Introduction to the Internet of Things and Embedded Systems

AAYUSH ANSHU

Definitions

« Thing »

« Thing » + Computational intelligence = Embedded System

« Thing » + Computational intelligence + Network Connection = IoT

Sensors (Input) → ADC → µC (IP+FPGA) → DAC → Actuators (Output)

- IP: Intellectual Property core (1 function)
- FPGA: Field Programmable Gate Array (Hardware reconfiguration via RAM – Rewiring)

-General Purpouse Processors (Many features)

-Digital Signal Processors (Specific features)

IC: Integrated Circuit (Small electronic device)

Components of embedded systems

- Development board (Arduino, Raspberry…)
- Connectors (USB, Ethernet…)
- Inputs (Sensors: Simple / Complex)
- Outputs (Actuators)
- Bread board

µC characteristics

- Datapath Bitwidth
- Input/Output pins
- Performance (Clock rate = Seconds / Cycle)
- Timers (Real time)
- ADC
- DAC
- Low power nodes
- Communication protocols

µC components

-Storage elements (Speed, cost)

-Registers (Stores a single value): Special-purpose registers, General-purpose registers

-Register file REG: a set of registers

-Cache memory:
- Slower than REG
- Cheaper than REG
- Instruction cache + Data cache

-Main memory:
- Slower than cache, CPU
- Cheaper than cache
- Not in CPU (Connected via bus)

Compilation & interpretation

- Machine language: Binary (001)
- Assembly language: Mnemonics (add r0,r1,r2)
- High language: C, C++…
  - Compilation: Translate instructions once before running the code (C, C++)

    ➔ Translation only once ➔ Saves time
  - Interpretation: Translate while code is executed (Python)

    ➔ Translation occurs every execution ➔ Can adapt to runtime situation

PS: User ⇔ Application ⇔ OS ⇔ Hardware

PS: Arduino: No OS ; Raspberry: With OS

Networking with IoT

- LAN: Ethernet
  - Switch: Smart device that transmits data
  - Hub: Dumb device that transmits data (Possibility of collision)
- WAN: Internet
  - Routers: From LAN to WAN
- MANET (Mobile Ad Hoc Net): WiFi
  - Access point + Mobile / Wireless devices

Protocols: Rules of communication

Encapsulation: Separation at different layers