Webinars by South Indian SDR User Group (SI-SDR-UG)

23 Oct, 2021 @ https://www.softwaredefinedradio.in/

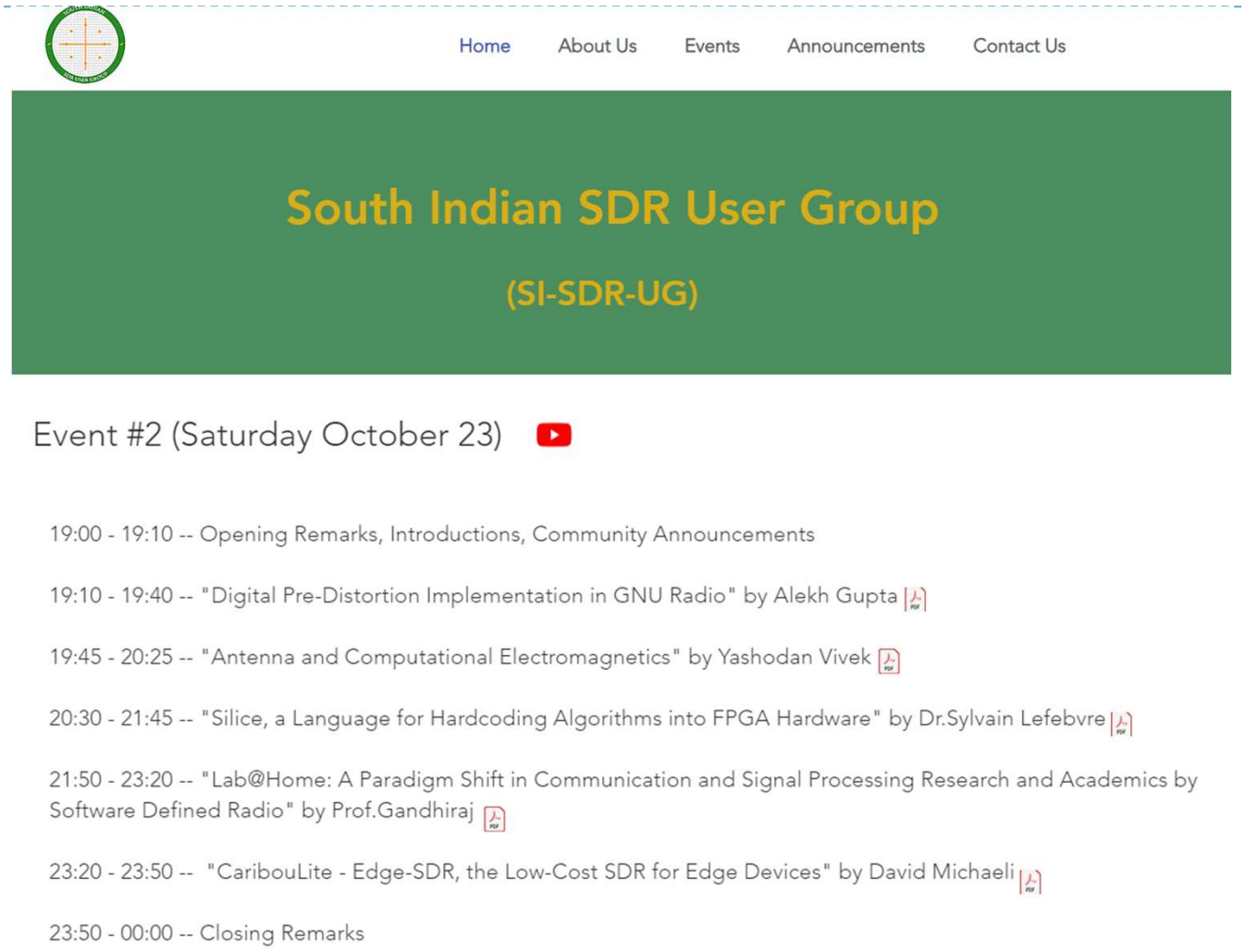
9.50 p.m. – 11.20 pm (IST)

Meeting ID:
https://meet.google.com/poo-rhxi-ghg

Lab@Home: A Paradigm Shift in Communication and Signal Processing Research and Academics by Software Defined Radio

Dr.R.Gandhiraj, Dept. of ECE, Amrita Vishwa Vidyapeetham, Coimbatore


MATA AMRITANANDAMAYI MATH
श्रद्धावान् लभते ज्ञानम्


Home
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South Indian SDR User Group
(SI-SDR-UG)
Event #2 (Saturday October 23)
19:00 - 19:10 -- Opening Remarks, Introductions, Community Announcements
19:10 - 19:40 -- "Digital Pre-Distortion Implementation in GNU Radio" by Alekh Gupta
19:45 - 20:25 -- "Antenna and Computational Electromagnetics" by Yashodan Vivek
20:30 - 21:45 -- "Silice, a Language for Hardcoding Algorithms into FPGA Hardware" by Dr.Sylvain Lefebvre
21:50 - 23:20 -- "Lab@Home: A Paradigm Shift in Communication and Signal Processing Research and Academics by Software Defined Radio" by Prof.Gandhiraj
23:20 - 23:50 -- "CaribouLite - Edge-SDR, the Low-Cost SDR for Edge Devices" by David Michaeli
23:50 - 00:00 -- Closing Remarks

Acknowledgement

Dedicating this presentation

to all

my GURUs

Almighty

Mother Nation

Overview

- Introduction

- Part I : Signals & Systems foundation
- Part II : SDR for Research & Academics
- Conclusion

Quotes

"Katrathu Kai Mann Alavu, Kallathathu Ulagalavu"

(Tamil Poet : Avvaiyar)

Meaning: "What you have learned is a mere handful; What you haven't learned is the size of the world"

Quotes

தொட்டனைத் தூறும் மணற்கேணி மாந்தர்க்குக்
கற்றனைத் தூறும் அறிவு.

Thirukkural – 396

Meaning: Water will flow from a well in the sand in proportion to the depth to which it is dug, andknowledge will flow from a man in proportion to his learning.

Part 1: Signals & Systems foundations

26 October 2021

Nobel Prize winners

- 1933: WERNER HEISENBERG
- Topic : "The development of quantum mechanics"
- Quote: "…To each stationary state of an atom corresponds a whole complex of parameters which specify the probability of transition from this state to another. There is no direct relation between the radiation classically emitted by an orbiting electron and those parameters defining the probability of emission; nevertheless Bohr's principle of correspondence enables a specific term of the **Fourier expansion** of the classical path to be assigned to each transition of the atom, and the probability for the particular transition follows qualitatively similar laws as the intensity of those **Fourier components**…."

https://www.nobelprize.org/nobel_prizes/physics/laureates/1932/heisenberg-lecture.pdf

Nobel Prize

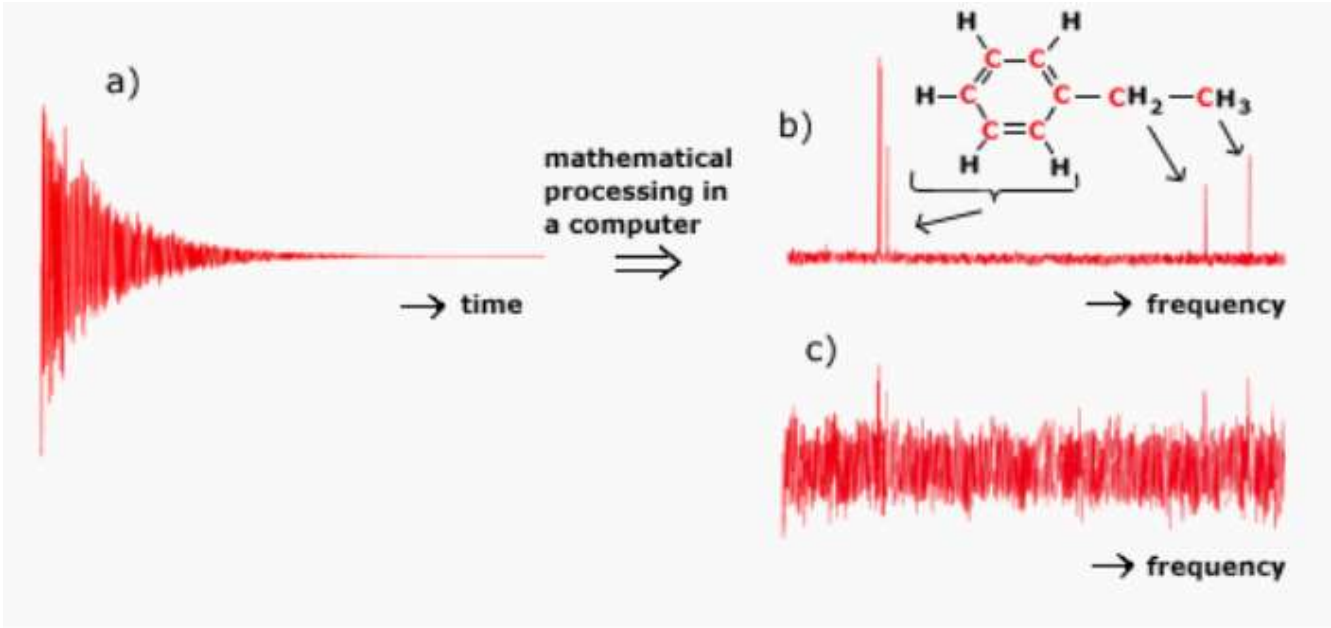
- 1985 : JEROME KARLE
- Laboratory for the Structure of Matter, Naval Research Laboratory, Washington, D. C. 20375-5000, U.S.A
- Topic: "RECOVERING PHASE INFORMATION FROM INTENSITY DATA"
- Quote :"The concept of a crystal is that of a solid body in which the atomic or molecular units are so arranged as to form an array having three dimensional periodicity. Because of the periodicity, it is possible to describe the arrangements of the atomic composition by means of **Fourier series**. The type of **Fourier series** that is used in crystal structure analysis represents the electron density distribution in a crystal.

https://www.nobelprize.org/nobel_prizes/chemistry/laureates/1985/karle-lecture.pdf

Nobel Prize

- The Nobel Prize in Chemistry 1991: Richard R. Ernst
- Fourier Transform Nuclear magnetic resonance spectroscopy (FT-NMR)
- A major breakthrough occurred in 1966. Richard R. Ernst then discovered (together with Weston A. Anderson, USA) that the sensitivity of NMR spectra could be increased dramatically if the slow frequency sweep was replaced by short, intense radiofrequency pulses.
- Ernst discovered, however, that it was possible to extract the resonance frequencies from such a signal and to convert the signal into a NMR spectrum by a mathematical operation (Fourier* transformation, FT).
- The type of spectroscopy determines the physical and chemical properties of atoms or the molecules.

https://www.nobelprize.org/nobel_prizes/chemistry/laureates/1991/illpres/fourier.html



The diagram a) shows a NMR signal from carbon-13 nuclei (which only occur in 1% of all the carbon atoms in nature) in ethyl benzene solution, obtained with the pulse technique by accumulating the response of the nuclear spins to two hundred pulses. The total experiment time was 20 minutes. After Fourier transformation, one obtains the carbon-13 NMR spectrum in the diagram b). If the experiment was performed with the old technique, in the same time one would only manage to perform a single sweep and the spectrum would look like the diagram c).

- 2014: Eric Betzig, Stefan W. Hell and W. E. Moerner, in Chemistry.

Topic : "Super-resolved fluorescence microscopy "

Key : "Fourier Transform“

- 1989: NORMAN F. RAMSEY, in Physics
- Topic "EXPERIMENTS WITH SEPARATED OSCILLATORY FIELDS AND HYDROGEN MASERS“
- Key: “Fourier Transform”

- And many

FT in Anna Univ's ECE curriculum

- MA6351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS
- EC6303 SIGNALS AND SYSTEMS
- EC6502 PRINCIPLES OF DIGITAL SIGNAL PROCESSING
- EC6002 ADVANCED DIGITAL SIGNAL PROCESSING
- IT6005 DIGITAL IMAGE PROCESSING
- EC6007 SPEECH PROCESSING

https://www.annauniv.edu/academic_courses/01. UG WS upt on 29.06.2015 -F/04.1 & C/21. ECE.pdf

Fourier Transform Research Trend

Analyze search results

Analyze search results

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KEY (fourier AND transform) Back to your search results

265601 document results Choose date range to analyze: 1870 to 2018 Analyze

Year | Source | Author | Affiliation | Country/Territory | Document type | Subject area

2018	557
2017	16616
2016	18802
2015	18488
2014	16407
2013	15931
2012	14102
2011	13519
2010	12831
2009	14204
2008	11403
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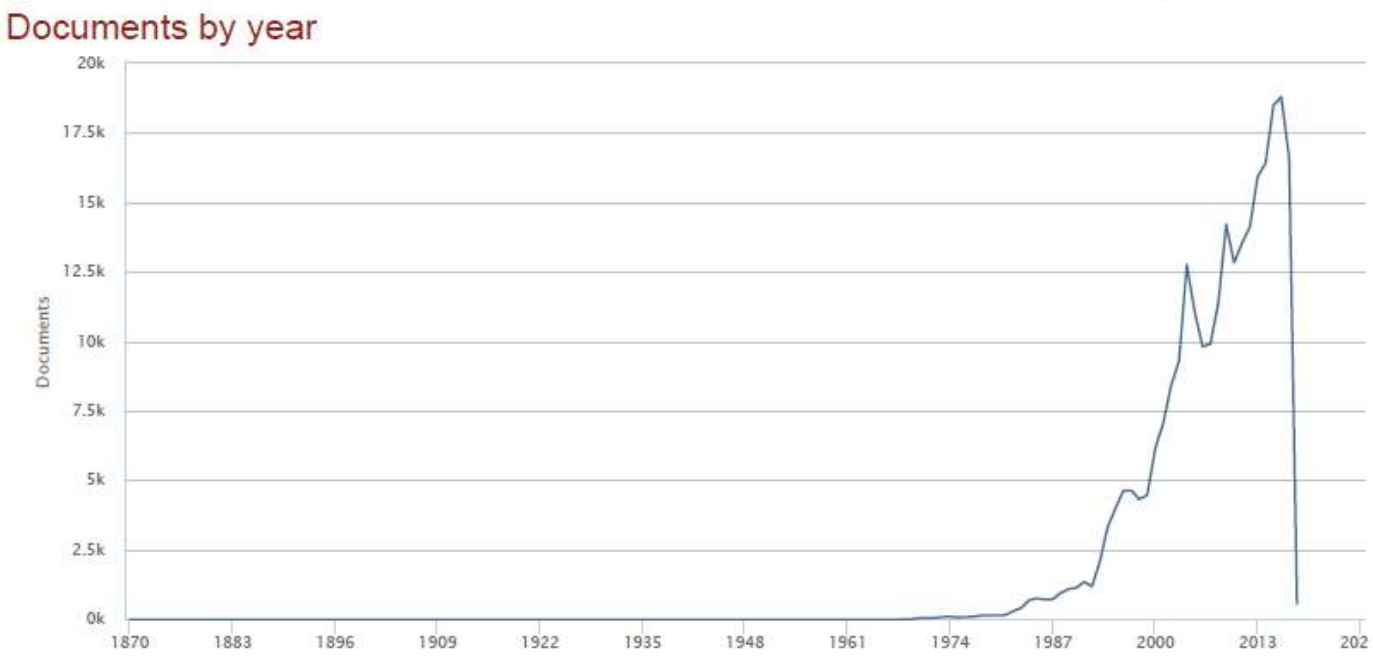

https://www.scopus.com/

FT in Different Domain

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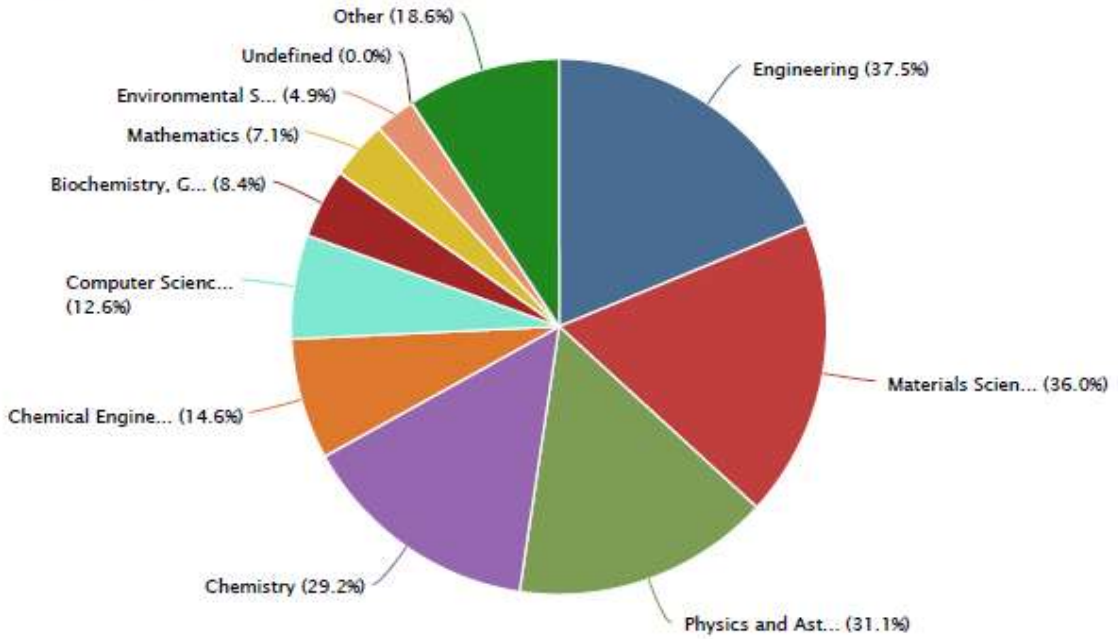
Year | Source | Author | Affiliation | Country/Territory | Document type | **Subject area**

Engineering	99720
Materials Science	95733
Physics and Astronomy	82619
Chemistry	77449
Chemical Engineering	38891
Computer Science	33352
Biochemistry, Genetics and Molecular...	22220
Mathematics	18766
Environmental Science	12988
Energy	10108
Medicine	9801
Earth and Planetary Sciences	8196
Agricultural and Biological Sciences	6254
Pharmacology, Toxicology and Pharm...	5700
Immunology and Microbiology	2109
Social Sciences	1883

Documents by subject area



https://www.scopus.com/

Wavelet Transform : Research trend

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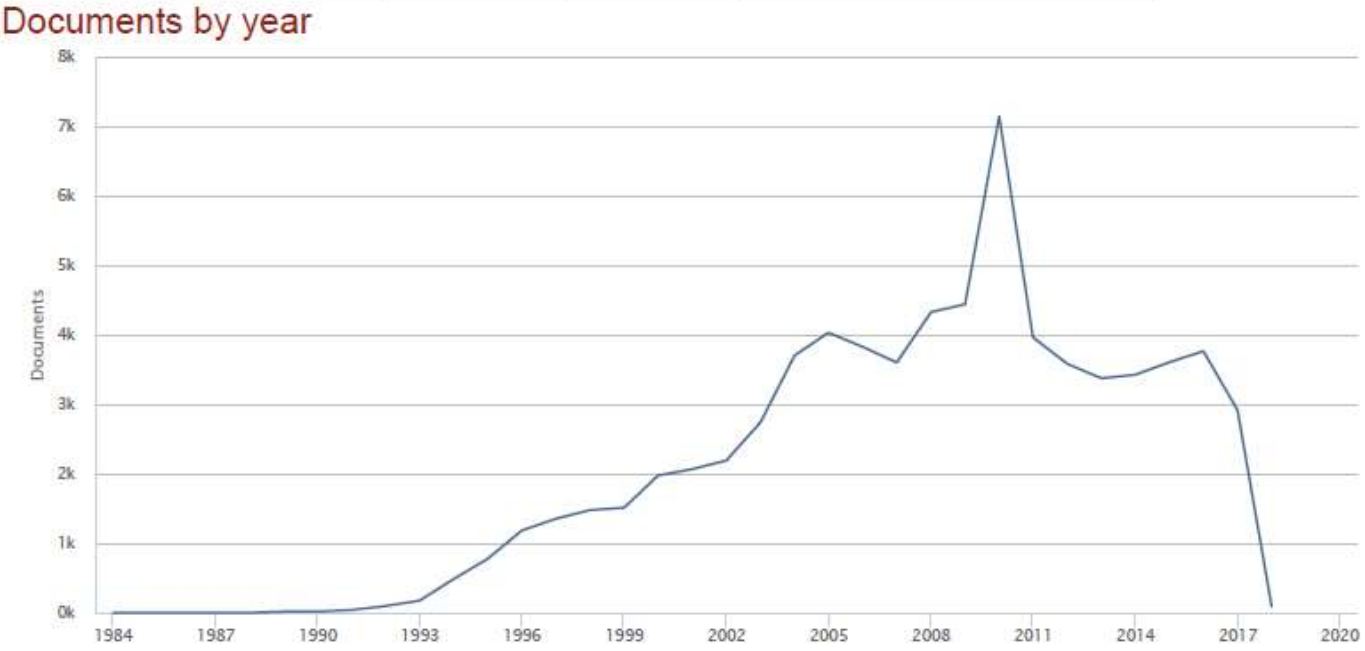
72038 document results Choose date range to analyze: 1984 to 2018 Analyze

Year | Source | Author | Affiliation | Country/Territory | Document type | Subject area

Year	Documents
2018	91
2017	2921
2016	3771
2015	3610
2014	3432
2013	3380
2012	3588
2011	3968
2010	7153
2009	4443
2008	4330
2007	3605
2006	3835
2005	4040
2004	3711



WT in different domain

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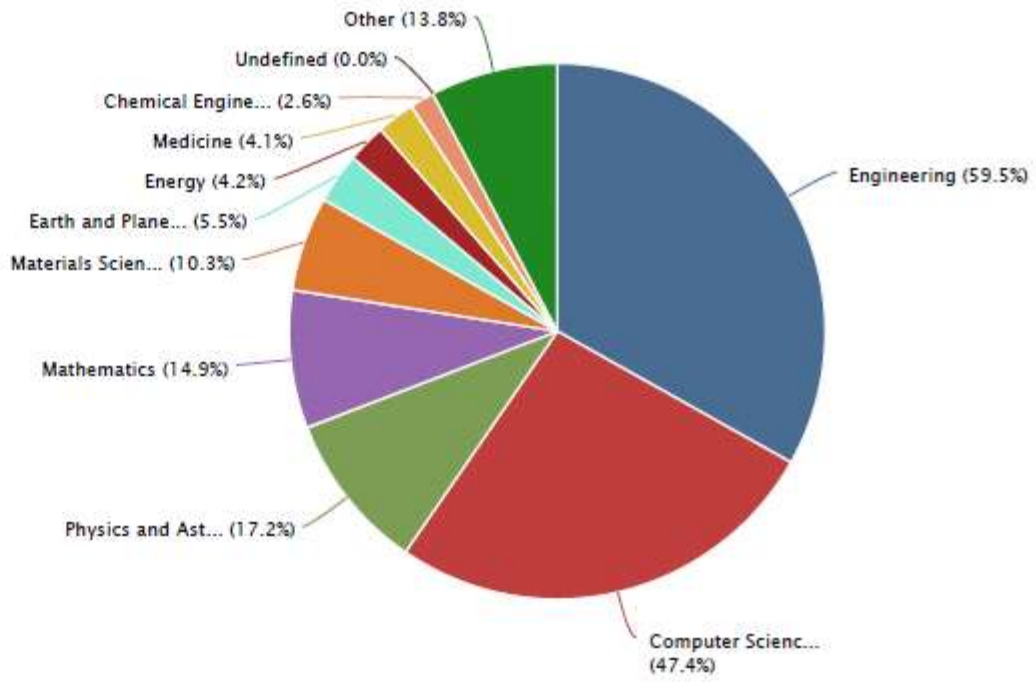
72038 document results Choose date range to analyze: 1984 to 2018 Analyze

Year | Source | Author | Affiliation | Country/Territory | Document type | **Subject area**

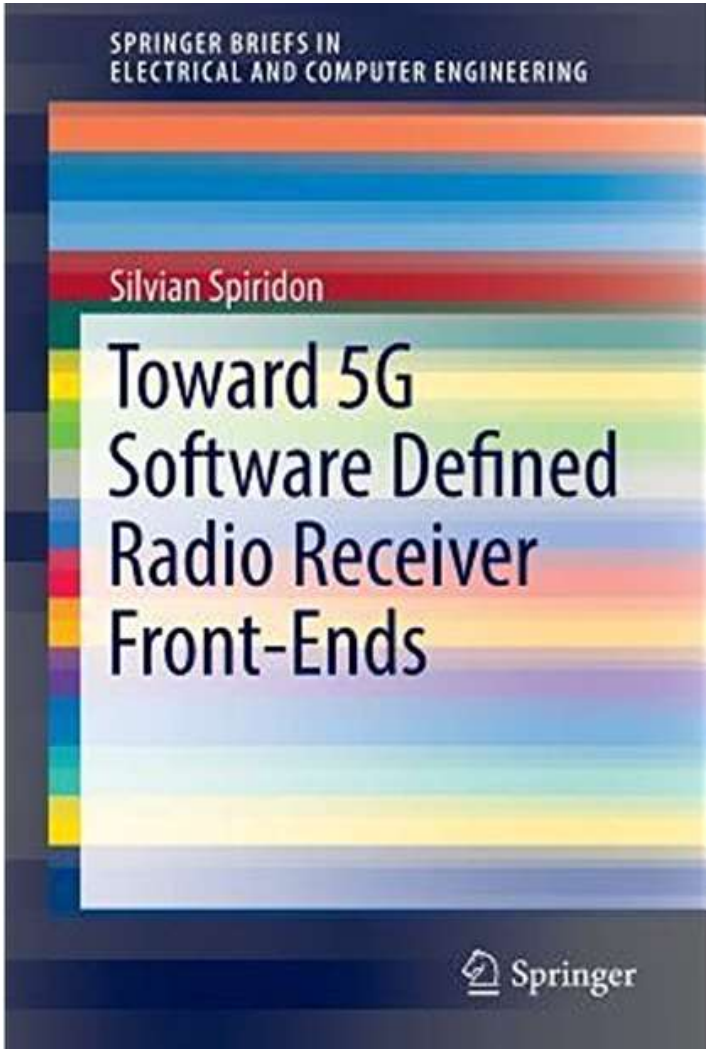
Subject Area	Documents
Engineering	42853
Computer Science	34151
Physics and Astronomy	12358
Mathematics	10753
Materials Science	7388
Earth and Planetary Sciences	3930
Energy	3029
Medicine	2975
Chemical Engineering	1897
Chemistry	1743
Social Sciences	1514
Biochemistry, Genetics and Molecular...	1331
Environmental Science	1286
Agricultural and Biological Sciences	710
Decision Sciences	646

Documents by subject area



Book 1:SDR in 5G

- Dr. Silvian Spiridon (B.Sc.−2003, M.Sc.−2004 and Ph.D.−2011) is Principal Scientist with Broadcom Ltd. in Irvine, CA, USA. He is the project leader responsible for the design and development of wireline transceivers, high speed mixed-signal and RF circuits for cable applications.
- Dr. Spiridon is also a Senior Member with IEEE. His main research interest is focused on the development of a standard independent design methodology for wireless transceivers.
- Table of Contents (TOC)

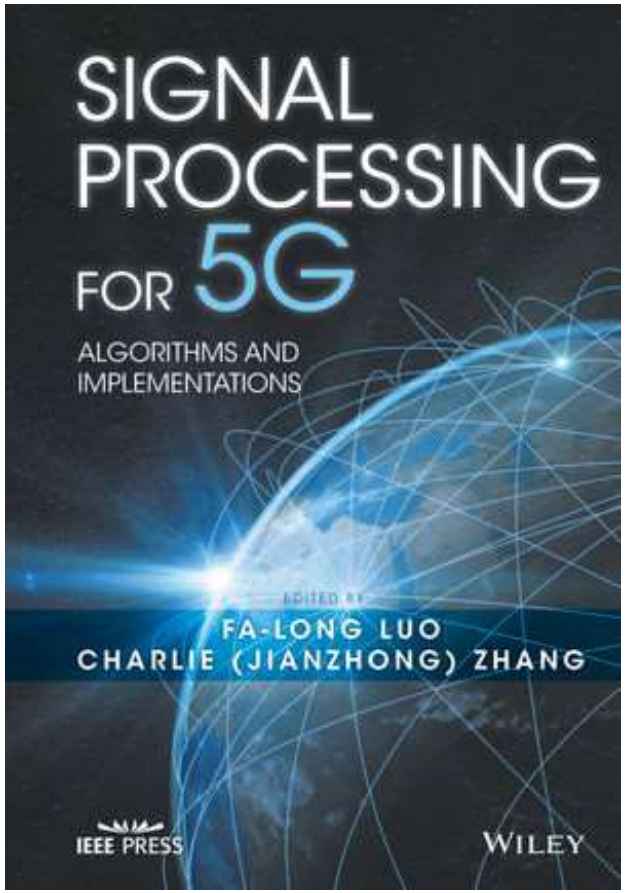


About Book

- This book introduces a new intuitive design methodology for the optimal design path for next-generation software defined radio front-ends (SDRXs). The methodology described empowers designers to "attack" the multi-standard environment in a parallel way rather than serially, providing a critical tool for any design methodology targeting 5G circuits and systems.
- Throughout the book the SDRX design follows the key wireless standards of the moment (i.e., GSM, WCDMA, LTE, Bluetooth, WLAN), since a receiver compatible with these standards is the most likely candidate for the first design iteration in a 5G deployment.
- The author explains the fundamental choice the designer has to make regarding the optimal channel selection: how much of the blockers/interferers will be filtered in the analog domain and how much will remain to be filtered in the digital domain. The system-level analysis the author describes entails the direct sampling architecture is treated as a particular case of mixer-based direct conversion architecture.
- This allows readers give a power consumption budget to determine how much filtering is required on the receive path, by considering the ADC performance characteristics and the corresponding blocker diagram.

Book 2

- **Fa-Long Luo, Element CXI, San Jose, California**
  Dr. Fa-Long Luo is an IEEE Fellow and the Chief Scientist of two leading international companies, headquartered in Silicon Valley, dealing with software-defined radio and wireless multimedia. He is also an Affiliate Full Professor at the University of Washington. From 2007 to 2011, he was the founding editor-in-chief of the International Journal of Digital Multimedia Broadcasting. From 2011 to 2012, he was the chairman of the IEEE Industry DSP Standing Committee and technical board member of the IEEE Signal Processing Society. He is now associate editor of the IEEE Access and IEEE Internet of Things Journal. He has 33 years of research and industry experience in signal processing, multimedia, communication and broadcasting with real-time implementation, applications and standardization and has gained international recognition. He has published 5 books, more than 100 technical papers, and has 18 patents in these fields. He was awarded the Fellowship by the Alexander von Humboldt Foundation of Germany.
- Table of Content (TOC)



http://as.wiley.com/WileyCDA/WileyTitle/productCd-1119116465.html

- **Charlie (Jianzhong) Zhang, Samsung Research America, USA**
  Charlie (Jianzhong) Zhang is Vice President and head of the Standards and Research Lab with Samsung Research America at Dallas, where he leads research and standard efforts for 5G cellular systems and next generation multimedia networks. From Aug 2009 to Aug 2013, he served as the Vice Chairman of 3GPP RAN1 working group and led development of LTE and LTE-Advanced technologies such as 3D channel modeling, UL-MIMO and CoMP, Carrier Aggregation for TD-LTE, etc. Before joining Samsung, he was with Motorola from 2006 to 2007 working on 3GPP HSPA standards, and with Nokia Research Center from 2001 to 2006 working on IEEE 802.16e (WiMAX) standard and EDGE/CDMA algorithms. He received his Ph.D. degree from the University of Wisconsin, Madison. Dr. Zhang is also an IEEE Fellow.

About Book

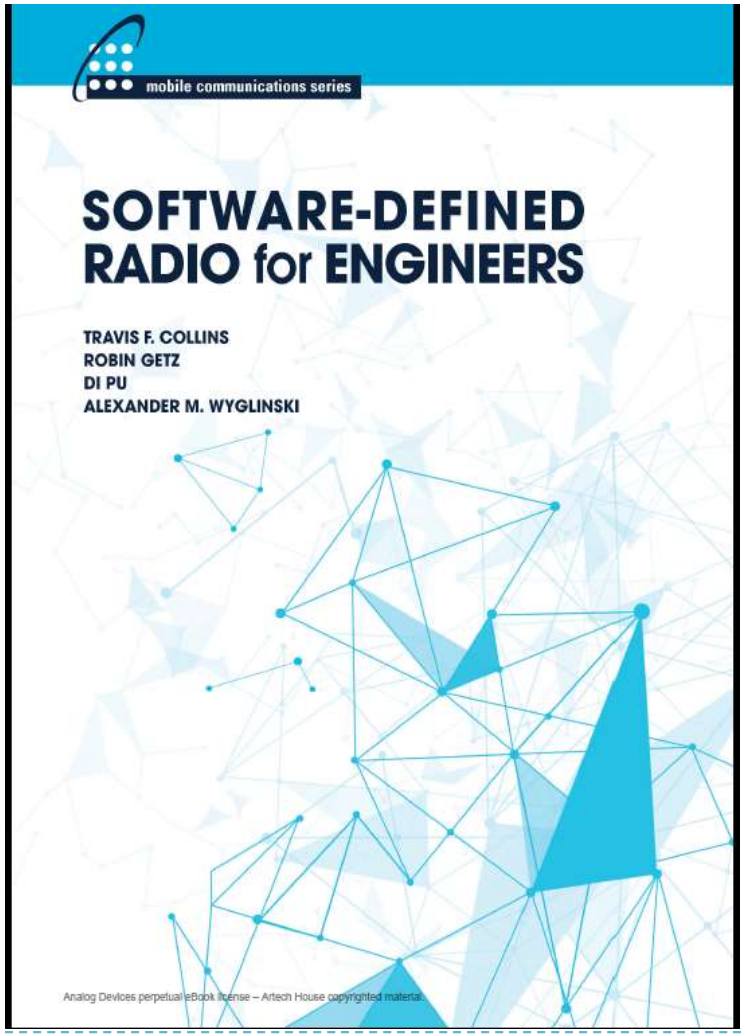
- Signal processing techniques have played the most important role in wireless communications since the second generation of cellular systems. It is anticipated that new techniques employed in 5G wireless networks will not only improve peak service rates significantly, but also enhance capacity, coverage, reliability , low-latency, efficiency, flexibility, compatibility and convergence to meet the increasing demands imposed by applications such as big data, cloud service, machine-to-machine (M2M) and mission-critical communications.
- This book is a comprehensive and detailed guide to all signal processing techniques employed in 5G wireless networks. Uniquely organized into four categories, New Modulation and Coding, New Spatial Processing, New Spectrum Opportunities and New System-level Enabling Technologies, it covers everything from network architecture, physical-layer (down-link and up-link), protocols and air interface, to cell acquisition, scheduling and rate adaption, access procedures and relaying to spectrum allocations. All technology aspects and major roadmaps of global 5G standard development and deployments are included in the book.
  Key Features:

About Book

Key Features:

- Offers step-by-step guidance on bringing 5G technology into practice, by applying algorithms and design methodology to real-time circuit implementation, taking into account rapidly growing applications that have multi-standards and multi-systems.
- Addresses spatial signal processing for 5G, in particular massive multiple-input multiple-output (massive-MIMO), FD-MIMO and 3D-MIMO along with orbital angular momentum multiplexing, 3D beamforming and diversity.
- Provides detailed algorithms and implementations, and compares all multicarrier modulation and multiple access schemes that offer superior data transmission performance including FBMC (Filter Bank Multi-Carrier), GFDM (Generalised Frequency Division Multiplexing), F-OFDM, UFMC (Universal Filtered MultiCarrier), SEFDM, FTN, MUSA, SCMA and NOMA.
- Demonstrates the translation of signal processing theories into practical solutions for new spectrum opportunities in terms of millimeter wave, full-duplex transmission and license assisted access.
- Presents well-designed implementation examples, from individual function block to system level for effective and accurate learning.
- Covers signal processing aspects of emerging system and network architectures, including ultra-dense networks (UDN), software-defined networks (SDN), device-to-device (D2D) communications and cloud radio access network (C-RAN).

Book 3


mobile communications series
SOFTWARE-DEFINED RADIO for ENGINEERS
TRAVIS F. COLLINS
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DI PU
ALEXANDER M. WYGLINSKI
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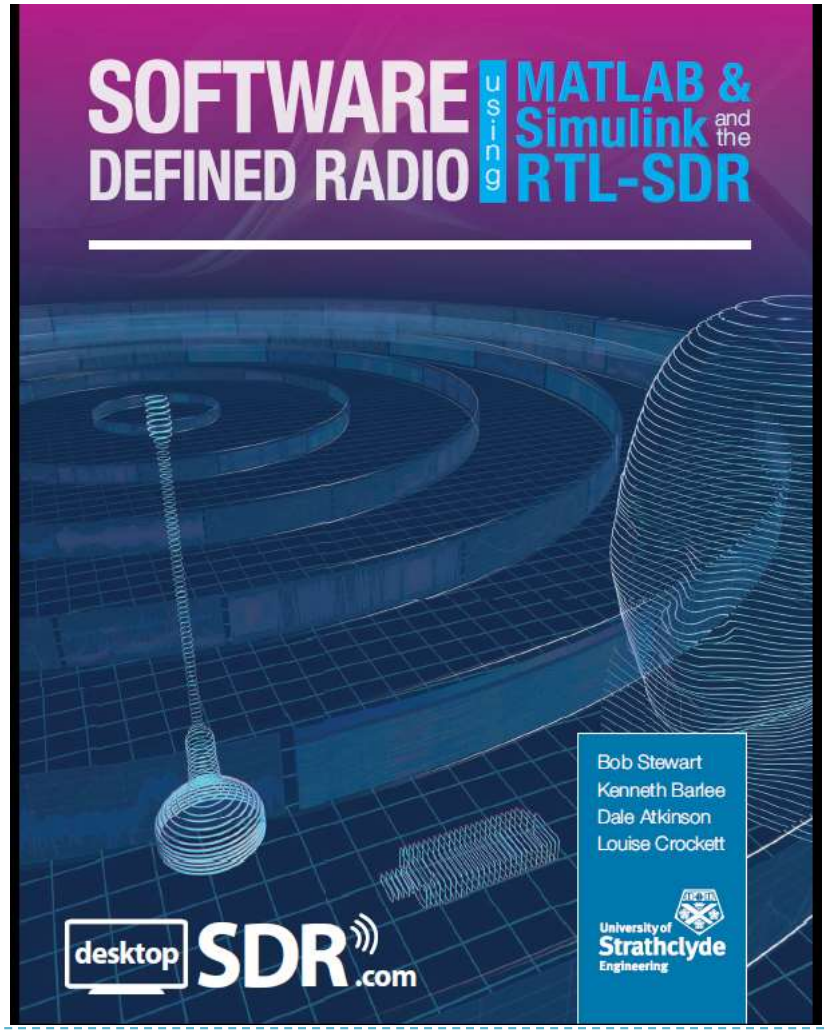
Book 4


SOFTWARE DEFINED RADIO using MATLAB & Simulink and the RTL-SDR
Bob Stewart
Kenneth Barlee
Dale Atkinson
Louise Crockett
University of Strathclyde Engineering
desktop SDR .com

Signal Processing Algorithms in 5G

- Key terminologies
  - 3D channel modeling
  - massive-MIMO
  - FD-MIMO (Full Dimension MIMO)
  - 3D-MIMO along with orbital angular momentum multiplexing,
  - 3D beamforming and diversity
  - FBMC (Filter Bank Multi-Carrier)
  - GFDM (Generalized Frequency Division Multiplexing)
  - F-OFDM (Filtered-OFDM (*F-OFDM*)
  - UFMC (Universal Filtered MultiCarrier),
  - SEFDM (Spectrally efficient frequency division multiplexing)
  - FTN (Faster-than-Nyquist Signaling)
  - MUSA (Multi User Shared Access)
  - SCMA (Sparse Code Multiple Access)
  - NOMA (Non-Orthogonal Multiple Access)

Weblinks for Demo

- http://falstad.com/fourier/
- http://www.falstad.com/dfilter/

MIT OPEN COURSE WARE (MIT-OCW)

- Main link
- https://ocw.mit.edu/courses/find-by-topic/#cat=engineering&subcat=electricalengineering&spec=signalprocessing

Fourier Series & Transform

- MIT OCW
- Author:

  Instructor(s)

  Prof. Dennis Freeman

  MIT Course Number - 6.003

  As Taught In Fall 2011
- {CT, DT } Fourier series & Transform
- Link: Click here
- Gram-Schmidt Orthogonalisation
- Fourier Series & Filter design Applet
- DEMO using Audacity

freeman@mit.edu
(617) 253-8795
http://www.rle.mit.edu/freeman

Part II : SDR for Research & Academics

26 October 2021

Part II: SDR for Research & Academic

- Lab@Home: A Paradigm shift in Communication and Signal Processing Research and Academics by Software Defined Radio

  Context : How to use, SDR framework for the following engineering courses

  - Signals and Systems
  - Digital Signal Processing
  - Multi Rate Signal Processing
  - Analog Communication
  - Digital Communication
  - Wireless Communication

- Click here for PPT

Support

- https://www.nutaq.com/blog/5g-research-nutaq
- https://myriadrf.org/blog/tag/5g/
- http://www.openairinterface.org/

- GNU Radio resources
  - https://github.com/kit-cel/gr-gfdm
  - http://claws.be/spectrum-challenge/node/20
  - http://sdr-lab.com/
  - https://www.nutaq.com/blog/accelerating-massive-mimo-wireless-waveform-deployment-using-gnu-radio
  - https://www.nutaq.com/support/gnu-radio-plug-in-nutaq-sdrs

Support

- https://arxiv.org/pdf/1501.00035.pdf
- https://www.analog.com/en/design-center/evaluation-hardware-and-software/evaluation-boards-kits/adalm-pluto.html

Queries ???

Thank You