7-1999

Guest Editorial: Special Section on Acousto-optic Devices and Optical Information Processing: Research and Developments

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Although acousto-optics has been around for many decades, refinements in theory, development of new materials, and novel practical applications have kept the field alive to this day. Of late, the theory of acousto-optics has been advanced to incorporate arbitrary light and sound fields, and a unified transfer function approach to acousto-optic diffraction has been developed. Acousto-optic devices are increasingly finding applications in photonic delay lines for radar systems, tunable filters for wavelength-division multiplexing applications, for detection of phase-shift keying and frequency-shift keying signals for realization of IIR filters, and more recently, in programmable real-time image processing such as edge enhancement, notch spatial filtering, etc.

It has almost become a tradition among many researchers in acousto-optics to participate in the Spring Schools in Acousto-optics, now organized in Poland every three years by the University of Gdansk. During the 7th Spring School held in Jurata last May, researchers from around the world presented the latest research in areas of light-sound interaction, acousto-optical materials including integrated optics, and applications such as deflectors, modulators, filters, tomography, computing, etc. Thanks to Dr. O'Shea's enthusiastic support of our proposal, the announcement of the special section on acousto-optics was made at this meeting and several of the presenters at the School have contributed to articles in this special section.

The twelve papers in this special section bring out some of the recent advances in the areas of the theory of interaction of light with sound, new acousto-optical and magneto-optical materials and devices, and novel applications. The first four papers deal with interaction theory. Of these, the first two, by Gondek, Katkowski, and Kwiek, deal with the near field region during the interaction of light with one sound column and two adjacent sound columns, respectively, for a wide range of Raman–Nath and Klein–Cook parameters. Theoretical results are compared with experimental observations. The other two papers deal with the transfer function for interaction between a profiled light beam and a periodic induced grating. Chatterjee and Reagan apply the concept of the acousto-optic transfer function to study beam propagation through a thick holographic grating during monochromatic and polychromatic readout. Huang et al. extend the transfer function by removing the paraxial approximation and pointing out differences between the paraxial and non-paraxial theories.

Material aspects of acousto-optics (and magneto-optics) are the subject of focus of the next two papers. Molchanov and Makarov discuss the electro-mechanical matching of transducers to the acousto-optic medium taking a lithium niobate transducer on tellurium dioxide as an example, and study the effect of the intermediate bonding layer. Tsai provides an exhaustive summary of acousto-optic and magneto-optic Bragg cell modulators, their uniqueness, fabrication and integration, operation and applications.

The rest of the papers in the special section are devoted to innovative applications of acousto-optic devices. A unique acousto-optic tunable filter, which has the advantages of collinear and noncollinear tunable filters, is introduced by Tran and Huang. Parygin, Vershoubskiy, and Kholostov show how to realize programmable transmission functions and bandwidths from acousto-optic tunable filters by using pulsed ultrasound rather than continuous-wave sound beams. A hybrid acousto-optic system discussed by Balakshy and Kazaryan can provide for laser beam direction stabilization. Acousto-optic diffraction can be utilized to derive the time averaged probability density function of arbitrary signals, as demonstrated theoretically and experimentally by Mehrl, Markov, and Soni. The state of polarization of light can be monitored by measuring its Stokes parameters; simultaneous monitoring of the four Stokes parameters can potentially be done by passing the light through an acousto-optic cell that diffracts the incident beam into at least four diffracted orders, as shown by El-Saba and Abushagur. Finally, a reconfigurable acousto-optic algebraic processor presented by Naughton et al. can have the capability to ''learn'' for neural network applications, and can be trained for curve detection.

We hope that the collection of papers in this special section will inspire researchers to rediscover acousto-optics, and think of many more interesting applications in the future.

Partha P. Banerjee received the BTech degree in electronics and electrical communication engineering from the Indian Institute of Technology, Kharagpur, India, in 1979, and the MS and PhD degrees in electrical and computer engineering from the University of Iowa in 1980 and 1983, respectively. From 1983 to 1984, he was a visiting assistant professor of electrical and computer engineering at the University of Iowa. From 1984 to 1988, he was an assistant professor of electrical and computer engineering at Syracuse University. In 1988, he was on leave at the University of Wisconsin at Madison. From 1988 to 1991 he was an associate professor at Syracuse University before moving to the University of Alabama in Huntsville, where he is currently professor of electrical and computer engineering. During his 1998–1999 sabbatical year, he spent three months each at Osaka City University, Japan, and the Army Research Labs in Adelphi, Maryland. His research interests include nonlinear optics, photorefractives, acousto-optics, and optical information and image processing. Currently he is working on photorefractive polymers, acousto-optic image processing, nonlinear characterization of materials, and phase distortion compensation in images. Dr. Banerjee is the author of 75 refereed journal publications and co-author of the textbook *Principles of Applied Optics* published by Irwin/CRC Press. He is also co-authoring the textbook *Computational Methods for Electromagnetic Systems Analysis* to be published by Marcel-Dekker in 1999. He was the guest editor of a special section on Photorefractive Nonlinear Optics in *Optical Engineering* in 1995. He is on the Program Committee of the SPIE Photorefractive Fiber and Crystal Devices Conference and has chaired sessions at SPIE and OSA annual meetings. Dr. Banerjee is a fellow of the OSA and SPIE, and a senior member of the IEEE.

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