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Principles of Signal Estimation for MIMO/ OFDM Wireless Communication

By Prof. Aditya K. Jagannatham | IIT Kanpur

Learners enrolled: 917

Introduction - Estimation for Wireless Communications MIMO OFDM Cellular And Sensor Networks

ABOUT THE COURSE :

Signal estimation theory provides a wide variety of tools and techniques which form the basis for several key applications in modern wireless communications and signal processing. Various signal processing procedures in communication systems such as channel estimation, equalization, synchronization etc, which are also employed in MIMO-OFDM based 3G/ 4G wireless systems, are based on fundamental concepts in estimation theory. Further, recent research developments in areas such as wireless sensor networks also employ several tools from estimation theory towards distributed parameter estimation etc. Therefore, principles of estimation are naturally of a significant interest in research and industry. A clear grasp of the basic principles of estimation can significantly enhance understanding by providing deeper insights into various techniques in signal processing and communication. Beginning with a brief overview of the basic concepts of maximum likelihood (ML) and Least Squares Estimation (LS), this course will comprehensively cover several applications of estimation theory in wireless communications such as channel estimation, equalization, MIMO, OFDM. Further, we will also cover Bayesian Estimation, MMSE, LMMSE principles.

INTENDED AUDIENCE : Can be both core or elective. Core course for students in Signal Processing and Communications stream. Both UG/ PG can be allowed.

PREREQUISITES : BE/ME/MS /PhD can be allowed
Basic knowledge of
- Probability, random variables
- Linear Algebra, DSP

INDUSTRY SUPPORT : Most companies in wireless communications area should find this useful. Examples are Qualcomm, Broadcom, Intel etc.

Summary

Course Status :	Completed
Course Type :	Core
Duration :	12 weeks
Category :	• Electrical, Electronics and Communications Engineering
Credit Points :	3

Course layout

Week 1- Basics of Estimation, Maximum Likelihood (ML)
Week 2- Application: Wireless Sensor Network, Reliability of Estimation
Week 3- Application: Wireless Fading Channel Estimation, Cramer-Rao Bound for Estimation
Week 4- Vector Parameter Estimation, Properties of Estimate; Applications: Multi-antenna Wireless Channel Estimation
Week 5- Application: MIMO Wireless Channel Estimation, Error Covariance of Estimation, Equalization for Frequency Selective Channels
Week 6- Application: OFDM Estimation, Sequential Estimation
Week 7- Minimum Mean-Squared Error (MMSE) Estimate, Gaussian Parameter
Week 8- Application: Wireless Sensor Network, Wireless Fading Channel Estimation
Week 9- Application: MMSE Estimation for Multi-Antenna Channel
Week 10- Application: MMSE for MIMO Channel Estimation, Properties of Estimate
Week 11- Application: MMSE for Equalization of Wireless Channel
Week 12- Application: MMSE for OFDM Channel Estimation

Books and references

NIL

Instructor bio

Prof. Aditya K. Jagannatham

IIT Kanpur

Prof. Aditya K. Jagannatham received his Bachelors degree from the Indian Institute of Technology, Bombay and M.S. and Ph.D. degrees from the University of California, San Diego (UCSD). From April '07 to May'09 he was employed as a senior wireless systems engineer at Qualcomm Inc., San Diego, California, where he was a part of the Qualcomm CDMA Technologies (QCT) division. His research interests are in the area of next-generation wireless cellular and WiFi networks, with special emphasis on various 5G technologies such as Massive MIMO, mmWave MIMO, FBMC, NOMA, Full Duplex and others. He has contributed to the 802.11n high throughput wireless LAN standard and has published extensively in leading international journals and conferences. He was awarded the CAL(IT)2 fellowship at the University of California San Diego and the Upendra Patel Achievement Award at Qualcomm.

He is currently a Professor in the Electrical Engineering department at IIT Kanpur, where he holds the Arun Kumar Chair Professorship, and is also associated with the BSNL-IITK Telecom Center of Excellence(BITCOE). He has been twice awarded the P.K. Kelkar Young Faculty Research Fellowship for excellence in research, the Qualcomm Innovation Fellowship (QIF) and the IIT Kanpur Excellence in Teaching Award. His popular video lectures for the NPTEL(National Programme on Technology Enhanced Learning) course on Advanced 3G and 4G Wireless Mobile Communications can found at the following YouTube link (NPTEL 3G/4G). He has also successfully conducted several Massive Open Online Courses (MOOCs) on

Course certificate

This course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.

The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).

Date and Time of Exams: **30 October 2022** Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.

Registration url: Announcements will be made when the registration form is open for registrations.

The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.

Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

CRITERIA TO GET A CERTIFICATE

Average assignment score = 25% of average of best 8 assignments out of the total 12 assignments given in the course.

Exam score = 75% of the proctored certification exam score out of 100

Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75. If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.

Certificate will have your name, photograph and the score in the final exam with the breakup.It will have the logos of NPTEL and IIT Kanpur .It will be e-verifiable at nptel.ac.in/noc (http://nptel.ac.in/noc).

Only the e-certificate will be made available. Hard copies will not be dispatched.

Once again, thanks for your interest in our online courses and certification. Happy learning.

NPTEL team

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Department: Electronics and Telematics Engineering

2022-23

REPORT

FDP on "Principles of Signal Estimation for MIMO/ OFDM Wireless Communication"

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Date of program: 25-07-2022 to 14-10-2022

Resource person: KMB: Prof. Kishore Bhurchandi, VNIT Nagpur TKK: Prof. T. Kishore Kumar, NIT Warangal, SDR: Prof. Sumantra Dutta Roy, IIT Delhi IIA: Dr. Irshad Ahmad Ansari, IITDMJ

About the Program: This FDP gives the knowledge of various signal processing procedures in communication systems such as channel estimation, equalization, synchronization etc, which are also employed in MIMO-OFDM based 3G/ 4G wireless systems, are based on fundamental concepts in estimation theory. The course begins with a brief overview of the basic concepts of maximum likelihood (ML) and Least Squares Estimation (LS) and several applications of estimation theory in wireless communications such as channel estimation, equalization, MIMO, OFDM. Further, we will also cover Bayesian Estimation, MMSE, LMMSE principles.

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