Chapter 15

Automotive Electronics

Avionics
Cameras

- Auto-focus cameras
- Digital camcorders
- Digital cameras

Communication Systems

- Demodulator for satellite communication
- Encryption/decryption
- Error correction codes
- Modulator for satellite communication
- Network card
- Network switches/routers
- Quadrature amplitude modulator (QAM) and demodulator
- Radar imagery system
- Submarine detector
- Wireless LAN/WAN

Computers and Peripherals

- Low cost computer
- Mobile phone personal computers
- Scan pen and PC notes taker

Control Systems

- Alarm Annunciator
- Ash level controller for Electrostatic precipitator
- Automatic packaging/sealing machines
- Electrostatic precipitator communication controller
- Data acquisition system
Image/Video Processing Systems
Measuring Instruments

- Digital high voltage tester
- 3 GHz Digital frequency meter
- Digital LCR meter
- Digital Megohm meter
- 6 digit digital multimeter
- Digital Ph meter
- Digital oscilloscope

Medical Applications

- Digital acupressure
- Digital blood glucose meter
- Digital blood pressure and heart rate monitor
- Electro cardiograph
- Life-support systems
- MRI/CT scan
  - Doppler
  - Echo
Miscellaneous Applications

Music
Office Equipments

Phones

Security Systems
Toys and Games

Embedded Systems Design

- An embedded system is a system that is designed to perform only a dedicated application, no matter what processor is used. It executes a single program repeatedly, having to meet tight constraints.
- Embedded systems are characterized by low cost, low power, small, fast, etc. and, continually reacting to changes in the system's environment and computing certain results in real-time without delay.
- Embedded systems make use of microprocessors, microcontrollers and DSPs right from 4 bits to 32 bits on one hand to FPGA/ASIC on the other. Applications include digital cameras, automobile automation, avionics, ATMs, cell phones, electronic toys/games, medical equipments, defense equipments, industrial controllers, etc.
- Most embedded systems need to be designed with built-in real time clock and/or watch dog timers.
- Design metric is a measurable feature of a system's implementation. Common metrics are:
  - the functionality implemented,
Issues involved in the Design of Digital VLSI Systems

Detailed Specifications and Basic Architectures for a Couple of Applications Suggested for FPGA/ASIC Implementations

Electrostatic Precipitator Controller – an Embedded System
Electrostatic precipitator (EP) controllers are used in fly ash disposal in a thermal power plant. Several tons of fly ash are generated, disposal of which is quite cumbersome. For example, a 210 MW thermal power plant generates about 4000 tonnes of ash every day. If released in the air, the entire township will be covered by ash. Water stream cannot directly wash the ash away – passage will get clogged in a short time. The solution is to apply a high DC voltage in the order of 80 KV in the EP, a large chamber with electrodes all over, where the fly ash is blown in from a boiler. Ash gets attracted to negative electrode and hence tamed. Activating special hammers frees the ash, which is promptly washed away by a water stream at the bottom of the electrostatic precipitator and finally disposed of in huge ash ponds situated about 5 miles away from the power house. The special hammers need to be activated in a specific sequence in order to dislodge the ash from the electrode. These hammers are, however, controlled by another controller called Rapper controller. The DC high voltage is generated by firing a couple of thyristors configured as full-wave rectifiers.
Front Panel of Electrostatic Precipitator Controller

Function modes

<table>
<thead>
<tr>
<th>Set mode in DS1 using Up/Down DISPLAY SELECT</th>
<th>Adjust potmeter (as shown in DS1) on FPGA board</th>
<th>Set value displayed in DS4-DS2</th>
<th>Check full range of potmeter setting in DS4-DS2</th>
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<td>0-104</td>
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<td>Address in BCD switches (DS3-DS2)</td>
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Is limit

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<td>Nil</td>
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### Input/Output Connections

- **AC IN**
- **REF1**
- **REF2**
- **AC +/- CYCLE OPTO ISO. CKT.**
- **AC +ve (CYCLE)**
- **EP**
- **Current (P3 Pot)**
- **EP**
- **I0**
Industrial Input/Output Board

FPGA Board of the Electrostatic Precipitator Controller

Architecture of JPEG/H.263/MPEG 1/MPEG 2 Codec

Standards available for compression of image/video sequences:
Functional modules used in Standards are as follows:

- **JPEG**: For still picture compression - DCT/Q/Huffman coding and their inverses
- **JPEG 2000**: Also for still picture compression but uses discrete wavelet transform (DWT) – DWT, Q, bit plane coding (BPC), binary arithmetic coding (BAC), rate control, bit stream assembly and their inverses
- **H.261/H.263**: For video phone/conferencing - Low bit rate (p X 64 Kbps, p=1-30)
- **MPEG 1**: Audio-visual codec for digital storage - Transmission rate: Up to 1.5 Mbps
- **MPEG 2**: Consumer electronics / Telecommunications / Broadcasting - Transmission rate: 2 to 100 Mbps

**Basic Architecture of JPEG/ H.261/H.263/MPEG 1/MPEG 2 Codec**
Basic Architecture of Image/Video Encoder

Basic Architecture of Image/Video Decoder
Basic Architecture of the Implemented MPEG 2 Encoder

Architecture of the VLC (Variable Length Coder)

Processing Order of Variable Length Code
Architecture of VLC

Header Serial Output Converter
VLC Generator