Introduction to Solid-State Imaging Issue

THE IMPORTANCE of image sensing systems as a means of collecting information has long been established and their economic value clearly demonstrated by the massive television systems linking the world. The spectacular photographs transmitted from the surface of the moon and some of the planets have demonstrated their value for scientific purposes. Closed-circuit television systems are finding increasing application to area surveillance, process monitoring, in industrial, commercial, and other fields. Requirements for relatively low-cost, extremely small, highly reliable imaging systems for military, scientific, industrial, and commercial applications provided the impetus for the development of solid-state imaging systems when the evolution of planar semiconductor and active thin-film technologies provided the method of approach. That some success has been achieved toward this end was demonstrated in early 1967 by the deliveries of the thin-film camera system developed by RCA for the Air Force and the silicon phototransistor mosaic system developed by Westinghouse for NASA. While at this stage of development these systems do not provide performance comparable with conventional electron beam read systems, they have demonstrated that recognizable and usable images can be derived in an all solid-state form requiring only low supply voltages. Further refinements of these systems are currently under development, and additional applications are being explored. As set forth in the various papers in this issue, current work includes efforts to build relatively large monolithic sensor arrays in silicon, monolithic sensor/readout systems in silicon, hybrid thin film on silicon sensors, and totally thin-film systems. Although not included in this issue, papers in recent unclassified publications have included descriptions of hybrid solid-state sensing-electron beam scanning systems which promise to provide improved imaging performance over what is achievable with conventional pickup tubes.

In any area requiring considerable development support, the cost effectiveness question must ultimately be faced. When only limited development funding is available for all scientific studies, why expend a considerable portion in this area? There are several reasons. First, one answer lies principally in the economic area—ultimately lower cost than conventional imaging systems because of both lower initial costs and lower maintenance costs. Second, better compatibility with hostile environments than alternative approaches—the near vacuum of space for example poses a significant restraint on systems requiring high voltage. Third, ultimately smaller size and more efficient light sensing. Fourth, the relatively infinite life that the all solid-state system should provide which makes it ideal for deep-space probes, or long-term unattended applications, whether earthbound or spaceborne.

The degree to which the current exploratory work in solid-state imaging will succeed will depend to a large degree on the ingenuity and skill of the investigators, but probably to a larger degree on the availability of adequate financial support both for the research work needed to complete the evolution of true high-performance solid-state imaging systems and for the manufacturing technology effort needed to realize the potential low costs which should be achievable with batch-processing technologies.

While some applications of solid-state imaging such as television are quite obvious, the availability of low-cost, long-life, no-maintenance imaging systems would open new classes of applications in the instrumentation and monitoring areas. As an example, one of the most frequent suggestions heard is that a relatively low-resolution solid-state camera be placed in the wheel wells of an aircraft to determine whether or not the wheels are really up or down as the indicator light says. A second area of application will apparently lie in the general field of pattern recognition, whether it be relatively simple character recognition devices or more complex photographic analysis systems. A third area (as yet little developed, but under active pursuit at several laboratories) lies in the humanitarian quest to develop a system to provide at least a crude degree of sight for the blind.

The papers in this TRANSACTION are intended to provide a summary of the various approaches being taken toward the goal of solid-state imaging and the current understanding of the light integration phenomena in solid-state sensors utilizing single-crystalline structures. In the final paper, the editor has yielded to the impulse to attempt to summarize the various approaches, to outline their salient characteristics, and to evaluate their potential for development within the framework of the state of the art of solid-state technology.

—WILLIAM F. LIST, *Guest Editor*