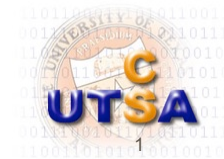


Embedded Systems

Reviews for Midterm Exam I

Instructor: Dr. Dakai Zhu

CS 4833: Embedded Systems



Introduction to Embedded Systems

- What are ***embedded*** systems?
 - **NOT seen/noticed** unless something goes wrong
- Why do we care about embedded systems?
 - From iPhone to Boeing 787, to space shuttle and satellites
- **Typical Characteristics:**
 - **Single functioned, tightly-constrained, reactive & RT**
- Constraints and design tradeoffs:
 - Cost (NRE vs. unit), performance, time etc.
- Design challenges & metrics

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Hardware Architecture

- Basic components: hardware
 - Transistors and gates vs. **logical gates**
 - **Combinational & sequential** logic circuits
 - Timers and **Counters**
- Customized Greatest Common Divisor
- General hardware architectures
 - von Neumann vs. Harvard
- Computing engines in embedded systems
 - Microprocessor, microcomputer, microcontroller
 - Digital signal processors (DSPs)
 - Graphics processing units (GPUs)
- **Understand hardware words**
 - Data, address or instructions

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Instruction Set Architecture (ISA)

- Overview of ISA: outside view
 - Inst. Types: arithmetic/logic, data transfer & flow control
- **Address modes:**
 - **Immediate, direct & indirect, Register direct/indirect indexed, PC relative**
- Register Transfer Language (RTL): inside view
 - Registers & register operations: read & write
 - Concept of data-path
 - Instruction cycle: fetch, decode, execute, next
- Example: a simple ISA & processor design
- Case study: ISA for ARM processors

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I/O Interface

- Overview of I/O interface
 - Types of devices & communications; **Bus** vs. ports
- **Bus** in computing systems
 - Hierarchical buses: system bus vs. I/O bus
- **I/O Addressing**
 - Standard I/O mapping
 - Memory-mapped I/O
- I/O control: **Interrupt** and **DMA**
 - Arbitration: who can use the communication media?
- Error checking and correction

Communications

- Communication **protocols**
- Parallel communication
 - Peripheral Component Interconnect (PCI)
- **Serial communication**
 - RS232, **UART**, I2C, USB and PCIe
- Real time communication
 - Event vs. time driven; CAN, FlexRay etc.
- Wireless communication
 - RFID, Wifi, Bluetooth, Zigbee etc.

Sensors/Actuators and AD/DA Conversion

- Sensors and actuators
 - **Quantization** and sampling
 - Uniform vs. non-uniform quantization
- Analog-to-Digital converter
 - Dual-Slope and **Successive Approximation**
- Digital-to-Analog converter
 - Binary weighted
- Digital signal measurement
- Device interfaces
- Control: Proportional, Integral, & Derivative → PID

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Labs 1, 2 and 3

- Lab 1: PRIZM controller and Handfollwer
 - **Cross compilation** concept
- Lab 2: Serial communication: PRIZM vs. RP3
 - Serial setup: baud rate etc.
 - Read/write primitives on both sides: bytes vs. string
- Lab 3: Customized Comm. Library/functions
 - Comm. Protocols: what to send/receive on both sides?
 - PRIZM: retrieve command, parameter(s), action, send ack.
 - RP3: modular functions: setup serial comm., send command, receive ack., action functions etc.

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