

Igor V. Kozintsev

Education

- 2000, Ph.D. in Electrical Engineering, University of Illinois at Urbana-Champaign
- 1997, MS in Electrical Engineering, University of Illinois at Urbana-Champaign
- 1994, Diploma with Honors in Electrical Engineering, Moscow State Technical University, Moscow, Russia, recipient of the President of Russia scholarship in 1994

Professional experience

May 2000 – Present: Intel Labs, Santa Clara, CA

Senior Researcher

Current and recent activities include:

- Leading research and advanced development projects in the areas of signal processing, multimedia, networking, wireless communications, SoC design and simulations;
- Collaborating with research and product teams inside Intel and externally in multi-team projects;
- Mentoring and coordinating the relationship with Universities research groups.

Major projects:

- **Power-performance optimization for software and hardware co-design.** The goal of the project was to investigate the power-performance tradeoffs by exploring software and hardware design options, while running the clock-cycle accurate simulation of complex workload on a complete platform simulator. We have implemented a system simulation infrastructure that replicated closely the hardware platform based on Intel XScale® microprocessor, bus, memory controller and several peripherals. Our simulation infrastructure allowed us to run complex applications (H.264 decoder and software 3D rendering) in full-featured OS environment and investigate power and performance tradeoffs for different hardware and software choices. **Together with a team of researchers I developed execution driven power model that was validated against real system and transferred to the product team performing SoC development.**
- **Distributed Digital Signal Processing (DDSP).** The goal of the project was to transform a network of heterogeneous, distributed computing platforms like laptops, PDAs or cell phones into an array of audio/video sensors and actuators capable of performing complex DSP tasks such as distributed beamforming, audio rendering, audio/visual tracking, camera array processing. In particular, this requires putting distributed heterogeneous computing platforms with audio-visual sensors into a common time and space coordinate system. Towards that goal ad-hoc synchronization, I/O calibration, sensor/actuator localization, joint audio-video processing, distributed source coding as well as distributed signal processing in general are investigated from a system hardware-software angle. **Together with a team of researchers I developed new algorithms for DDSP, distributed time synchronization, localization and speaker tracking, co-authored 6 patent applications and multiple conference/journal papers. I have transferred the time synchronization technology to the product teams responsible for the current and next generation 802.11 hardware and software and it is currently supported in production HW, FW and drivers.**
- **Scalable video multicast of real-time video over Wireless LANs.** We developed a framework for distributing video over heterogeneous packet wireless channels to multiple users. MPEG4 Fine Granularity Scalability (FGS) was combined with Forward Error Control (FEC) coding scheme. The proposed solution achieves minimax-fair scalable transmission of video to wireless and/or wired heterogeneous receivers. **Together with a team of researchers I developed software for multicast of HDTV-resolution streams of up to 24 MB/s to multiple clients using application-level FEC.**
- **Efficient point-to-point real-time media streaming over Wireless LANs.** We proposed a new hybrid Automatic Repeat-ReQuest (ARQ) scheme for improving media streaming over IEEE 802.11b networks. The algorithm involved packet erasure correcting FECs and improved the effective data throughput by **25%** compared to TCP-based transmission. **The performance of our scheme allows**

transmitting DVD-quality videos in real-time over conventional IEEE802.11b networks.

- **Scalable adaptive video streaming over Bluetooth LAN.** We proposed a low-overhead standard-compatible scheme for streaming MPEG4 FGS video over Bluetooth isochronous channel. **The proposed method allows implementing scalable channel-adaptive video streaming in the existing hardware.**
- **Network simulator for wireless and wired video streaming.** I co-developed a BSD-based network simulator that emulates Markov channel model approximation for IEEE802.11, Bluetooth and Ethernet. The simulator is capable of handling real-time traffic for up to 100 MBit/s.

1995 – 2000: Image Formation and Processing Group, UIUC
Graduate Research Assistant

Performed research in the area of image and video processing and communications. Specific projects included source coding (transform coding, quantization and entropy coding), channel coding (Forward Error Control coding, Automatic Repeat Request strategies, List Decoding Viterbi algorithm with continuous error detection), joint source-channel coding, image restoration, statistical modeling of image data, graphical models for image processing and communication, information theory, statistical learning theory.

- **Joint Source-Channel coding for image communication** (Ph.D. thesis work). I developed novel statistical models for images and wireless fading channels. I proposed new multiresolution and hybrid analog-digital schemes for optimal image communications over time-varying wireless channels. I have implemented a framework that solved the problem of multidimensional optimization using Lagrange multiplier methods, convex optimization methods and integer programming methods.
- **Arithmetic coding based continuous error detection.** I co-developed a new error detection mechanism based on arithmetic coder and successfully applied it to improve the memory/performance tradeoff in the List Viterbi decoding of Rate-compatible Punctured Convolutional Codes (RCPC). One patent was issued.
- **Graphical models for communications** (Ph.D. thesis work). I have introduced a factor graph framework for joint source-channel coding. **I have developed a factor-graph MATLAB toolbox for low-density parity check (LDPC) codes available online (Google's Coding Theory section).**
- **Statistical learning theory for semantic video indexing** I have applied graphical models to the problem of video objects classifications by introducing a hierarchical Markov model for video features and performing EM learning of model parameters and message passing based classification.
- **Statistical-modeling based image restoration.** I co-developed several image denoising algorithms that are currently still the state-of-the-art in the field. One method was based on local modeling of image coefficients and adaptive Wiener filtering. The other method employed statistical graphical model of image wavelet coefficients. Yet another method was based on robust kernel smoothing.

Development skills

- **Platforms: Windows** (desktop) – advance knowledge, hands-on experience with network and audio drivers, **Windows** (mobile) – familiar with, **Linux, BSD** – familiar with.
- **Tools:** advance knowledge of **.Net** development tools (**C, C++**), advance knowledge of optimization tools and libraries (**VTune, TCM, IPP**), several years experience with **multithreading, network programming**, working experience with **DDK** (network, audio) and **DirectX SDK, WinCE tools (Platform Builder, Intel Suite), SystemC**, version control software, expert in **Matlab**.
- **Experience:** Developed video and audio encoding/decoding/streaming applications, implemented **network and FEC real-time applications**, developed **distributed (RPC and UPnP-based) signal processing applications**, developed customized **Windows drivers for 802.11** network adapters and audio drivers. Implementation included requirement document preparation, coding, optimization, multithreading, debugging and testing.
 - **Example applications:** live video capture, encoding, streaming over wireless and decoding; live multichannel audio capture on wireless platforms, synchronization (this included audio and network driver customization), wireless streaming and array processing (beamforming and blind signal separation).

Professional activities

- **IEEE Senior Member**
- **Conferences:**
 - Co-organizer for Special Session on Distributed DSP, ICASSP2004
 - Co-organizer for Special Session on Multistream Audio and Video Processing for Telepresence, ICME2003
 - Program Committee Member of 2003 International Workshop on Multimedia Technologies in E-Learning and Collaboration, 2003
- **Reviewer** for IEEE Transactions on Signal Processing, IEEE Transactions on Communications, IEEE Transactions on Information Theory, IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Image Processing, IEEE Transactions on Multimedia, IEEE Signal Processing Letters.

Publications

- **Journal and book publications**
- 1. **Position Calibration of Audio Sensors and Actuators in a Distributed Computing Platform**
Raykar, V.C.; Kozintsev, I.V.; Lienhart, R., IEEE Transactions on Speech and Audio Processing, vol.13, no.1, Jan. 2005. p. 70-83.
- 2. **Providing Common Time and Space in Distributed AV-Sensor Networks by Self-Calibration**
R. Lienhart, I. Kozintsev, D. Budnikov, I.Chikalov, V. Raykar, in Intelligent Multimedia Processing with Soft Computing. Yap Peng Tan, Kim Hui Yap, Lipo Wang (Ed.), Springer-Verlag, Heidelberg. 2004
- 3. **Challenges in Distributed Video Management and Delivery**
Lienhart R.; Kozintsev I.; Chen Y-K.; Holliman M.; Yeung M.; Zaccarin A.; Puri R., in Challenges in Distributed Video Management and Delivery. *Handbook of Video Databases*. CRC Press, Boca Raton, Florida , pp. 961-990, 2003.
- 4. **Multicast and unicast real-time video streaming over wireless LANs**
A. Majumdar, D. Sachs, I. Kozintsev, K. Ramchandran and M. Yeung, IEEE Transactions on Circuits and Systems for Video Technology, vol.12, no.6, June 2002. p. 524-34
- 5. **Improving media services on P2P networks**
Lienhart, R.; Holliman, M.; Yen-Kuang Chen; Kozintsev, I.; Yeung, M, IEEE Internet Computing, vol.6, no.1, Jan.-Feb. 2002. p. 73-7.
- 6. **Factor graph framework for semantic video indexing** (This paper won the IEEE CSVT Outstanding Young author award for the first author in 2004)
M. Naphade, I. Kozintsev, T. Huang, IEEE Trans. on CSVT, vol.12, no.1; Jan. 2002; p.40-52.
- 7. **Continuous error detection (CED) for reliable communication**
Anand, R.; Ramchandran, K.; Kozintsev, I.V., IEEE Transactions on Communications. Volume: 49 Issue: 9, Sept. 2001, Page(s): 1540 –1549.
- 8. **Low-complexity image denoising based on statistical modeling of wavelet coefficients**
Kivanc Mihcak, M.; Kozintsev, I.; Ramchandran, K.; Moulin, P., IEEE Signal Processing Letters, Volume: 6 Issue: 12, Dec. 1999, Page(s): 300 –303.
- 9. **Robust image transmission over energy-constrained time-varying channels using multiresolution joint source-channel coding**
Kozintsev, I.; Ramchandran, K., IEEE Transactions on Signal Processing, Volume: 46 Issue: 4, April 1998, Page(s): 1012 –1026.

Conference publications

1. **Improving multicast streaming media over WLANs**
I. Kozintsev and J. McVeigh, BroadWIM2004
2. **Instruction-level power dissipation in the Intel XScale embedded microprocessor**
Varma, Debes, Kozintsev, Jacob, SPIE 2005.
3. **Distributed Array of Synchronized Sensors and Actuators**
Budnikov, D.; Chikalov, I.; Kozintsev, I.; Lienhart, R., EUSIPCO 2004.
4. **Acoustic Source Localization in Distributed Sensor Networks**
Ajdlar, T.; Kozintsev, I.; Lienhart R.; Vetterli M., Signals, Systems & Computers, 2004. Conference Record of the Thirty -Eighth Asilomar Conference. Volume: 2, 2004, Page(s): 1328 –1332.
5. **Providing common I/O clock for wireless distributed platforms**
Budnikov, D.; Chikalov, I.; Egorychev, S.; Kozintsev, I.; Lienhart, R., 2004 IEEE International Conference on Acoustics, Speech, and Signal Processing, vol.3. Piscataway, NJ, USA: IEEE, 2004. p. iii-909-12 vol.3.
6. **Self-aware distributed AV sensor and actuator networks for improved media adaptation**
Lienhart, R.; Kozintsev, I., 2004 IEEE International Conference on Multimedia and Expo (ICME) (IEEE Cat. No.04TH8763), Vol.3. Piscataway, NJ, USA: IEEE, 2004. p. 2131-4 Vol.3.

7. **On the importance of exact synchronization for distributed audio signal processing**
Lienhart, R.; Kozintsev, I.; Wehr, S.; Yeung, M., 2003 IEEE International Conference on Acoustics, Speech, and Signal Processing (Cat. No.03CH37404), vol.4. Piscataway, NJ, USA: IEEE, 2003. p. IV-840-3 vol.4.
8. **Distributed coding for wireless audio sensors**
Majumdar Majumdar, A.; Ramchandran, K.; Kozintsev, I., 2003 IEEE Workshop on Applications of 2003 IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (IEEE Cat. No.03TH8684). Piscataway, NJ, USA: IEEE, 2003. p. 209-12.
9. **On the importance of exact synchronization for distributed audio signal processing**
Lienhart, R.; Kozintsev, I.; Yeung, M.; Wehr, S., 2003 IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (IEEE Cat. No.03TH8684). Piscataway, NJ, USA: IEEE, 2003. p. 147.
10. **Multimedia technology infrastructure for emerging peer-to-peer applications and services**
Lienhart, R.W.; Holliman, M.J.; Yen-Kuang Chen; Kozintsev, I.V.; Yeung, M.M., Proceedings of the SPIE - The International Society for Optical Engineering, vol.5021, 2003. p. 187-98.
11. **Robust video multicast under rate and channel variability with applications to wireless LANs**
Majumdar, B.; Puri, R.; Ramchandran, K.; Kozintsev, I., 2002 IEEE International Symposium on Circuits and Systems. Proceedings (Cat. No.02CH37353), vol.1. Piscataway, NJ, USA: IEEE, 2002. p. I-49-52 vol.1.
12. **Hybrid ARQ for robust video streaming over wireless LANs**
Sachs, D.G.; Kozintsev, I.; Yeung, M.; Jones, D.L. Proceedings. International Conference on Information Technology: Coding and Computing, 2001, 2001, Page(s): 317 -321.
13. **Stochastic wavelet-based image modeling using factor graphs and its application to denoising**
Xiao, S.; Kozintsev, I.; Ramchandran, K. ICASSP '00. Proceedings. IEEE International Conference on Acoustics, Speech, and Signal Processing, 2000, Page(s): 2187 -2190 vol.4.
14. **On the transmission of a class of hidden Markov sources over Gaussian channels with applications to image communication**
Kozintsev, I.; Ramchandran, K. Proceedings. 2000 International Conference on Image Processing, 2000, Page(s): 363 -366 vol.1.
15. **A factor graph framework for semantic indexing and retrieval in video**
Naphade, M.; Kozintsev, I.; Huang, T.; Ramchandran, K., Proceedings. IEEE Workshop on Content-based Access of Image and Video Libraries, 2000, Page(s): 35 -39.
16. **Graphical statistical modeling of wavelet coefficients and its applications**
Kozintsev, I.; Xiao, S.; Ramchandran, K., Proceedings of the SPIE - The International Society for Optical Engineering, vol.4119, 2000. p. 806-20.
17. **Stochastic wavelet-based image modeling using factor graphs and its application to denoising**
Xiao, S.; Kozintsev, I.; Ramchandran, K., Proceedings of the SPIE - The International Society for Optical Engineering, vol.3974, 2000. p. 549-57.
18. **Spatially adaptive statistical modeling of wavelet image coefficients and its application to denoising**
Kivanc Mihcak, M.; Kozintsev, I.; Ramchandran, K., Proceedings. IEEE International Conference on Acoustics, Speech, and Signal Processing, 1999, Page(s): 3253 -3256 vol.6.
19. **A wavelet zerotree-based hybrid compressed/uncompressed framework for wireless image transmission**
Kozintsev, I.; Ramchandran, K., Signals, Systems & Computers, 1997. Conference Record of the Thirty-First Asilomar Conference. Volume: 2, 1997, Page(s): 1023 -1027.
20. **Image transmission using arithmetic coding based continuous error detection**
Kozintsev, I.; Chou, J.; Ramchandran, K., Data Compression Conference, 1998. DCC '98. Proceedings, 1998, Page(s): 339 -348.
21. **The role of arithmetic coding based continuous error detection in digital transmission systems**
Kozintsev, I.; Chou, J.; Ramchandran, K. Proceedings. 1998 IEEE International Symposium on Information Theory, Page(s): 290.
22. **Efficient hybrid framework for wireless image transmission**
Kozintsev, I.; Ramchandran, K., Global Telecommunications Conference, 1997. GLOBECOM '97. IEEE, 1997, Page(s): 1037 -1041 vol.2.
23. **Hybrid compressed-uncompressed framework for wireless image transmission**
Kozintsev, I.; Ramchandran, K. Proceedings. International Conference on Image Processing, 1997, Page(s): 77 -80 vol.2.
24. **Multiresolution joint source-channel coding using embedded constellations for power-constrained time-varying channels**
Kozintsev, I.; Ramchandran, K., Acoustics, Speech, and Signal Processing, 1996. ICASSP-96. Conference Proceedings. Volume: 4, 1996, Page(s): 2343 -2346.

Patents

1. **Method for synchronizing platform clocks in distributed wireless platforms**
US Patent pending, 2003
2. **3-Dimensional position calibration of audio sensors and actuators on a distributed computing platform under temporal synchronization uncertainties** US Patent pending, 2003
3. **System for time synchronization of I/O devices on multiple computing platforms**
US Patent pending, 2003
4. **Method for synchronized distributed audio input on general purpose computing platforms**
US Patent pending, 2003
5. **Method for 3-Dimensional position calibration of audio sensors and actuators on a distributed computing platform** US Patent pending, 2003
6. **Universal adaptive synchronization scheme for distributed audio-video capture on heterogeneous computing platforms** US Patent pending, 2003
7. **An Apparatus and Method for SIMD Modular Multiplication**
US Patent pending, 2002
8. **Method and Apparatus for Multimedia Communications over Packet Channels**
US Patent pending, 2002
9. **System and Method for Streaming Multimedia over Packet Networks**
US Patent pending, 2001
10. **An Apparatus and Method for Loading a Data Storage Device with a Plurality of Randomly Located Data** US Patent pending, 2001
11. **System for Providing Multimedia Peer-to-Peer Computing Platform**
US Patent pending, 2001
12. **Method for Multimedia Communications Over Packet Erasure Channels** US Patent pending, 2000
13. **Data Transmission Using Arithmetic Coding Based Continuous Error Detection**
US Patent Number 6,418,549, July 9, 2002