Topics for the MSCSP

Advanced Research Projects

Winter Semester 2015 / 2016

Selection of topics and submission of topic sheets until

October 26, 2015.

MS CSP

ILMENAU UNIVERSITY OF TECHNOLOGY

**Department of Electrical Engineering
and Information Technology**

Institute for Information Technology

INSTITUT
INFORMATIONS-
TECHNIK

Division of Communication Networks

Head: Prof. Dr. rer. nat. habil. Jochen Seitz

MS CSP

ILMENAU UNIVERSITY OF
TECHNOLOGY

**Department of Electrical Engineering
and Information Technology**

**Institute for Information
Technolog**

Lab: Communications Research Laboratory

Head: Prof. Dr.-Ing. Martin Haardt

Unique Word OFDM for LTE-A Downlink

Responsible Professor: Prof. Martin Haardt
Supervisor: Sher Ali Cheema

- **Description:**

  In OFDM based systems, the symbols are separated by guard intervals which are usually implemented by cyclic prefixes (CP). CP is a random sequence and is solely created in time domain by copying the last part of the output of IDFT. Instead of using a random sequence as CP, a known deterministic sequence called as unique word (UW) can be used which, in result, can be very helpful for channel estimation and synchronization. Therefore, such UW systems does not require dedicated pilot carriers as compared to systems using CP. In [1], two different methods are introduced to construct UW-OFDM. In this project, we will compare the performance of UW-OFDM against the CP-OFDM for the LTE-A downlink scenario.

- **Requirements:** Programming skills in MATLAB.

- **Tasks**

  ❑   Review of the literature

  ❑   Implementation of UW-OFDM in Matlab

  ❑   Performance comparison of UW-OFDM and CP-OFDM for LTE-A downlink

- **Literature:**

  [1].   A. Onic and M. Huemer, "Direct vs. two-step approach for unique word generation in UW-OFDM," in Proc. 2010 Int. OFDM Work., pp.   145–149 Hamburg (Germany), September 2010.

  [2].   Huemer, M., Hofbauer, C., Huber, J.B "The Potential of Unique Words in OFDM" in Proceedings of the 15th International OFDM Workshop. Hamburg (Germany), September 2010.

- **Focus**   1/2 students   theory / programming

Channel Estimation Techniques for UW-OFDM

Responsible Professor: Prof. Martin Haardt

Supervisor: Sher Ali Cheema

- **Description:**

  In OFDM based systems, the symbols are separated by guard intervals which are usually implemented by cyclic prefixes (CP). CP is a random sequence and is solely created in time domain by copying the last part of the output of IDFT. Instead of using a random sequence as CP, a known deterministic sequence called as unique word (UW) can be used which, in result, can be very helpful for channel estimation and synchronization. Therefore, such UW systems does not require dedicated pilot carriers as compared to systems using CP. In this project, we will investigate the channel estimation techniques for UW-OFDM.

- **Requirements:** Programming skills in MATLAB.

- **Tasks**
  - ❑ Review of the literature
  - ❑ Channel estimation using UW

- **Literature:**

  [1]. A. Onic and M. Huemer, "Direct vs. two-step approach for unique word generation in UW-OFDM," in Proc. 2010 Int. OFDM Work., pp. 145–149 Hamburg (Germany), September 2010.

  [2]. Huemer, M., Hofbauer, C., Huber, J.B "The Potential of Unique Words in OFDM" in Proceedings of the 15th International OFDM Workshop. Hamburg (Germany), September 2010.

- **Focus**   1 students   theory / programming

CRL

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Unique Word based DMT Schemes

Responsible Professor: Prof. Martin Haardt

Supervisor: Sher Ali Cheema

- **Description:**
OFDM and its real-valued version DMT are popular schemes used to compensate the channel dispersion in direct detection optical systems. DMT schemes also take advantage of the CP, as in CP-OFDM, to mitigate the effect of channel dispersion. CP is a random sequence and is solely created in time domain by copying the last part of the output of IDFT. Instead of using a random sequence as CP, a known deterministic sequence called as unique word (UW) can be used which, in result, can be very helpful for channel estimation and synchronization. In this work, we will investigate the UW-OFDM structure for the DMT schemes and, based on this, propose new UW based DMT schemes for optical communication systems.

- **Requirements:** Programming skills in MATLAB.

- **Tasks**

  ❑   Review of the literature

  ❑   Implementation of these schemes in Matlab

- **Literature:**

  [1]. Huemer, M., Hofbauer, C., Huber, J.B "The Potential of Unique Words in OFDM" in Proceedings of the 15th International OFDM Workshop. Hamburg (Germany), September 2010.

  [2]. M. Wolf, L.Grobe, M. R. Rieche, A. Koher and J. Vucic, " Block transmission with linear frequency domain equalization for dispersive optical channels" in 12th International Conference on Transparent Optical Networks (ICTON) 2010, Munich, Germany.

  [3]. M. Wolf, M. Haardt, " Comparison of OFDM and frequency domain equalization for dispersive optical channels with direct detection" in 14th International Conference on Transparent Optical Networks (ICTON) 2012, Coventry, England.

- **Focus**   1 students   theory / programming

CRL

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Peak to Average Power Ratio Reduction for DMT Schemes

Responsible Professor: Prof. Martin Haardt
Supervisor: Sher Ali Cheema

- **Description:**
OFDM and its real-valued version DMT are popular schemes used to compensate channel dispersion in direct detection optical systems. One of the major drawback of OFDM is its high peak to average power ratio (PAPR) of the output signal which seriously limits the power efficiency of transmitter's high power amplifier. Transmitting a signal with high PAPR requires highly linear power amplifiers with a large back-off to avoid adjacent channel interference due to nonlinear effects. In this work, we will investigate the different PAPR reduction algorithms for DMT schemes such as AC-DMT and DC-biased DMT.

- **Requirements:** Programming skills in MATLAB.

- **Tasks**
  - ❏ Review of the literature
  - ❏ Implementation of different PAPR reduction algorithms in Matlab

- **Literature:**
  - S.H. Han, J. H. Lee, "An overview of peak-to-average power ratio reduction techniques for multicarrier transmission" in IEEE wireless communication volume 12, issue2, April 2005.
  - M. Wolf, L.Grobe, M. R. Rieche, A. Koher and J. Vucic, " Block transmission with linear frequency domain equalization for dispersive optical channels" in 12th International Conference on Transparent Optical Networks (ICTON) 2010, Munich, Germany
  - M. Wolf, M. Haardt, " Comparison of OFDM and frequency domain equalization for dispersive optical channels with direct detection" in 14th International Conference on Transparent Optical Networks (ICTON) 2012, Coventry, England.

- **Focus**   1 students   theory / programming

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Carrierless Amplitude and Phase Modulation with Decision Feedback Equalization for VLC

Responsible Professor: Prof. Martin Haardt

Supervisor: Sher Ali Cheema

- **Description:**

Visible light communication (VLC) is a technology with enormous potential for wide range of applications within next generation transmission and broadcasting technologies. Despite many advantages, the main challenge in VLC systems to date has been in improving data rates while considering the low bandwidths of the commercial LED devices. Many advance modulation schemes such as block transmission with frequency domain equalization, discrete multi-tone transmission (DMT), and carrier less amplitude and phase (CAP) have been suggested for VLC. Moreover, equalization also plays a vital role in improving the spectral efficiency of VLC systems. In this work, we will investigate the performance of CAP modulation scheme with decision feedback equalization and will compare it with the other schemes in indoor multipath environment.

- **Requirements:** Programming skills in MATLAB.

- **Tasks**
  - ❏   Review of the literature
  - ❏   Implementation of CAP with DFE in Matlab

- **Literature:**
  - ❑   M. Wolf, L.Grobe, M. R. Rieche, A. Koher and J. Vucic, " Block transmission with linear frequency domain equalization for dispersive optical channels" in 12th International Conference on Transparent Optical Networks (ICTON) 2010, Munich, Germany
  - ❑   F.-M.Wu, C.-T. Lin, et al., "1.1-Gb/sWhite-LED-Based Visible Light Communication Employing Carrier-Less Amplitude and Phase Modulation," IEEE Photonics Technology Letters, pp. 1730 – 1732, Oct. 2012

- **Focus**   1 students   theory / programming

Device to Device (D2D) communications

Responsible Professor: Prof. Martin Haardt
Supervisor: Bilal Zafar, Sher Ali Cheema

- **Description:**
  In conventional cellular networks, users communicate via base stations (BS) however close range users may gain if they communicate directly between each other. Device-to-device (D2D) networking allows direct communication between cellular users and provide the following benefits:
 - Offload traffic from the core network
  - Higher data rates and power efficiency for both users and networks
  - Optimized spectrum reuse if sharing is allowed (underlay case)
  - Better coverage
  - Improved energy efficiency and reduced backhaul demand

- **Requirements:** Strong programming skills in MATLAB and good knowledge about wireless systems.

- **Tasks**
  - When one should use direct D2D communication instead of cellular?
  - Comparison between in-band (overlay and underlay) and out-of-band modes
  - Use of MIMO to provide additional degrees of freedom
  - How to implement D2D on new generation systems where the transceivers for uplink and downlink are different
  - (please contact the supervisors for more details)

- **Focus**   1 students   theory / programming

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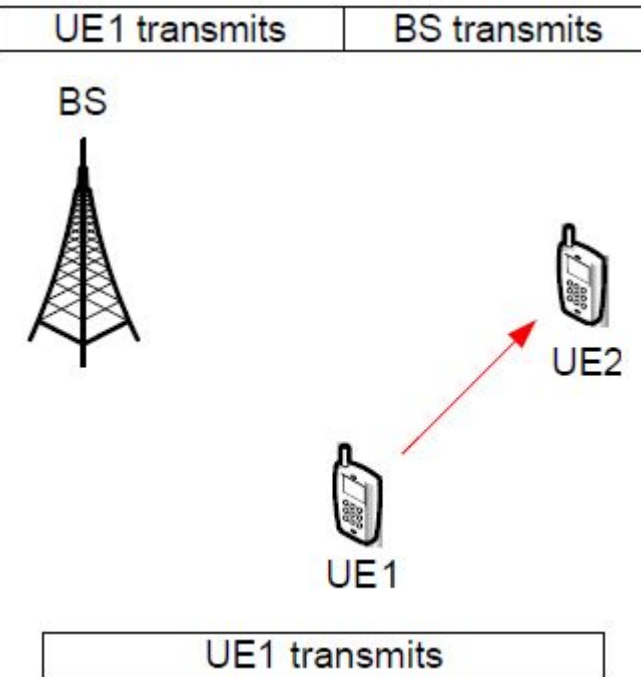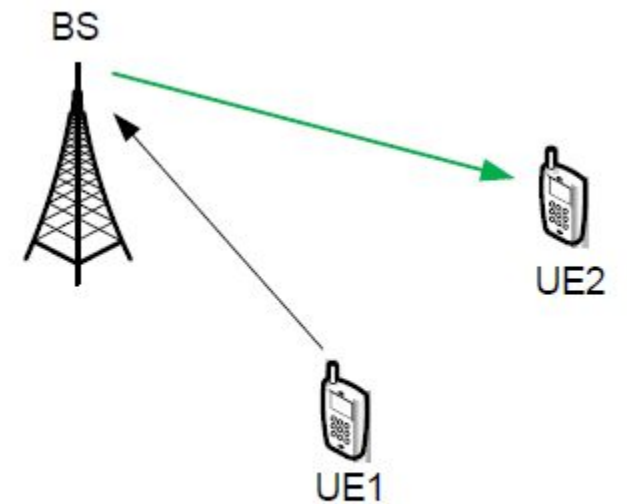
The Physical Layer of Future mmWave WiFi

Responsible Professor: Prof. Dr. -Ing. Martin Haardt
Research Adviser: Dr. -Ing. Jianshu Zhang
E-Mail: jianshu.zhang@tu-ilmenau.de

- **Description**:
  60 GHz band provides a large amount of unlicensed bandwidth, which can be used to boost the data rate. The use of CMOS techniques makes it feasible to produce mmWave arrays. To exploit the benefits of 60 GHz band and massive MIMO arrays, novel physical layer techniques are desired.

- **Tasks**
  - Literature study of the current mmWave WiFi Standard, i.e., 802.11 ad
  - Build up a standard compliant link level simulator via simulink
  - Investigate and / or develop signal processing techniques in one of the following research directions:

    MIMO strategies / Channel Estimation / Comparison of single and multi-carrier PHY/

    limited feedback

- **References**

  [1] Agilent Technologies, "Wireless LAN at 60 GHz – IEEE 802.11 ad Explained: Application Note", *White paper,* 2013.

  [2] O. El Ayach, S. Rajagopal, S. Abu-Surra, Z. Pi, and R. W. Heath, "Spatially Sparse Precoding in Millimeter Wave MIMO Systems", *IEEE Transactions on Wireless Communications*, vol. 13, no. 3, 2014.

- **Focus**

  1 or 2 students,   theory / programming / hardware / measurements / protocols

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System Level Simulator for SDMA Enhanced LTE Heterogeneous networks

Responsible Professor: Prof. Dr. -Ing. Martin Haardt
Research Adviser: Dr. –Ing. Jianshu Zhang
E-Mail: jianshu.zhang@tu-ilmenau.de

- **Description**:
In the development, standardization as well as the implementation process of equipment manufacturers of wireless networks, simulations are necessary to test and optimize algorithms and procedures. System level simulations focus on network-related issues and are indispensable for evaluating new mobile network technologies.

- **Tasks**

  - Understand the concept of system level simulator

  - Develop a System Level Simulator for LTE Heterogeneous Networks, involving relaying, D2D, and M2M, with a focus on:

    Mobility management / radio resource management / PHY abstraction / stochastic modelling

- **References**

  [1] J. C. Ikuno, M. Wrulich, and M. Rupp, "System level simulation of LTE networks", IEEE 71st Vehicular Technology Conference, Taipei, Taiwan, May 2010

  [2] H. Zhang, Y. Xie, L. Feng, and Y. Fang, "Base Station Design and Siting Based on Stochastic Geometry", Vehicular Technologies Deployment and Application, InTech, Feb. 2013.

- **Focus**

    1 or 2 students,   theory / programming / hardware / measurements / protocols

The Potential of MIMO Multi-Carrier Radar Systems

Responsible Professor: Prof. Dr. -Ing. Martin Haardt
Research Adviser: Dr. -Ing. Jianshu Zhang
E-Mail: jianshu.zhang@tu-ilmenau.de

- **Description**:
Compared to traditional FMCW radar, OFDM radar offers several attractive features for radar applications, e.g., tolerance against Doppler shift. Yet the potential of OFDM radar, or using other multi-carrier techniques, has not been fully exploited, especially when multiple antennas are used.

- **Tasks**

  – Literature study of current MIMO OFDM radar techniques

  – Implement and improve the performance of MIMO OFDM radar in range, velocity, and angle estimation, with the focus on

    novel estimation techniques \ near-field radar \ alternative multicarrier techniques, e.g., FBMC

- **References**

[1] C. Sturm, E. Pancera, T. Zwick, and W. Wiesbeck, "A novel approach to OFDM Radar processing", *Radar Conference, IEEE, May* 2009.

[2] M. Braun, C. Sturm, and F. K. Jondral, "Maximum likelihood speed and distance estimation for OFDM radar", *in IEEE Radar Conference*, 2010.

[3] Y. L. Sit and W. Wiesbeck, "MIMO OFDM Radar with Communication and Interference Cancellation Features", *in IEEE Radar Conference*, 2014.

- **Focus**

    1 or 2 students,   theory / programming / hardware / measurements / protocols

Compression of a big tensor using tensor decompositions

Responsible Professor: Prof. Martin Haardt

Supervisor: Kristina Naskovska

- **Description**:
  More and more often we deal with massive amounts of heterogeneous data, for that reason we would like to analyse the so called big data using tensor algebra. Since the big data requires a lot of memory space a first and obvious solution is to perform a compression of the data. For that reason an implementation of the state of the algorithms as well as appropriate modifications should be achieved.

- **Tasks**
  - Literature study on tensor algebra and tensor decompositions.
  - Literature study on big data compression
  - Implementation of the state of the art algorithms

- **References**

  [1] T. G. Kolda and B. W. Bader. "Tensor decompositions and applications". SIAM, 51:455-500, 2009.

  [2] N. D. Sidiropoulos, E.E Papalexakis and C. Faloutsos . "A Parallel Algorithm for Big tensor decomposition using randomly compressed cubes (PARACOMP)", IEEE Internation Conference on Acoustic, Speech and Signal Processing (ICASSP), 2014

Focus

1 student   theory / programming / hardware / measurements

MS CSP

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Decomposition of a low-rank tensor with mission entries

Responsible Professor:	Prof. Martin Haardt
Supervisor:	Kristina Naskovska

- **Description**:
More and more often we deal with massive amounts of heterogeneous data, for that reason we would like to analyse the so called big data using tensor algebra. Moreover, some of this data is either missing or it is corrupted and needs to be estimated. This can be achieved via decomposition of a low-rank tensor with mission entries. An implementation of the state of the algorithms as well as appropriate modifications should be achieved.

- **Tasks**
    - Literature study on tensor algebra and tensor decompositions.
    - Literature study on decomposition of low-rank tensor
    - Implementation of the state of the art algorithms

- **References**

[1] T. G. Kolda and B. W. Bader. "Tensor decompositions and applications". SIAM, 51:455-500, 2009.

[2] M. Mardani, G. Mateos and G.B. Giannakis. "Imputation of Streaming Low-Rank Tensor data", 8th IEEE Sensor Array and Multichannel Signal Processing Workshop (SAM), 2014

Focus

1 student   theory / programming / hardware / measurements

Decomposition of a tensor in rank-one components

Responsible Professor: Prof. Martin Haardt
Supervisor: Kristina Naskovska

- **Description**:
Factorization of a tensor in its rank-one component is essential part of a tensor and data analysis. Decomposition of a tensor in its rank-one components is commonly know as the CP decomposition, and its is calculated based on Trilinear-ALS. There exist other algebraic solutions such as SECSI, based on joint matrix diagonalization. In this project we would like to investigate non-symmetric matrix diagonalizations as well as possibility to introduce constrains on the factor matrices.

- **Tasks**
  - Literature study on tensor algebra and tensor decompositions.
  - Literature study on decomposition of low-rank tensor
  - Implementation of the state of the art algorithms

- **References**
  [1] T. G. Kolda and B. W. Bader. "Tensor decompositions and applications". SIAM, 51:455-500, 2009.
  [2] P. Tichavsky, A. H. Phan and A. Cichocki "TWO-SIDED DIAGONALIZATION OF ORDER-THREE TENSORS", EUSIPCO, 2015 (submitted)
  [3] F. Roemer, C. Schroeter and M. Haardt. "A semi-algebraic framework for approximate CP decompositions via joint matrix diagonalization and generalized unfoldings. ASILOMAR, 2012

Focus   2 student   theory / programming / hardware / measurements

Non-binary LDPC codes

Responsible Professor: Prof. Martin Haardt
Supervisor: Marko Hennhöfer

- **Description**:
  In future wireless systems there are many challenges to be addressed. Besides the increase of data-rates also new aspects need to be considered, i.e., relaying, cooperation, MIMO. The terminals which access the network are not only powerful mobile phones but also small devices, like sensors with very limited resources.
  Non-binary LDPC codes achieve a high spectral efficiency with a moderate increase of complexity as compared to their binary counterparts.

- **Tasks**
  - Get an understanding of non-binary LDPC codes and the basic decoding schemes (Belief propagation, Extended-Min-Sum (EMS) decoding) by considering just a single link.
  - Extend the scenario by a relay and investigate how the decoding complexity can be decreased, e.g., by cooperation.

- **References**

  [1] Esdras Nicoletto da Cunha and Renato Baldini Filho. "A Simple Cooperative LDPC Coding Scheme", Revista Telecomunicacoes, vol. 15, no. 02, 2013.

  [2] Marjan Karkooti and Joseph R. Cavallaro. "Communications Using Scalable, Medium Block-length LDPC Codes", in *Proc. IEEE WCNC*, 2008.

Focus   **1** student   theory / programming / hardware / measurements

Poly-Gaussian Modelling in Wireless Systems

Responsible Professor: Prof. Adel Nadeev, Prof. Martin Haardt
Supervisor: Damir Rakhimov, Marko Hennhöfer

- **Description**:
In common wireless scenarios we will often face noise and interference processes which don't have a Gaussian distribution. Receivers with decision schemes based on Gaussian assumptions will show a performance degradation in such scenarios as not all information can be exploited. Modelling the interference as poly-gaussian process allow simplified receiver implementations.

- **Tasks**
  - Get an understanding of the poly-Gaussian modelling of noise and interference.
  - Implement a poly-Gaussian receiver structure for a SIMO system.
  - Evaluate the performance by comparing the results with traditional receiver schemes.

- **References**

[1] Chabdarov Sh.M., Safiullin N.Z., Feoktistov A.Yu. Osnovy statisticheskoi teorii radiosvyazi: Poligaussovy modeli i metody. Kazan': KAI, 1983, 87p. (in Russian)

[2] Gantmakher F.R. Teoriya matrits. M.:Nauka, 1967, 574p. (in Russian)

[3] Levin B.R. Teoreticheskie osnovy statisticheskoi radiotekhniki. M.: Radio i svyaz', 1989, 656p. (in Russian)

[4] Venttsel' E.S. Teoriya veroyatnostei. M.: Nauka, 1969, 576p. (in Russian)

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Focus student / theory / **programming** / hardware / measurements

ILMENAU UNIVERSITY OF TECHNOLOGY

**Department of Electrical Engineering
and Information Technology**

Institute for Information Technology

RF and Microwave Research Laboratory

Head: Prof. Dr. rer. nat. habil. Matthias Hein

Estimation of K-factor from Measured and Parametric Channel Data Sets

Supervisor : Christian Schneider

Responsible Professor : Reiner S. Thomä

Description:

The K-factor plays an important role in wireless channel analysis and modelling. Different methods to estimate the K-factor from measured channel sounding data sets are known, e.g. Maximum Likelihood estimation and different moment based methods[1-3]. For parametric data sets no specific approach has been discussed so far.

Tasks:

– Study the estimation algorithm available in literature and our own papers [3]

– Propose extension/application of K-Factor estimation for parametric channel data sets

– Getting familiar with the available implementation the estimation of the K-Factor [1],[3], and different channel data sets (measured and parametric)

– Implementation of the new algorithms (ML and moment method [2] and extend this to parametric data sets)

– Compare and study the different methods, derive conclusion

References:

[1] Greenstein, L.J.; Michelson, D.G.; Erceg, V., "Moment-method estimation of the Ricean K-factor," *Communications Letters, IEEE* , vol.3, no.6, pp.175,176, June 1999, doi: 10.1109/4234.769521

[2] Tepedelenlioglu, C.; Abdi, A.; Giannakis, G.B., "The Ricean K factor: estimation and performance analysis," *Wireless Communications, IEEE Transactions on* , vol.2, no.4, pp.799,810, July 2003, doi: 10.1109/TWC.2003.814338

[3] Bottcher, A.; Vary, P.; Schneider, C.; Narandzic, M.; Thoma, R.S., "Estimation of the Radio Channel Parameters from a Circular Array with Directional Antennas," Vehicular Technology Conference (VTC Spring), 2011 IEEE 73rd , vol., no., pp.1,5, 15-18 May 2011, doi: 10.1109/VETECS.2011.5956303

Focus:

1-2 students   Theory/programming/simulations/measurements/hardware

User selection in multiuser MIMO systems

Supervisor: Christian Schneider
Responsible Professor: Reiner S. Thomä

Description:

Multiuser MIMO (MU-MIMO) significantly increase the spectral efficiency of cellular systems. When a base station (BS) or access point (AP) has fewer RF chains than the number of Tx antennas at BS/AP and the number of users are comparatively large, then the selection and scheduling of users plays a vital role in maximizing spectral efficiency inside a cell.

Tasks:

- Theoretical understanding and implementation of state of the art user selection techniques.
- Analysis of pros and cons of different algorithms from complexity and performance point of view.

References:

[1]   T. Yoo and A. Goldsmith, "On the optimality of multiantenna broadcast scheduling using zero-forcing beamforming," *Selected Areas in Communications, IEEE Journal on, vol. 24, no. 3, pp. 528–541, March 2006.*

[2]   S. Huang, H. Yin, J. Wu, and V. Leung, "User selection for multiuser MIMO downlink with zero-forcing beamforming," *IEEE Transactions on Vehicular Technology, vol. 62, no. 7, pp. 3084–3097, Sept 2013.*

Focus: 2 students   Theory/programming/simulations/measurements/hardware

Department of Computer Science and Automation

Institute of Computer Engineering

Institut für Technische Informatik und Ingenieurinformatik

Integrated Communication Systems Group

Head: Prof. Dr.-Ing. habil. Andreas Mitschele-Thiel

ics

Comparison of Different Signal Propagation Models for a Mixed Indoor-Outdoor Scenario

Responsible Professor: **Prof. Andreas Mitschele-Thiel**

Supervisor: **M.Sc. Alina Rubina**

- Description:

    We are considering a challenging scenario in which an unmanned aerial vehicle (UAV) is flying over an urban area, which suffers from a disaster. The purpose of an UAV is to localize 'survived' devices, enabled with Wi- Fi module. In order to improve localization, a suitable signal propagation model is required. In our unique scenario it is crucial to find a fitting signal model which will result in the improved localization accuracy.

- Tasks
    - Literature study on existing signal propagation models
    - Implementation of chosen models in Python
    - Simulation of different signal propagation models in different scenarios
    - Real time experiments with the most suitable model (optional)

- References

    [1] Faria, Daniel B.: Modeling Signal Attenuation in IEEE 802.11 Wireless LANs - Vol. 1 / University. 2006 (TR-KP06-0118). – Forschungsbericht

    [2] Oleksandr Artemenko, Adarsh Harishchandra Nayak, Sanjeeth Baptist Menezes, Andreas Mitschele-Thiel: Evaluation of Different Signal Propagation Models for a Mixed Indoor-Outdoor Scenario Using Empirical Data , 7th International Conference on Ad Hoc Networks (ADHOCNETS'15), San Remo, Italy, September 2015

- Focus

2 students   **theory / programming** / hardware / measurements

Implementation and Comparison of Reference Selection Algorithms for Localization in Wireless Networks

Responsible Professor: **Prof. Andreas Mitschele-Thiel**
Supervisor: **M.Sc. Alina Rubina**

- Description:
So called mobile anchors gather reference information while traversing through the network of wireless static nodes. Different selection algorithms of reference data improve the localization information.

- Tasks
  - Implementation of existing algorithms in Python
  - Simulation of different algorithms in different scenarios
  - Implementation of a new algorithm (optional)

- References
[1] Artemenko, Oleksandr ; Simon, Tobias ; Mitschele-Thiel, Andreas; Schulz, Dominik .... S.: Comparison of Anchor Selection Algorithms for Improvement of Position Estimation During the WPT Localization Process in Disaster Scenario. In: The 37th IEEE Conference on Local Computer Networks (LCN). Clearwater, Florida, USA, 10 2012

- Focus

2 students   **theory / programming** / hardware / measurements

Development of the Trajectory for Multi-UAV Scenario in Wireless Networks

Responsible Professor: **Prof. Andreas Mitschele-Thiel**
Supervisor: **M.Sc. Alina Rubina**

- Description:
  Existing literature barely considers a scenario including more than one mobile anchor (UAV). Usage of multiple UAV will improve the speed of localization process. Time is a crucial factor in the disaster scenario.
- Tasks
  – Literature research on the application of multiple UAVs in 2D and 3D scenarios
  – Implementation of one of the strategies in Python
  – Comparison of the scenario with one or multiple UAVs
- References
  [1] Artemenko, Oleksandr ; Rubina, Alina ; Golokolenko, Oleg ; Mitschele-Thiel, Andreas: How Different Trajectories of Moving Beacons Influence the Localization of Nodes in Disaster Scenarios Using Wireless Communication. In: The 17th International Symposium on Wireless Personal Multimedia Communications (WPMC'2014). Sydney, Australia, 09 2014
  [2] Besada-Portas, E.; De La Torre, L.; de la Cruz, J.M.; de Andrés-Toro, B., "Evolutionary Trajectory Planner for Multiple UAVs in Realistic Scenarios," Robotics, IEEE Transactions on , vol.26, no.4, pp.619,634, Aug. 2010
- Focus
  2 students   **theory / programming** / hardware / measurements

Advanced Ultrasonic-Based Obstacle Avoidance on Small UAVs

Responsible Professor: Prof. Dr.-Ing. Habil. Andreas Mitschele-Thiel

Supervisor: M.Sc. Oleksandr Andryeyev

- **Description**:
  Small unmanned aerial vehicles attract a lot of attention today. One of the most challenging tasks is a obstacle/collision avoidance. Ultrasonic-based obstacle avoidance algorithms are studied in this work.

- **Tasks**
  - Literature study on existing approaches on obstacle avoidance and requirements for them
  - Implementation of several different algorithms on UAV
  - Comparison of results
  - Extension of the best approach (optional)

- **References**

  [1] Borenstein, J.; Koren, Y., "Obstacle avoidance with ultrasonic sensors," Robotics and Automation, IEEE Journal of , vol.4, no.2, pp.213,218, Apr 1988. doi: 10.1109/56.2085
  [2] Frew, Eric, and Raja Sengupta. "Obstacle avoidance with sensor uncertainty for small unmanned aircraft." Decision and Control, 2004. CDC. 43rd IEEE Conference on. Vol. 1. IEEE, 2004.

- **Focus**

  1/2 student   theory / programming / hardware / measurements

Safe Flight Routines For Small UAVs

Responsible Professor: Prof. Dr.-Ing. Habil. Andreas Mitschele-Thiel

Supervisor: M.Sc. Oleksandr Andryeyev

- **Description**:
  Small unmanned aerial vehicles (UAVs) attract a lot of attention today. UAV should be able to safely take-off, land and follow some route. During these operations, UAV should consider the current state of environment. In addition, operator should be able to takeover control in case of emergency.

- **Tasks**
  - Literature study on existing approaches on safe take-off, landing and route following approaches
  - Implementation and comparison between chosen approaches on UAV
  - Extension of existing approaches (optional)

- **References**

  [1] Jahn, B.; Barth, A.; Wulff, K.; Simon, T.; Romisch, J., "Rate control and flight stabilization for a quadrotor system", Unmanned Aircraft Systems (ICUAS), 2013 International Conference on , vol., no., pp.642,649, 28-31 May 2013; doi: 10.1109/ICUAS.2013.6564744
  [2] Eendebak, P. T., A. W. M. van Eekeren, and R. J. M. den Hollander. "Landing spot selection for UAV emergency landing." *SPIE Defense, Security, and Sensing*. International Society for Optics and Photonics, 2013.

- **Focus**

  1 student   theory / programming / hardware / measurements

Applied Media Systems

Head: Prof. Dr.-Ing. Gerald Schuller