Signal Processing Module:

Signal processing has created a significant effect on our information society. Signal processing can be found everywhere: in cell phones, TVs, automobiles, GPSs, modems, scanners, and all kinds of communication systems and electronic devices. Modern cell phones are indeed a most typical example—within these small wonders, voice, audio, image, video, and graphics are processed. Technological advancement in recent years has heralded a new golden age for signal processing. Many exciting directions, such as bioinformatics, human language, networking, and security, are emerging from the traditional field of signal processing on raw information content.

The challenge in the new era is to transcend from the conventional role of processing the low level, waveform-like signal to the new role of understanding and mining the high-level, human-centric semantic signal and information. Such a fundamental shift has already taken place in limited areas of signal processing and is expected to become more pervasive in coming years of research in more areas of signal processing. The new technological development requires nontraditional signal processing tasks including understanding, mining, and retrieving of high-level information sources and contents often embedded in low-level signals.

Polarization diversity provides meaningful information to discriminate targets from clutter. A closed-loop system is considered that sequentially estimates the target and clutter scattering parameters and then uses the estimates to optimally select the polarization of subsequent waveforms. This adaptive system significantly improves radar capabilities when compared with fixed-polarization schemes, as it can achieve optimal performance in several operating modes, including detection, estimation, and tracking. The choice of agile waveform in sensing can be affected by many factors, including whether the sensing environment is narrowband or wideband, is immersed in heavy clutter or strong noise. Tracking can exploit the optimization of waveform-dependent cost or objective functions, such as tracking errors and information retrieval, to update the transmitted waveform for the next time step. Waveforms with nonlinear time-frequency signatures have been found to be more conducive to adverse environmental conditions and these waveforms are shown to better match the bio-sonar mechanism of mammals.

During the past decade digital signal processors (DSPs) have hit critical mass for high-volume applications. Today, the entire digital wireless industry operates with DSP-enabled handsets and base stations. The mass-storage industry depends on DSPs to produce hard-disk drives and digital versatile disc players. Ever-increasing numbers of digital subscriber line and cable modems, line cards, and other wired telecommunication equipments are based on DSPs. Digital still cameras, hearing aids, motor control, consumer audio gear such as Internet audio are just some of the many mass market applications in which DSPs are routinely found today. More specialized DSP applications include image processing, medical instrumentation, navigation, and guidance. With the growing importance of DSPs and their applications, it seems appropriate to look at the changes occurring in these devices and to hazard a few guesses about where DSP innovations will lead in the opening decades of the new century.

The continued growth of DSP enabled applications will depend on developments in several areas of technology: the underlying manufacturing processes, the DSP core and chip architectures, and the software for development and applications. An additional factor, and the most difficult one to anticipate, is innovation. In a few years, designers will be dealing with DSPs that integrate hundreds of millions of on-chip transistors and deliver performance measured in trillions of instructions per second. The DSP phenomenon is part of the overall microprocessor success story, and it must be seen in that light. Like the high-end reduced instruction set computing (RISC) engines used in computers and the medium range RISC microcontrollers in embedded systems, DSPs are becoming increasingly differentiated, designed to handle the processing tasks of specific types of applications. This trend will continue with all microprocessors in the years ahead, and it will be responsible for much of the future success of DSPs.