



IEEE Signal Processing Society 75th Anniversary During ICASSP 2023

Remembering the past, engaging with the present, and building the future

The ICASSP 2023 conference in Rhodes, Greece, was remarkable from multiple perspectives. Notably, this was the first fully in-person ICASSP after three consecutive virtual conferences, which were necessitated by the COVID-19 pandemic. Attendees fully embraced the opportunity to engage in live interactions and reestablish their networks.

Moreover, this conference held special significance as it coincided with the 75th anniversary of the IEEE Signal Processing Society (SPS), established on 2 June, 1948.

During the opening ceremony, Petros Maragos, general chair of ICASSP23, discussed the unprecedented growth of ICASSP, evidence of a vibrant and growing Signal Processing (SP) community. He also presented the technical program, announced several innovative features, and an abundance of social events, emphasizing the significance of the SPS 75th anniversary (Figure 1). Subsequently, Athina Petropulu, president of the SPS, reviewed the significant milestones that marked the incredible growth of SP over the past seven decades, starting from its inception in 1948 (Figure 2). She highlighted the strong interconnections between advancements in

microelectronics, computer science, industrial and personal applications and provided insights gained from signal and image processing, all of which have shaped the evolution of the SPS. Further details regarding this historical journey can be found in the article “Empowering the Growth of Signal Processing: The Evolution of the IEEE Signal Processing Society” [1], which she coauthored and published in the June issue of *IEEE Signal Processing Magazine (SPM)*.

Several events were organized to commemorate this momentous anniversary, including two special sessions dedicated to the SPS anniversary. The first session featured presentations by three pioneers of digital SP (DSP), namely, Alan Oppenheim, Ron Schafer, and Tony Constantinides, who shared their perspectives on the history of DSP.

Oppenheim, Schafer, and Mos Kaveh (on behalf of Tony Constantinides, who, unfortunately, could not travel to Rhodes) shared their first-hand experiences and



FIGURE 1. Petros Maragos, ICASSP 2023 General Chair presented the ICASSP technical program and planned events.

Digital Object Identifier 10.1109/MSP.2023.3286188
 Date of current version: 14 July 2023

stories about the origins of DSP in various locations in the United States and Europe. They emphasized that, in addition to military applications like radar and sonar, audio and speech processing played a prominent role in the early stages of SP expansion, especially after the Second World War. The birth and history of DSP were closely intertwined with issues in audio and speech, as Oppenheim and Schaffer conveyed during their talks (Figure 3). This can be attributed to factors such as the ease of recording audio signals using tape recorders and the relatively low data rates of audio, which were compatible with the technological tools available at that time.

Their discussions also underscored the strong correlation between the development of SP and advancements in computers and integrated circuits, particularly microprocessors. They traced the evolution from massive computing rooms with limited performance at institutions like the Massachusetts Institute of Technology and Bell Labs to the advent of the first microprocessors. Additionally, they highlighted the significance of programming languages in SP, starting with Fortran, Basic, and Pascal and progressing to MATLAB, which has now been surpassed by languages like Python and Julia.

Both Oppenheim and Schaffer emphasized the significance of their interactions with other researchers in shaping their lives and contributions. In Oppenheim's eloquent words, "All of us were at the right place, at the right time, with the right people." This highlights the importance of collaborations and the role they played in their achievements.

Tony Constantinides recounted the challenges he faced in getting "out-of-the-box" ideas accepted. He shared an anecdote from a 1966 industry meeting where he spoke about the implementation of digital filters and received a dismissive response: "A waste of time and money. Nobody is and will ever be interested in such digital computer-based communication systems." Similarly, in 1967, when predicting the high impact of digital techniques in telecommunications, he

was rebuffed with the statement, "You are quite wrong. Digital techniques will never be used in telecommunications." And in the late 1970s, during a conference, a well-known scientist in SP remarked, "Digital signal processing . . . an interesting mathematical curiosity." These experiences demonstrate the resistance and skepticism faced by innovators that introduce groundbreaking ideas. In one of

his slides, Tony cited a quote by Lord Rayleigh in 1897: "The history of science shows that important original work is liable to be overlooked, and perhaps the more liable the higher the degree of originality." More than a half-century later, Tony's experiences emphasize that innovators still face roadblocks in the pursuit of progress.

The publication of the first book on DSP in 1975 (Figure 4) was



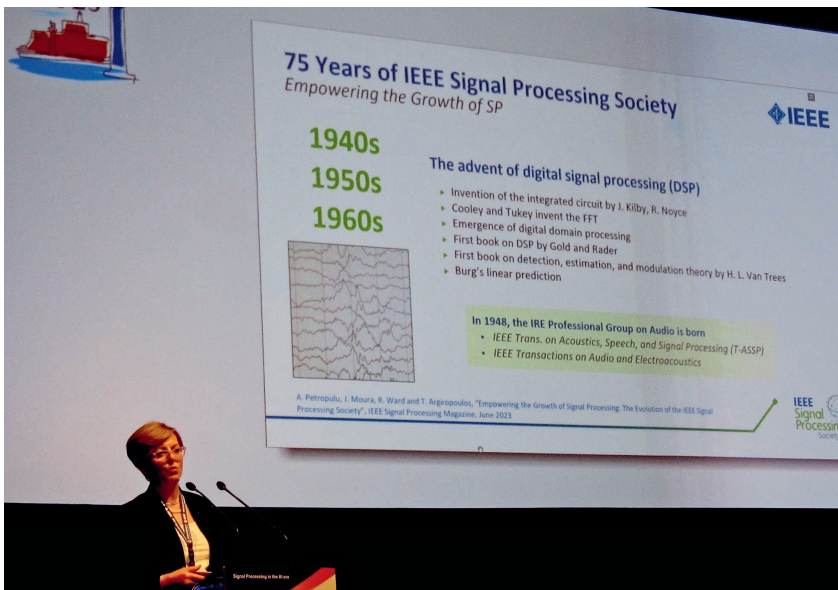


FIGURE 2. Athina Petropulu presented milestones in the history of signal and image processing.



FIGURE 3. Alan Oppenheim and Ron Schafer.

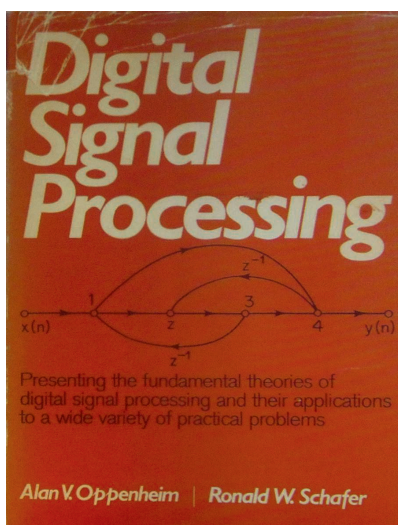


FIGURE 4. The first book on DSP, published in 1975.



FIGURE 5. The 75th anniversary lounge at ICASSP 2023.

undoubtedly a pivotal milestone in the field, coinciding with the early stages of computer science. The initial release of this book, along with its subsequent editions, laid the groundwork for the continued progress and expansion of SP. The panel audience, composed of both young and seasoned members, deeply recognized the importance of this book and eagerly gathered around the stage at the end to get the autographs of Oppenheim and Schafer, acknowledging their significant contributions to the field.

The second session involved a discussion on the past, present, and future of SP, which brought together six distinguished scientists and recipients of the Norbert Wiener Society Award: Alex Acero, Ray Liu, Jose Moura, Ali Sayed, Sergios Theodoridis and Rabab Ward.

The discussion on the evolution of the SP featured the topic of SP in the artificial intelligence (AI) era, which was also the theme of ICASSP 2023. The speakers emphasized that SP plays a unique role in AI, particularly that a key factor in designing explainable and reliable AI algorithms is exploiting domain knowledge—something very familiar to SP researchers and practitioners.

The conference plenary talks also highlighted the role of SP in the AI era and the relevance of explainability in deep neural networks. In her “Disrupting NextG”

(continued on page 11)

learning, and data science, with their applications to tackling societal grand challenges, e.g., global urbanization, the United Nations' sustainable development goals, and climate change. She is a Fellow of IEEE.

Appendix: Related articles

[A1] G. Richard, P. Smaragdakis, S. Gannot, P. A. Naylor, S. Makino, W. Kellermann, and A. Sugiyama, "Audio signal processing in the 21st century," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 12–26, Jul. 2023, doi: 10.1109/MSP.2023.3276171.

[A2] D. Yu et al., "Twenty-five years of evolution in speech and language processing," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 27–39, Jul. 2023, doi: 10.1109/MSP.2023.3266155.

[A3] W. C. Karl, J. E. Fowler, C. A. Bouman, M. Çetin, B. Wohlberg, and J. C. Ye, "The foundations of computational imaging," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 40–53, Jul. 2023, doi: 10.1109/MSP.2023.3274328.


[A4] X. Li, W. Dong, J. Wu, L. Li, and G. Shi, "Superresolution image reconstruction," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 54–66, Jul. 2023, doi: 10.1109/MSP.2023.3271438.

[A5] M. Barni et al., "Information forensics and security," *IEEE Signal Process. Mag.*, vol. 40, no. 5,

pp. 67–79, Jul. 2023, doi: 10.1109/MSP.2023.3275319.

[A6] L. Wu, A. Liu, R. K. Ward, Z. J. Wang, and X. Chen, "Signal processing for brain–computer interfaces," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 80–91, Jul. 2023, doi: 10.1109/MSP.2023.3278074.

[A7] S. Vlaski, S. Kar, A. H. Sayed, and J. M. F. Moura, "Networked signal and information processing," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 92–105, Jul. 2023, doi: 10.1109/MSP.2023.3267896.

[A8] F. Liu, L. Zheng, Y. Cui, C. Masouros, A. P. Petropulu, H. Griffiths, and Y. C. Eldar, "Seventy years of radar and communications," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 106–121, Jul. 2023, doi: 10.1109/MSP.2023.3272881. 

FROM THE EDITOR (continued from page 6)

plenary talk, Andrea Goldsmith emphasized two important future developments. First, that SP will play an outsized role in next-generation wireless technologies. And second, that machine learning can be viewed as a tool in the SP toolbox, while knowledge about the application and the data can lead to more effective and explainable machine learning algorithms for wireless communications. Richard Baraniuk's talk, "The Local Geometry of Deep Learning," discussed a new way to view the geometry of deep learning through the lens of approximation theory via splines. This approach provides a window to the inner workings of those algorithms. Michael Jordan provided the keynote talk, "An Alternative View on AI: Collaborative Learning, Incentives, and Social Welfare," sharing his view of a future AI that is more collective and autonomous, with particular attention on statistical inference, such as prediction-powered inference, for computing valid confidence intervals.

The IEEE Historical Center exhibited photographs of pioneers and early contributions in SP at the 75th anniversary lounge (Figure 5).

In this issue

The second part of this *SPM* special issue on the SPS 75th anniversary includes eight articles that will help readers appreciate the diversity of SP, including how its expansion is impacted by technological progress, especially in microelectronics and computer science, and on many application domains that impact our everyday lives. The contents of these articles are presented in more detail in the "From the Guest Editors" column [A1]. Here is a summary of the key factors that illustrate the evolution of SP, with the emergence of new domains and technologies that have touched all aspects of our lives.

- Audio, speech, and language processing, and radar, and communications have a long history, which began before the term *SP* appeared, but they continued to evolve quite dramatically with technological innovations and societal needs becoming increasingly synergistic.
- Major technological advancements such as computer technologies, the cloud and the Internet of Things have recently spawned new SP domains, such as computational imaging, superresolution image

reconstruction, information forensics and security, and networked information.

- Brain–computer interfaces, a concept introduced by Vidal in 1973 [3], required both technological and SP advances, illustrating that complex technologies impact human health and also come with complex ethical issues related to the development of science.

We finish this editorial with the help of Constantinides, who concluded his talk with the message, "Keep calm and carry on. The future is yours."

Appendix: Related article

[A1] R. C. Guido, "IEEE Signal Processing Society: Celebrating 75 years of remarkable achievements (Part 2)," *IEEE Signal Process. Mag.*, vol. 40, no. 5, pp. 8–11, Jul. 2023, doi: 10.1109/MSP.2023.3285483.

References

- [1] A. Petropulu, J. M. F. Moura, R. K. Ward, and T. Argiropoulos, "Empowering the growth of signal processing: The evolution of the IEEE Signal Processing Society," *IEEE Signal Process. Mag.*, vol. 40, no. 4, pp. 14–22, Jun. 2023, doi: 10.1109/MSP.2023.3262905.
- [2] A. Oppenheim and R. Schaffer, *Digital Signal Processing*. London: Pearson, 1975.
- [3] J. Vidal, "Toward direct brain–computer communication," *Annu. Rev. Biophys. Bioengineering*, vol. 2, no. 1, pp. 157–180, 1973, doi: 10.1146/annurev.bb.02.060173.001105.

