc for exg applications,” pp. 199–213, *IEEE Journal of Solid-State Circuits*, vol. 48, no. 1, 2013. DOI: 10.1109/JSSC.2012.2221217.

[155] Y. Sargolzaeiaval, *et al.*, “Flexible thermoelectric generators for body heat harvesting – enhanced device performance using high thermal conductivity elastomer encapsulation on liquid metal interconnects,” p. 114 370, *Applied Energy*, vol. 262, 2020. DOI: 10.1016/j.apenergy.2019.114370.

[156] E. Katz, A. F. Bückmann, and I. Willner, “Self-powered enzyme-based biosensors,” pp. 10 752–10 753, *J. Am. Chem. Soc.*, vol. 123, no. 43, 2001. DOI: 10.1021/ja0167102.

[157] M. Zhou, “Recent progress on the development of biofuel cells for self-powered electrochemical biosensing and logic biosensing: A review,” pp. 1786–1810, *Electroanalysis*, vol. 27, no. 8, 2015. DOI: 10.1002/elan.201500173.

[158] T. Hanashi, T. Yamazaki, W. Tsugawa, K. Ikebukuro, and K. Sode, “Bioradiotransmitter: A self-powered wireless glucose-sensing system,” 2011.

[159] S. Seok, C. Wang, E. Lefeuvre, and J. Park, “Autonomous energy harvester based on textile-based enzymatic biofuel cell for on-demand usage,” *Sensors*, vol. 20, no. 17, 2020. DOI: 10.3390/s20175009.

[160] D. M. Pozar, *Microwave engineering*. Publishing House of Elec, 2004.

[161] W. Zhou, Y. Su, L. Huang, X. Qing, and A. P. Hu, "Wireless power transfer across a metal barrier by combined capacitive and inductive coupling," pp. 4031–4041, *IEEE Transactions on Industrial Electronics*, vol. 66, no. 5, 2019.

[162] K. Agarwal, R. Jegadeesan, Y. Guo, and N. V. Thakor, "Wireless power transfer strategies for implantable bioelectronics," pp. 136–161, *IEEE Reviews in Biomedical Engineering*, vol. 10, 2017.

[163] W. Zhong and S. Y. R. Hui, "Maximum energy efficiency operation of series-series resonant wireless power transfer systems using on-off keying modulation," pp. 3595–3603, *IEEE Transactions on Power Electronics*, vol. 33, no. 4, 2018.

[164] R. Narayanamoorthi, "Modeling of capacitive resonant wireless power and data transfer to deep biomedical implants," pp. 1253–1263, *IEEE Transactions on Components, Packaging and Manufacturing Technology*, vol. 9, no. 7, 2019.

[165] M. Wu, X. Chen, C. Qi, and X. Mu, "Considering losses to enhance circuit model accuracy of ultrasonic wireless power transfer system," pp. 8788–8798, *IEEE Transactions on Industrial Electronics*, vol. 67, no. 10, 2020.

[166] A. Ibrahim and M. Kiani, "A figure-of-merit for design and optimization of inductive power transmission links for millimeter-sized biomedical implants," pp. 1100–1111, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 10, no. 6, 2016.

[167] Z. Zhang, H. Pang, A. Georgiadis, and C. Cecati, "Wireless power transfer—an overview," pp. 1044–1058, *IEEE Transactions on Industrial Electronics*, vol. 66, no. 2, 2019.

[168] W. Zhang, S. Wong, C. K. Tse, and Q. Chen, "Analysis and comparison of secondary series- and parallel-compensated inductive power transfer systems operating for optimal efficiency and load-independent voltage-transfer ratio," pp. 2979–2990, *IEEE Transactions on Power Electronics*, vol. 29, no. 6, 2014.

[169] Y. Li, J. Zhao, Q. Yang, L. Liu, J. Ma, and X. Zhang, "A novel coil with high misalignment tolerance for wireless power transfer," pp. 1–4, *IEEE Transactions on Magnetics*, vol. 55, no. 6, 2019.

[170] Y. Chen, R. Mai, Y. Zhang, M. Li, and Z. He, "Improving misalignment tolerance for ipt system using a third-coil," pp. 3009–3013, *IEEE Transactions on Power Electronics*, vol. 34, no. 4, 2019.

[171] A. Trigui, S. Hached, F. Mounaim, A. C. Ammari, and M. Sawan, "Inductive power transfer system with self-calibrated primary resonant frequency," pp. 6078–6087, *IEEE Transactions on Power Electronics*, vol. 30, no. 11, 2015.

[172] M. Kiani and M. Ghovanloo, "An rfid-based closed-loop wireless power transmission system for biomedical applications," pp. 260–264, *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 57, no. 4, 2010.

[173] S. S. Hashemi, M. Sawan, and Y. Savaria, "A high-efficiency low-voltage cmos rectifier for harvesting energy in implantable devices," pp. 326–335, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 6, no. 4, 2012.

[174] F. Lu, H. Zhang, and C. Mi, "A review on the recent development of capacitive wireless power transfer technology," *Energies*, vol. 10, no. 11, 2017.

[175] S. Sinha, A. Kumar, B. Regensburger, and K. K. Afridi, "Design of high-efficiency matching networks for capacitive wireless power transfer systems," pp. 1–1, *IEEE Journal of Emerging and Selected Topics in Power Electronics*, 2020.

[176] X. Dai, L. Li, Y. Li, G. Hou, H. F. Leung, and A. P. Hu, "Determining the maximum power transfer condition for ultrasonic power transfer system," in *2016 IEEE 2nd Annual Southern Power Electronics Conference (SPEC)*, pp. 1–6, 5-8 Dec. 2016.

[177] H. Vihvelin, J. R. Leadbetter, M. Bance, J. A. Brown, and R. B. A. Adamson, "Compensating for tissue changes in an ultrasonic power link for implanted medical devices," pp. 404–411, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 10, no. 2, 2016.

[178] E. So, P. Yeon, E. J. Chichilnisky, and A. Arbabian, "An rf-ultrasound relay for powering deep implants across air-tissue interfaces with a multi-output regulating rectifier and ultrasound beamforming," in *2021 Symposium on VLSI Circuits*, pp. 1–2, 13-19 June 2021.

[179] T. C. Chang, M. Wang, and A. Arbabian, "Multi-access networking with wireless ultrasound-powered implants," in *2019 IEEE Biomedical Circuits and Systems Conference (BioCAS)*, pp. 1–4, 17-19 Oct. 2019.

[180] M. M. Ghanbari and R. Muller, "Optimizing volumetric efficiency and backscatter communication in biosensing ultrasonic implants," pp. 1381–1392, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 14, no. 6, 2020.

[181] C. Shi, T. Costa, J. Elloian, Y. Zhang, and K. L. Shepard, "A 0.065-mm^3 monolithically-integrated ultrasonic wireless sensing mote for real-time physiological temperature monitoring," pp. 412–424, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 14, no. 3, 2020.

[182] A. Ibrahim, M. Meng, and M. Kiani, "A comprehensive comparative study on inductive and ultrasonic wireless power transmission to biomedical implants," pp. 3813–3826, *IEEE Sensors Journal*, vol. 18, no. 9, 2018.

[183] A. Kiourti and K. S. Nikita, "A review of in-body biotelemetry devices: Implantables, ingestibles, and injectables," pp. 1422–1430, *IEEE Transactions on Biomedical Engineering*, vol. 64, no. 7, 2017.

[184] M. K. Goenka, S. Majumder, and U. Goenka, "Capsule endoscopy: Present status and future expectation," p. 10 024, *World Journal of Gastroenterology: WJG*, vol. 20, no. 29, 2014.

[185] X. Li, W. A. Serdijn, W. Zheng, Y. Tian, and B. Zhang, "The injectable neurostimulator: An emerging therapeutic device," pp. 388–394, *Trends in biotechnology*, vol. 33, no. 7, 2015.

[186] A. K. Teshome, B. Kibret, and D. T. Lai, "A review of implant communication technology in wban: Progress and challenges," pp. 88–99, *IEEE reviews in biomedical engineering*, vol. 12, 2018.

[187] B. John, *et al.*, "A stent graft occlusion detection: Pressure sensing implant device with inductive power and data telemetry," in *2018 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1–4, IEEE, 2018.

[188] Y. Yu, T. Nguyen, P. Tathireddy, D. J. Young, and S. Roundy, "Wireless hydrogel-based glucose sensor for future implantable applications," in *2016 IEEE SENSORS*, pp. 1–3, IEEE, 2016.

[189] G. Wang, W. Liu, M. Sivaprakasam, and G. A. Kendir, "Design and analysis of an adaptive transcutaneous power telemetry for biomedical implants," pp. 2109–2117, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 52, no. 10, 2005.

[190] J. Zhao, L. Yao, R.-F. Xue, P. Li, M. Je, and Y. P. Xu, "An integrated wireless power management and data telemetry ic for high-compliance-voltage electrical stimulation applications," pp. 113–124, *IEEE transactions on biomedical circuits and systems*, vol. 10, no. 1, 2015.

[191] Y.-P. Lin and K.-T. Tang, "An inductive power and data telemetry subsystem with fast transient low dropout regulator for biomedical implants," pp. 435–444, *IEEE transactions on biomedical circuits and systems*, vol. 10, no. 2, 2015.

[192] Y.-J. Chi and F.-C. Chen, "On-body adhesive-bandage-like antenna for wireless medical telemetry service," pp. 2472–2480, *IEEE Transactions on Antennas and Propagation*, vol. 62, no. 5, 2014.

[193] J. Ung and T. Karacolak, "A wideband implantable antenna for continuous health monitoring in the medradio and ism bands," pp. 1642–1645, *IEEE Antennas and Wireless Propagation Letters*, vol. 11, 2012.

[194] A. Kiourti and K. S. Nikita, "A review of implantable patch antennas for biomedical telemetry: Challenges and solutions [wireless corner]," pp. 210–228, *IEEE Antennas and Propagation Magazine*, vol. 54, no. 3, 2012.

[195] H. Cruz, H.-Y. Huang, S.-Y. Lee, and C.-H. Luo, "A 1.3 mw low-if, current-reuse, and current-bleeding rf front-end for the mics band with sensitivity of-97 dbm," pp. 1627–1636, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 62, no. 6, 2015.

[196] M. Song *et al.*, "A millimeter-scale crystal-less mics transceiver for insertable smart pills," pp. 1218–1229, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 14, no. 6, 2020.

[197] M.-C. Lee, *et al.*, "A cmos medradio transceiver with supply-modulated power saving technique for an implantable brain–machine interface system," pp. 1541–1552, *IEEE Journal of Solid-State Circuits*, vol. 54, no. 6, 2019.

[198] P. D. Bradley, "An ultra low power, high performance medical implant communication system (mics) transceiver for implantable devices," in *2006 IEEE Biomedical Circuits and Systems Conference*, pp. 158–161, IEEE, 2006.

[199] H. Cruz, H.-Y. Huang, S.-Y. Lee, and C.-H. Luo, "Analysis and design of a 1.3-mw current-reuse rf front-end for the mics band," in *2014 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1360–1363, IEEE, 2014.

[200] M. Zgaren and M. Sawan, "A low-power dual-injection-locked rf receiver with fsk-to-ook conversion for biomedical implants," pp. 2748–2758, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 62, no. 11, 2015.

[201] N. Cho, J. Bae, and H.-J. Yoo, "A 10.8 mw body channel communication/mics dual-band transceiver for a unified body sensor network controller," pp. 3459–3468, *IEEE Journal of Solid-State Circuits*, vol. 44, no. 12, 2009.

[202] S. Kim, W. Lepkowski, S. J. Wilk, T. J. Thornton, and B. Bakkaloglu, "A low-power cmos bfsk transceiver for health monitoring systems," in *2011 IEEE Biomedical Circuits and Systems Conference (BioCAS)*, pp. 157–160, IEEE, 2011.

[203] T. G. Zimmerman, "Personal area networks: Near-field intrabody communication," pp. 609–617, *IBM systems Journal*, vol. 35, no. 3.4, 1996.

[204] B. Kibret, M. Seyedi, D. T. Lai, and M. Faulkner, "Investigation of galvanic-coupled intrabody communication using the human body circuit model," pp. 1196–1206, *IEEE Journal of Biomedical and Health Informatics*, vol. 18, no. 4, 2014.

[205] M. Seyedi, B. Kibret, D. T. Lai, and M. Faulkner, "A survey on intrabody communications for body area network applications," pp. 2067–2079, *IEEE Transactions on Biomedical Engineering*, vol. 60, no. 8, 2013.

[206] R. Xu, H. Zhu, and J. Yuan, "Electric-field intrabody communication channel modeling with finite-element method," pp. 705–712, *IEEE transactions on biomedical engineering*, vol. 58, no. 3, 2010.

[207] J. Bae, K. Song, H. Lee, H. Cho, and H.-J. Yoo, "A 0.24-nj/b wireless body-area-network transceiver with scalable double-fsk modulation," pp. 310–322, *IEEE Journal of Solid-State Circuits*, vol. 47, no. 1, 2011.

[208] Y.-T. Lin, Y.-S. Lin, C.-H. Chen, H.-C. Chen, Y.-C. Yang, and S.-S. Lu, "A 0.5-v biomedical system-on-a-chip for intrabody communication system," pp. 690–699, *IEEE Transactions on Industrial Electronics*, vol. 58, no. 2, 2010.

[209] J. Bae, K. Song, H. Lee, H. Cho, and H.-J. Yoo, "A low-energy crystal-less double-fsk sensor node transceiver for wireless body-area network," pp. 2678–2692, *IEEE Journal of Solid-State Circuits*, vol. 47, no. 11, 2012.

[210] Y. Jeon, *et al.*, "A 100mb/s galvanically-coupled body-channel-communication transceiver with 4.75 pj/b tx and 26.8 pj/b rx for bionic arms," in *2019 Symposium on VLSI Circuits*, pp. C292–C293, IEEE, 2019.

[211] J. Jang, H. Cho, and H.-J. Yoo, "An 802.15. 6 hbc standard compatible transceiver and 90 pj/b full-duplex transceiver for body channel communication," in *2019 IEEE Biomedical Circuits and Systems Conference (BioCAS)*, pp. 1–4, IEEE, 2019.

[212] S. Maity, B. Chatterjee, G. Chang, and S. Sen, "Bodywire: A 6.3-pj/b 30-mb/s 30-db sir-tolerant broadband interference-robust human body communication transceiver using time domain interference rejection," pp. 2892–2906, *IEEE Journal of Solid-State Circuits*, vol. 54, no. 10, 2019.

[213] P.-Y. Tsai, Y.-Y. Chang, S.-Y. Hsu, and C.-Y. Lee, "An ofdm-based 29.1 mbps 0.22 nj/bit body channel communication baseband transceiver," in *VLSI Design, Automation and Test (VLSI-DAT)*, pp. 1–4, IEEE, 2015.

[214] J. Zhao *et al.*, "A 4-mbps 41-pj/bit on-off keying transceiver for body-channel communication with enhanced auto loss compensation technique," in *2019 IEEE Asian Solid-State Circuits Conference (A-SSCC)*, pp. 173–176, IEEE, 2019.

[215] J. Charthad, M. J. Weber, T. C. Chang, M. Saadat, and A. Arbabian, "A mm-sized implantable device with ultrasonic energy transfer and rf data uplink for high-power applications," in *Proceedings of the IEEE 2014 Custom Integrated Circuits Conference*, pp. 1–4, IEEE, 2014.

[216] G. E. Santagati, T. Melodia, L. Galluccio, and S. Palazzo, "Medium access control and rate adaptation for ultrasonic intrabody sensor networks," pp. 1121–1134, *IEEE/ACM Transactions on Networking*, vol. 23, no. 4, 2014.

[217] G. E. Santagati, N. Dave, and T. Melodia, "Design and performance evaluation of an implantable ultrasonic networking platform for the internet of medical things," pp. 29–42, *IEEE/ACM Transactions on Networking*, vol. 28, no. 1, 2020.

[218] E. Demirors, G. Alba, G. E. Santagati, and T. Melodia, "High data rate ultrasonic communications for wireless intra-body networks," in *2016 IEEE International Symposium on Local and Metropolitan Area Networks (LANMAN)*, pp. 1–6, IEEE, 2016.

[219] F. Mazzilli and C. Dehollain, "184 μw ultrasonic on–off keying/amplitude-shift keying demodulator for downlink communication in deep implanted medical devices," pp. 502–504, *Electronics Letters*, vol. 52, no. 7, 2016.

[220] J. L. Abita and W. Schneider, "Transdermal optical communications," pp. 261–268, *Johns Hopkins APL Tech. Dig*, vol. 25, no. 3, 2004.

[221] M. Faria, L. N. Alves, and P. S. de Brito André, "Transdermal optical communications," in *Visible Light Communications*, pp. 309–336, CRC Press, 2017.

[222] M. J. Saikia, W. G. Besio, and K. Mankodiya, "Wearlight: Toward a wearable, configurable functional nir spectroscopy system for noninvasive neuroimaging," pp. 91–102, *IEEE Transactions on Biomedical Circuits and Systems*, vol. 13, no. 1, 2018.

[223] S. Saha, Y. Lu, F. Lesage, and M. Sawan, "Wearable sipm-based nirs interface integrated with pulsed laser source," pp. 1313–1323, *IEEE transactions on biomedical circuits and systems*, vol. 13, no. 6, 2019.

[224] E. Conca *et al.*, "Large-area, fast-gated digital sipm with integrated tdc for portable and wearable time-domain nirs," pp. 3097–3111, *IEEE Journal of Solid-State Circuits*, vol. 55, no. 11, 2020.

[225] J. Xu, *et al.*, "A 665 μw silicon photomultiplier-based nirs/eeg/eit monitoring asic for wearable functional brain imaging," pp. 1267–1277, *IEEE transactions on biomedical circuits and systems*, vol. 12, no. 6, 2018.

[226] G. Gurun, *et al.*, "Single-chip cmut-on-cmos front-end system for real-time volumetric ivus and ice imaging," pp. 239–250, *IEEE transactions on ultrasonics, ferroelectrics, and frequency control*, vol. 61, no. 2, 2014.

[227] J. Lim, C. Tekes, E. F. Arkan, A. Rezvanitabar, F. L. Degertekin, and M. Ghovanloo, "Highly integrated guidewire ultrasound imaging system-on-a-chip," pp. 1310–1323, *IEEE journal of solid-state circuits*, vol. 55, no. 5, 2020.

[228] J. Lim, C. Tekes, F. L. Degertekin, and M. Ghovanloo, "Towards a reduced-wire interface for cmut-based intravascular ultrasound imaging systems," pp. 400–410, *IEEE transactions on biomedical circuits and systems*, vol. 11, no. 2, 2016.

[229] M. M. Ahmadi and G. A. Jullien, “Current-mirror-based potentiostats for three-electrode amperometric electrochemical sensors,” pp. 1339–1348, *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 56, no. 7, 2008.

[230] C. Chen *et al.*, “A pitch-matched front-end asic with integrated subarray beamforming adc for miniature 3-d ultrasound probes,” pp. 3050–3064, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 11, 2018.

[231] J. Lee, *et al.*, “11.1 a 5.37 mw/channel pitch-matched ultrasound asic with dynamic-bit-shared sar adc and 13.2 v charge-recycling tx in standard cmos for intracardiac echocardiography,” in *2019 IEEE International Solid-State Circuits Conference-(ISSCC)*, pp. 190–192, IEEE, 2019.

[232] A. Bhuyan, *et al.*, “Integrated circuits for volumetric ultrasound imaging with 2-d cmut arrays,” pp. 796–804, *IEEE transactions on biomedical circuits and systems*, vol. 7, no. 6, 2013.

[233] Y. Katsube, *et al.*, “27.6 single-chip 3072ch 2d array ic with rx analog and all-digital tx beamformer for 3d ultrasound imaging,” in *2017 IEEE International Solid-State Circuits Conference (ISSCC)*, pp. 458–459, IEEE, 2017.

[234] M. Tan, *et al.*, “A front-end asic with high-voltage transmit switching and receive digitization for 3-d forward-looking intravascular ultrasound imaging,” pp. 2284–2297, *IEEE Journal of Solid-State Circuits*, vol. 53, no. 8, 2018.

[235] K. Chen, H.-S. Lee, and C. G. Sodini, “A column-row-parallel asic architecture for 3-d portable medical ultrasonic imaging,” pp. 738–751, *IEEE Journal of Solid-State Circuits*, vol. 51, no. 3, 2015.

[236] A. T. Mobashsher, A. M. Abbosh, and Y. Wang, “Microwave system to detect traumatic brain injuries using compact unidirectional antenna and wideband transceiver with verification on realistic head phantom,” pp. 1826–1836, *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 9, 2014.

[237] H. Bahramiabarghouei, E. Porter, A. Santorelli, B. Gosselin, M. Popović, and L. A. Rusch, "Flexible 16 antenna array for microwave breast cancer detection," pp. 2516–2525, *IEEE Transactions on Biomedical Engineering*, vol. 62, no. 10, 2015.

[238] M. Hopfer, R. Planas, A. Hamidipour, T. Henriksson, and S. Semenov, "Electromagnetic tomography for detection, differentiation, and monitoring of brain stroke: A virtual data and human head phantom study," pp. 86–97, *IEEE Antennas and Propagation Magazine*, vol. 59, no. 5, 2017.

[239] M. Persson, *et al.*, "Microwave-based stroke diagnosis making global prehospital thrombolytic treatment possible," pp. 2806–2817, *IEEE Transactions on Biomedical Engineering*, vol. 61, no. 11, 2014.

[240] M. R. Casu, *et al.*, "A cots-based microwave imaging system for breast-cancer detection," pp. 804–814, *IEEE transactions on biomedical circuits and systems*, vol. 11, no. 4, 2017.

[241] S. Hong, *et al.*, "A 4.9 mΩ-sensitivity mobile electrical impedance tomography ic for early breast-cancer detection system," pp. 245–257, *IEEE Journal of Solid-State Circuits*, vol. 50, no. 1, 2014.

[242] J. Xu and Z. Hong, "Low power bio-impedance sensor interfaces: Review and electronics design methodology," *IEEE Reviews in Biomedical Engineering*, 2020.

[243] S. Hong, J. Lee, J. Bae, and H.-J. Yoo, "A 10.4 mw electrical impedance tomography soc for portable real-time lung ventilation monitoring system," pp. 2501–2512, *IEEE Journal of Solid-State Circuits*, vol. 50, no. 11, 2015.

[244] M. Kim, *et al.*, "A 1.4-mΩ-sensitivity 94-db dynamic-range electrical impedance tomography soc and 48-channel hub-soc for 3-d lung ventilation monitoring system," pp. 2829–2842, *IEEE Journal of Solid-State Circuits*, vol. 52, no. 11, 2017.

[245] K. Kim, C. Kim, S. Choi, and H.-J. Yoo, "A 0.5 v, 6.2 μw, 0.059 mm 2 sinusoidal current generator ic with 0.088% thd for bio-impedance sensing,"

[246] J. Y. Liu, J. Xu, F. Forsberg, and J.-B. Liu, "Cmut/cmos-based butterfly iq-a portable personal sonoscope," pp. 115–118, *Advanced Ultrasound in Diagnosis and Therapy*, vol. 3, no. 3, 2019.

[247] M. J. Khan and K.-S. Hong, "Hybrid eeg–fnirs-based eight-command decoding for bci: Application to quadcopter control," p. 6, *Frontiers in neurorobotics*, vol. 11, 2017.

[248] N. J. Ronkainen, H. B. Halsall, and W. R. Heineman, "Electrochemical biosensors," pp. 1747–1763, *Chemical Society Reviews*, vol. 39, no. 5, 2010.

[249] W. Gao, *et al.*, "Fully integrated wearable sensor arrays for multiplexed in situ perspiration analysis," pp. 509–514, *Nature*, vol. 529, no. 7587, 2016.

[250] H. Li, X. Liu, L. Li, X. Mu, R. Genov, and A. J. Mason, "Cmos electrochemical instrumentation for biosensor microsystems: A review," p. 74, *Sensors*, vol. 17, no. 1, 2017.

[251] D. Aikens, *Electrochemical methods, fundamentals and applications.* ACS Publications, 1983.

[252] e. a. A. Cazalé, "Physiological stress monitoring using sodium ion potentiometric microsensors for sweat analysis," pp. 1–9, *Sensors and Actuators B: Chemical*, vol. 225, 2016.

[253] A. Sun, A. Venkatesh, and D. A. Hall, "A multi-technique reconfigurable electrochemical biosensor: Enabling personal health monitoring in mobile devices," pp. 945–954, *IEEE transactions on biomedical circuits and systems*, vol. 10, no. 5, 2016.

[254] T. Lee and M. Je, "Multimodal neural interface circuits for diverse interaction with neuronal cell population in human brain," pp. 574–580, *IEEE Transactions on Circuits and Systems II: Express Briefs*, vol. 68, no. 2, 2020.

[255] D. Jung, *et al.*, "28.4 a cmos multimodality in-pixel electrochemical and impedance cellular sensing array for massively paralleled synthetic exoelectrogen characterization," in *2020 IEEE International Solid-State Circuits Conference-(ISSCC)*, pp. 436–438, IEEE, 2020.

[256] M. H. Nazari, H. Mazhab-Jafari, L. Leng, A. Guenther, and R. Genov, "Cmos neurotransmitter microarray: 96-channel integrated potentiostat with on-die microsensors," pp. 338–348, *IEEE transactions on biomedical circuits and systems*, vol. 7, no. 3, 2012.

[257] D. Rairigh, A. Mason, and C. Yang, "Analysis of on-chip impedance spectroscopy methodologies for sensor arrays," pp. 398–402, *Sensor Letters*, vol. 4, no. 4, 2006.

[258] V. Viswam, *et al.*, "Impedance spectroscopy and electrophysiological imaging of cells with a high-density cmos microelectrode array system," pp. 1356–1368, *IEEE transactions on biomedical circuits and systems*, vol. 12, no. 6, 2018.

[259] D. A. Hall, R. S. Gaster, K. A. Makinwa, S. X. Wang, and B. Murmann, "A 256 pixel magnetoresistive biosensor microarray in 0.18 μm cmos," pp. 1290–1301, *IEEE journal of solid-state circuits*, vol. 48, no. 5, 2013.

[260] T. Costa, F. A. Cardoso, J. Germano, P. P. Freitas, and M. S. Piedade, "A cmos front-end with integrated magnetoresistive sensors for biomolecular recognition detection applications," pp. 988–1000, *IEEE transactions on biomedical circuits and systems*, vol. 11, no. 5, 2017.

[261] D. Jung, *et al.*, "A cmos 21 952-pixel multi-modal cell-based biosensor with four-point impedance sensing for holistic cellular characterization," pp. 2438–2451, *IEEE Journal of Solid-State Circuits*, vol. 56, no. 8, 2021.

[262] M. El Ansary, *et al.*, "50 nw 5 khz-bw opamp-less $\Delta\Sigma$ impedance analyzer for brain neurochemistry monitoring," in *2018 IEEE International Solid-State Circuits Conference-(ISSCC)*, pp. 288–290, IEEE, 2018.

[263] J. B. J. B. r. Ranck Jr, "Which elements are excited in electrical stimulation of mammalian central nervous system: A review," pp. 417–440, vol. 98, no. 3, 1975.

[264] M. M. Adams and A. L. J. S. c. Hicks, "Spasticity after spinal cord injury," pp. 577–586, vol. 43, no. 10, 2005.

[265] T. Fuhr, J. Quintern, R. Riener, G. J. I. e. i. m. Schmidt, and b. magazine b., "Walking with walk!" Pp. 38–48, vol. 27, no. 1, 2008.

[266] D. A. Schwarz, *et al.*, "Chronic, wireless recordings of large-scale brain activity in freely moving rhesus monkeys," pp. 670–676, vol. 11, no. 6, 2014.

[267] C. D. Marsden and J. A. J. B. Obeso, "The functions of the basal ganglia and the paradox of stereotaxic surgery in parkinson's disease," pp. 877–897, vol. 117, no. 4, 1994.

[268] N. Y. Kiang and E. C. J. A. o. O. Moxon, Rhinology, and Laryngology, "Physiological considerations in artificial stimulation of the inner ear," pp. 714–730, vol. 81, no. 5, 1972.

[269] G. E. J. E. Loeb and hearing, "Are cochlear implant patients suffering from perceptual dissonance?" Pp. 435–450, vol. 26, no. 5, 2005.

[270] A. Leccardi and M. J. Ildelfonsa, "Development of a new visual prosthesis for preclinical studies on artificial vision," *EPFL*, 2020.

[271] L. Yue, J. D. Weiland, B. Roska, M. S. J. P. i. r. Humayun, and e. research e., "Retinal stimulation strategies to restore vision: Fundamentals and systems," pp. 21–47, vol. 53, 2016.

[272] L. Montazeri, N. El Zarif, S. Trenholm, and M. J. I. t. o. b. c. Sawan, and systems, "Optogenetic stimulation for restoring vision to patients suffering from retinal degenerative diseases: Current strategies and future directions," pp. 1792–1807, vol. 13, no. 6, 2019.

[273] J. Coulombe, M. Sawan, and J.-F. J. I. t. o. b. c. Gervais, and systems, "A highly flexible system for microstimulation of the visual cortex: Design and implementation," pp. 258–269, vol. 1, no. 4, 2007.

[274] L. N. Ayton, *et al.*, "An update on retinal prostheses," pp. 1383–1398, vol. 131, no. 6, 2020.

[275] M. Vaiman, R. Abuita, and I. J. I. j. o. o. Bekerman, "Optic nerve sheath diameters in healthy adults measured by computer tomography," p. 1240, vol. 8, no. 6, 2015.

[276] J. Badia, T. Boretius, D. Andreu, C. Azevedo-Coste, T. Stieglitz, and X. J. J. o. n. e. Navarro, "Comparative analysis of transverse intrafascicular multichannel, longitudinal intrafascicular and multipolar cuff electrodes for the selective stimulation of nerve fascicles," p. 036 023, vol. 8, no. 3, 2011.

[277] E. H. Rijnbeek, N. Eleveld, and W. J. F. i. n. Olthuis, "Update on peripheral nerve electrodes for closed-loop neuroprosthetics," p. 350, vol. 12, 2018.

[278] K. T. Mullen, S. O. Dumoulin, and R. F. J. E. J. o. N. Hess, "Color responses of the human lateral geniculate nucleus: Selective amplification of s-cone signals between the lateral geniculate nucleno and primary visual cortex measured with high-field fmri," pp. 1911–1923, vol. 28, no. 9, 2008.

[279] E. Fernández, *et al.*, "Acute human brain responses to intracortical microelectrode arrays: Challenges and future prospects," p. 24, vol. 7, 2014.

[280] C. I. Baker, D. D. Dilks, E. Peli, and N. J. V. r. Kanwisher, "Reorganization of visual processing in macular degeneration: Replication and clues about the role of foveal loss," pp. 1910–1919, vol. 48, no. 18, 2008.

[281] R. Hornig, T. Zehnder, M. Velikay-Parel, T. Laube, M. Feucht, and G. Richard, "The imi retinal implant system," in *Artificial sight*, pp. 111–128, Springer, 2007.

[282] G. Roessler, *et al.*, "Implantation and explantation of a wireless epiretinal retina implant device: Observations during the epiret3 prospective clinical trial," pp. 3003–3008, vol. 50, no. 6, 2009.

[283] A. Horsager, *et al.*, "Predicting visual sensitivity in retinal prosthesis patients," pp. 1483–1491, vol. 50, no. 4, 2009.

[284] J. Menzel-Severing, *et al.*, "Implantation and explantation of an active epiretinal visual prosthesis: 2-year follow-up data from the epiret3 prospective clinical trial," pp. 501–509, vol. 26, no. 4, 2012.

[285] A. Vanhoestenberghe and N. J. J. o. n. e. Donaldson, "Corrosion of silicon integrated circuits and lifetime predictions in implantable electronic devices," p. 031 002, vol. 10, no. 3, 2013.

[286] M. N. Shivdasani, *et al.*, "Factors affecting perceptual thresholds in a suprachoroidal retinal prosthesis," pp. 6467–6481, vol. 55, no. 10, 2014.

[287] T. L. Edwards, *et al.*, "Assessment of the electronic retinal implant alpha ams in restoring vision to blind patients with end-stage retinitis pigmentosa," pp. 432–443, vol. 125, no. 3, 2018.

[288] L. N. Ayton, *et al.*, "First-in-human trial of a novel suprachoroidal retinal prosthesis," e115239, vol. 9, no. 12, 2014.

[289] R. Daschner, A. Rothermel, R. Rudorf, S. Rudorf, and A. J. S. M. Stett, "Functionality and performance of the subretinal implant chip alpha ams," pp. 179–192, vol. 30, no. 2, 2018.

[290] K. Stingl, *et al.*, "Interim results of a multicenter trial with the new electronic subretinal implant alpha ams in 15 patients blind from inherited retinal degenerations," p. 445, vol. 11, 2017.

[291] K. Mathieson, *et al.*, "Photovoltaic retinal prosthesis with high pixel density," pp. 391–397, vol. 6, no. 6, 2012.

[292] H. Lorach, *et al.*, "Photovoltaic restoration of sight with high visual acuity," pp. 476–482, vol. 21, no. 5, 2015.

[293] M. Monge, *et al.*, "A fully intraocular high-density self-calibrating epiretinal prosthesis," pp. 747–760, vol. 7, no. 6, 2013.

[294] J. H. Park, J. S. Y. Tan, H. Wu, and J. Yoo, "34.2 1225-channel localized temperature-regulated neuromorphic retinal-prosthesis soc with 56.3 nw/channel image processor," in *2020 IEEE International Solid-State Circuits Conference-(ISSCC)*, pp. 508–510, IEEE, 2020.

[295] A. Soltan, *et al.*, "High density, high radiance μled matrix for optogenetic retinal prostheses and planar neural stimulation," pp. 347–359, vol. 11, 2017.

[296] H. Lorach, *et al.*, "Performance of photovoltaic arrays in-vivo and characteristics of prosthetic vision in animals with retinal degeneration," pp. 142–148, vol. 111, 2015.

[297] I. Gharib and M. Sawan, "High-efficiency led driver for short fluorophores lifetime biosensing applications," in *2019 17th IEEE International New Circuits and Systems Conference (NEWCAS)*, pp. 1–4, IEEE, 2019.

[298] H.-A. Ahn, O.-K. J. I. T. o. C. Kwon, and S. I. E. Briefs, "A driving and compensation method for amled displays using adaptive reference generator for high luminance uniformity," pp. 1725–1729, vol. 67, no. 10, 2019.

[299] A. Soltan, *et al.*, "A head mounted device stimulator for optogenetic retinal prosthesis," p. 065 002, vol. 15, no. 6, 2018.

[300] B. Yan, S. J. I. T. o. N. S. Nirenberg, and R. Engineering, "An embedded real-time processing platform for optogenetic neuroprosthetic applications," pp. 233–243, vol. 26, no. 1, 2017.

[301] L. Montazeri, N. El Zarif, T. Tokuda, J. Ohta, and M. Sawan, "Active control of μled arrays for optogenetic stimulation," in *2018 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1–5, IEEE, 2018.

[302] H. Yuk, B. Lu, and X. Zhao, "Hydrogel bioelectronics," pp. 1642–1667, *Chemical Society Reviews*, vol. 48, no. 6, 2019. DOI: 10.1039/C8CS00595H.

[303] "Ansi/aami ec12:2000 (r2015): Disposable ecg electrodes," *American National Standards Institute*, 2000.

[304] "Iso 14708: Implants for surgery — active implantable medical devices," *International Organization for Standardization*, 2014.

[305] "Iso 10993-1: Biological evaluation of medical devices," *International Organization for Standardization*, 2018.

[306] K. Polachan, B. Chatterjee, S. Weigand, and S. Sen, "Human body–electrode interfaces for wide-frequency sensing and communication: A review," *Nanomaterials*, vol. 11, no. 8, 2021. DOI: 10.3390/nano11082152.

[307] E. H. T. Shad, M. Molinas, and T. Ytterdal, "Impedance and noise of passive and active dry eeg electrodes: A review," pp. 14 565–14 577, *Ieee Sensors Journal*, vol. 20, no. 24, 2020. DOI: 10.1109/jsen.2020.3012394.

[308] C. Keogh, "Optimizing the neuron-electrode interface for chronic bioelectronic interfacing," E7, *Neurosurg Focus*, vol. 49, no. 1, 2020. DOI: 10.3171/2020.4.Focus20178.

[309] L. Euler, L. Guo, and N.-K. Persson, "Textile electrodes: Influence of knitting construction and pressure on the contact impedance," p. 1578, *Sensors (Basel, Switzerland)*, vol. 21, no. 5, 2021. DOI: 10.3390/s21051578.

[310] M. Gori, G. Vadala, S. M. Giannitelli, V. Denaro, and G. Di Pino, "Biomedical and tissue engineering strategies to control foreign body reaction to invasive neural electrodes," p. 659 033, *Frontiers in Bioengineering and Biotechnology*, vol. 9, May 2021. DOI: 10.3389/fbioe.2021.659033.

[311] A. Campbell and C. Y. Wu, "Chronically implanted intracranial electrodes: Tissue reaction and electrical changes," p. 430, *Micromachines*, vol. 9, no. 9, 2018. DOI: 10.3390/mi9090430.

[312] J. W. Salatino, K. A. Ludwig, T. D. Y. Kozai, and E. K. Purcell, "Glial responses to implanted electrodes in the brain," pp. 862–877, *Nature Biomedical Engineering*, vol. 1, no. 11, 2017. DOI: 10.1038/s41551-017-0154-1.

[313] N. Wu, S. Wan, S. Su, H. Huang, G. Dou, and L. Sun, "Electrode materials for brain–machine interface: A review," *InfoMat*, vol. n/a, no. n/a, 2021. DOI: 10.1002/inf2.12234.

[314] H. Wu, *et al.*, "Materials, devices, and systems of on-skin electrodes for electrophysiological monitoring and human-machine interfaces," p. 2 001 938, *Advanced Science*, vol. 8, no. 2, 2021. DOI: 10.1002/advs.202001938.

[315] C. Günter, J. Delbeke, and M. Ortiz-Catalan, "Safety of long-term electrical peripheral nerve stimulation: Review of the state of the art," p. 13, *Journal of NeuroEngineering and Rehabilitation*, vol. 16, no. 1, 2019. DOI: 10.1186/s12984-018-0474-8.

[316] R. K. Shepherd, J. Villalobos, O. Burns, and D. A. X. Nayagam, "The development of neural stimulators: A review of preclinical safety and efficacy studies," p. 041 004, *Journal of Neural Engineering*, vol. 15, no. 4, 2018. DOI: 10.1088/1741-2552/aac43c.

[317] W. Yang, Y. Gong, and W. Li, "A review: Electrode and packaging materials for neurophysiology recording implants," *Frontiers in Bioengineering and Biotechnology*, vol. 8, no. 1515, 2021. DOI: 10.3389/fbioe.2020.622923.

[318] C. Boehler, S. Carli, L. Fadiga, T. Stieglitz, and M. Asplund, "Tutorial: Guidelines for standardized performance tests for electrodes intended for neural interfaces and bioelectronics," *Nature Protocols*, vol. 15, no. 11, 2020. DOI: 10.1038/s41596-020-0389-2.

[319] Y.-H. Chen, *Polymer-based dry electrodes for biopotential measurements*, 2016. [Online]. Available: https://limo.libis.be/primo-explore/fulldisplay?docid=LIRIAS1733146&context=L&vid=Lirias&search_scope=Lirias&tab=default_tab&lang=en_US&fromSitemap=1.

[320] G. He, X. Dong, and M. Qi, "From the perspective of material science: A review of flexible electrodes for brain-computer interface," p. 102 001, *Materials Research Express*, vol. 7, no. 10, 2020. DOI: 10.1088/2053-1591/abb857.

[321] P. Yin, Y. Liu, L. Xiao, and C. Zhang, "Advanced metallic and polymeric coatings for neural interfacing: Structures, properties and tissue responses," *Polymers*, vol. 13, no. 16, 2021. DOI: 10.3390/polym13162834.

[322] E. Kolaya and B. L. Firestein, "Deep brain stimulation: Challenges at the tissue-electrode interface and current solutions," e3179, *Biotechnology Progress*, vol. n/a, no. n/a, 2021. DOI: 10.1002/btpr.3179.

[323] T. Javanbakht, B. Ghane-Motlagh, and M. Sawan, "Comparative study of antibiofilm activity and physicochemical properties of microelectrode arrays," p. 111 305, *Microelectronic Engineering*, vol. 229, 2020. DOI: 10.1016/j.mee.2020.111305.

[324] C. Sung, W. Jeon, K. S. Nam, Y. Kim, H. Butt, and S. Park, "Multimaterial and multifunctional neural interfaces: From surface-type and implantable electrodes to fiber-based devices," pp. 6624–6666, *Journal of Materials Chemistry B*, vol. 8, no. 31, 2020. DOI: 10.1039/d0tb00872a.

[325] Y. H. Cho, Y.-G. Park, S. Kim, and J.-U. Park, "3d electrodes for bioelectronics," p. 2 005 805, *Advanced Materials*, vol. n/a, no. n/a, 2021/05/19 2021. DOI: 10.1002/adma.202005805.

[326] S.-H. Sunwoo, *et al.*, "Advances in soft bioelectronics for brain research and clinical neuroengineering," pp. 1923–1947, *Matter*, vol. 3, no. 6, 2020. DOI: 10.1016/j.matt.2020.10.020.

[327] S. Takamatsu, T. Lonjaret, D. Crisp, J.-M. Badier, G. G. Malliaras, and E. Ismailova, "Direct patterning of organic conductors on knitted textiles for long-term electrocardiography," p. 15 003, *Scientific Reports*, vol. 5, no. 1, 2015. DOI: 10.1038/srep15003.

[328] Y. H. Chen, *et al.*, "Soft, comfortable polymer dry electrodes for high quality ecg and eeg recording," pp. 23 758–23 780, *Sensors*, vol. 14, no. 12, 2014. DOI: 10.3390/s141223758.

[329] F. Wang, G. Li, J. Chen, Y. Duan, and D. Zhang, "Novel semi-dry electrodes for brain–computer interface applications," p. 046 021, *Journal of Neural Engineering*, vol. 13, no. 4, 2016. DOI: 10.1088/1741-2560/13/4/046021.

[330] Y. Lee, *et al.*, "Self-adherent biodegradable gelatin-based hydrogel electrodes for electrocardiography monitoring," *Sensors (Basel, Switzerland)*, vol. 20, no. 20, 2020. DOI: 10.3390/s20205737.

[331] D.-H. Kim, *et al.*, "Epidermal electronics," pp. 838–843, *Science*, vol. 333, no. 6044, 2011.

[332] Y. Zhao, *et al.*, "Ultra-conformal skin electrodes with synergistically enhanced conductivity for long-time and low-motion artifact epidermal electrophysiology," p. 4880, *Nature Communications*, vol. 12, no. 1, 2021. DOI: 10.1038/s41467-021-25152-y.

[333] S. M. Lee, J. H. Kim, H. J. Byeon, Y. Y. Choi, K. S. Park, and S. H. Lee, "A capacitive, biocompatible and adhesive electrode for long-term and cap-free monitoring of eeg signals," p. 036 006, *J Neural Eng*, vol. 10, no. 3, 2013. DOI: 10.1088/1741-2560/10/3/036006.

[334] R. Minev Ivan, *et al.*, "Electronic dura mater for long-term multimodal neural interfaces," pp. 159–163, *Science*, vol. 347, no. 6218, 2015. DOI: 10.1126/science.1260318.

[335] D.-W. Park, *et al.*, "Graphene-based carbon-layered electrode array technology for neural imaging and optogenetic applications," p. 5258, *Nature Communications*, vol. 5, no. 1, 2014. DOI: 10.1038/ncomms6258.

[336] B. G. Motlagh, M. Choueib, A. H. Mesgar, M. Hasanuzzaman, and M. Sawan, "Direct growth of carbon nanotubes on new high-density 3d pyramid-shaped microelectrode arrays for brain-machine interfaces," p. 9, *Micromachines (Basel)*, vol. 7, 2016. DOI: 10.3390/mi7090163.

[337] H. Yuk, *et al.*, "3d printing of conducting polymers," p. 1604, *Nature Communications*, vol. 11, no. 1, 2020. DOI: 10.1038/s41467-020-15316-7.

[338] Y. Zhang, *et al.*, "Battery-free, lightweight, injectable microsystem for in vivo wireless pharmacology and optogenetics," p. 21 427, *Proceedings of the National Academy of Sciences*, vol. 116, no. 43, 2019. DOI: 10.1073/pnas.1909850116.

[339] S. Park, *et al.*, "One-step optogenetics with multifunctional flexible polymer fibers," pp. 612–619, *Nat Neurosci*, vol. 20, no. 4, 2017. DOI: 10.1038/nn.4510.

[340] H. Sheng, *et al.*, "Neural interfaces by hydrogels," p. 100 510, *Extreme Mechanics Letters*, vol. 30, 2019. DOI: 10.1016/j.eml.2019.100510.

[341] G. Hong, X. Yang, T. Zhou, and C. M. Lieber, "Mesh electronics: A new paradigm for tissue-like brain probes," pp. 33–41, *Current Opinion in Neurobiology*, vol. 50, 2018. DOI: 10.1016/j.conb.2017.11.007.

[342] T. J. Oxley, *et al.*, "Minimally invasive endovascular stent-electrode array for high-fidelity, chronic recordings of cortical neural activity," pp. 320–327, *Nature Biotechnology*, vol. 34, no. 3, 2016. DOI: 10.1038/nbt.3428.

[343] T. Oxley, *et al.*, "Motor neuroprosthesis implanted with neurointerventional surgery improves capacity for activities of daily living tasks in severe paralysis: First in-human experience," pp. 102–108, *Journal of NeuroInterventional Surgery*, vol. 13, no. 2, 2020. DOI: 10.1136/neurintsurg-2020-016862.

[344] Y. Zhang, *et al.*, "Climbing-inspired twining electrodes using shape memory for peripheral nerve stimulation and recording," eaaw1066, *Sci Adv*, vol. 5, no. 4, 2019. DOI: 10.1126/sciadv.aaw1066.

[345] G.-L. Li, J.-T. Wu, Y.-H. Xia, Q.-G. He, and H.-G. Jin, "Review of semi-dry electrodes for eeg recording," p. 051 004, *Journal of Neural Engineering*, vol. 17, no. 5, 2020. DOI: 10.1088/1741-2552/abbd50.

[346] S. M. Won, E. Song, J. T. Reeder, and J. A. Rogers, "Emerging modalities and implantable technologies for neuromodulation," pp. 115–135, *Cell*, vol. 181, no. 1, 2020. DOI: 10.1016/j.cell.2020.02.054.

[347] G. Acar, O. Ozturk, A. J. Golparvar, T. A. Elboshra, K. Bohringer, and M. K. Yapici, "Wearable and flexible textile electrodes for biopotential signal monitoring: A review," p. 25, *Electronics*, vol. 8, no. 5, 2019. DOI: 10.3390/electronics8050479.

[348] M. M. Hasan and M. M. Hossain, "Nanomaterials-patterned flexible electrodes for wearable health monitoring: A review," pp. 14 900–14 942, *Journal of Materials Science*, vol. 56, no. 27, 2021. DOI: 10.1007/s10853-021-06248-8.

[349] J. Kubicek, *et al.*, “Recent trends, construction and applications of smart textiles and clothing for monitoring of health activity: A comprehensive multidisciplinary review,” *IEEE Rev. Biomed. Eng.*, 2020. DOI: 10.1109/rbme.2020.3043623.

[350] M. J. Zhu, *et al.*, “Flexible electrodes for in vivo and in vitro electrophysiological signal recording,” p. 2 100 646, *Advanced Healthcare Materials*, vol. 10, 2021. DOI: 10.1002/adhm.202100646.

[351] T. Torfs, Y. H. Chen, H. Kim, and R. F. Yazicioglu, “Noncontact ecg recording system with real time capacitance measurement for motion artifact reduction,” pp. 617–625, *IEEE Trans Biomed Circuits Syst*, vol. 8, no. 5, 2014. DOI: 10.1109/tbcas.2014.2359053.

[352] L. Ren, B. Liu, W. Zhou, and L. Jiang, “A mini review of microneedle array electrode for bio-signal recording: A review,” pp. 1–1, *IEEE Sensors Journal*, vol. PP, 2019. DOI: 10.1109/JSEN.2019.2944847.

[353] B. Ghane-Motlagh and M. Sawan, “Design and implementation challenges of microelectrode arrays: A review,” pp. 483–495, *Materials Sciences and Applications*, vol. 4, no. 8, 2013. DOI: 10.4236/msa.2013.48059.

[354] R. Feiner and T. Dvir, “Tissue–electronics interfaces: From implantable devices to engineered tissues,” p. 17 076, *Nature Reviews Materials*, vol. 3, no. 1, 2017. DOI: 10.1038/natrevmats.2017.76.

[355] S. E. John, D. B. Grayden, and T. Yanagisawa, “The future potential of the stentrode,” pp. 841–843, *Expert review of medical devices*, vol. 16, no. 10, 2019. DOI: 10.1080/17434440.2019.1674139.

[356] Y. Cho, S. Park, J. Lee, and K. J. Yu, “Emerging materials and technologies with applications in flexible neural implants: A comprehensive review of current issues with neural devices,” p. 2 005 786, *Advanced Materials*, 2021. DOI: 10.1002/adma.202005786.

[357] G. G. Rong, Y. Q. Zheng, and M. Sawan, “Energy solutions for wearable sensors: A review,” p. 23, *Sensors*, vol. 21, no. 11, 2021, Art no. 3806. DOI: 10.3390/s21113806.

[358] Y. Long, J. Li, F. Yang, J. Wang, and X. Wang, “Wearable and implantable electroceuticals for therapeutic electrostimulations,” p. 2 004 023, *Advanced Science*, vol. 8, no. 8, 2021. DOI: 10.1002/advs.202004023.