SENSORY INPUTS: FUEL FOR DIGITAL SYSTEMS

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The electronics industry is currently experiencing a proliferation of equipment to meet the need for larger quantity, lower cost, higher speed and higher accuracy computing. The basic fuel for every one of these machines is information. Information from the physical world is first detected by sensors, which are either mechanical devices or humans. This information must then be transported and fed into the computer as digital information. The process is done by humans again, or by electronic equipment. At this point, the computer can process this raw information along with other parameters and provide a logically deduced output using its software algorithms. Advances in computer hardware and software algorithms must be matched by comparable advances in sensor and data acquisition areas in order to provide the computers with the information fuel that they require. Silicon technology provides the means for achieving these needed advances in sensing and data acquisition.

Sensor Inputs

Sensors that are used with digital systems typically convert such physical information as pressure, temperature, optical characters or sound into various electrical signals. These signals are often represented as changes in voltages, currents, impedences or frequencies, which must subsequently be changed into a digital word that can be used by a computer. In addition, this digital word needs to find its way to the correct computer port at the correct time, and eventually route its way to a memory location so that it can be used as a piece of information upon which the computer can act.

The Need for Information

A unifying feature of the many potential applications of digital information systems is the need for accurate, rapid, and unexpensive information. Traditional techniques of human data entry fall short in each of these characteristics. Major needs for automatic data acquisition can be seen by looking at examples of current applications. In classical process control and industrial monitoring, as well as factory automation and robotics, there is a definite need for accurate information on multiple parameters. Computers and controllers are being used to respond to routine changes, but human monitoring is still used extensively to detect additional information and override the computer control. In aerospace applications, the speed and accuracy of a computer response is needed to overcome human limits, yet the human override still exists.

Similarly, commercial applications such as bar-code accounting systems, weighing systems and security systems currently use sensors and data acquisition. Lower cost accurate sensors that are more easily installed and interfaced with computers would undoubtedly be used for more complete information to the computer. With the exception of such simple systems as those presently found in automobiles and security systems, comsumer applications of information processing systems are also limited to uses that rely on human generated information.

Information Processing Hardware

Advances in computer technology have intensified the need for comparable developments in sensors, actuators and software. Powerful low-cost portable machines permit wholesale digital signal processing in distributed locations, and large high-speed mainframe computers give the capacity to perform large volumes of logic operations. A result of all of this capacity is that the cost per logic operation has been lowered and the capacity of the computing base has increased. This is further evidence of the need for a matching increase in quality of input output devices. The limiting cost of a control system is rapidly approaching that of the sensors and actuators which interface the real world to the computer.

Sensor Performance

Important performance parameters for sensors include accuracy, speed, linearity and compensation for parasitics. Cost, size and materials compatability are also significant factors. Sensor structures micromachined in silicon have many significant advantages over traditional materials in these areas, primarily from the ability to batch fabricate precision structures in silicon and the strength and inert characteristics of the material. Coupled with signal processing on the same chip, accuracy and compensation can be achieved to meet the needs for widespread application in digital systems.

Data Acquisition

Silicon circuitry also provides the means to process the signals from the physical sensor structure and format it for use by the computer. In addition, it can be addressed by the computer so that the correct information is received at the desired port at the required time. Data acquisition equipment to date ranges from devices using such standard serial communication formats as RS232C through higher speed paralell devices. Single input devices through recent multisensor networks have used a diverse set of architectures. In addition, there are a number of special purpose interface formats such as frequency encoding or special handshake and addressing formats to reduce processor and acquisition on overhead.

Algorithms

To use sensory information effectively, the computer needs to interpret it and relate it in a logical manner. Approaches such as distributed processing, compensation, and methods for relating information must be developed along with sensor, acquisition and computer hardware.

Realizing Information Systems

The computer industry has taken an early lead in developing tremendous computing and information processing hardware. Software and algorithms for handling information are also under development which are essential ingredients for an effective information processing system. Recent developments in micromachined silicon sensor structures and data acquisition systems promise comparable breakthroughs in fabricating these components.

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