ARM Microcontroller Internship Programme

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Course Content

- **ARM Cortex-M Architecture**
  - ARM processor family overview
  - Cortex-M core architecture (registers, pipeline, instruction set)
  - Memory map & addressing modes
  - Exception & interrupt architecture
- **Embedded C Programming for ARM**
  - Startup code & linker scripts
  - Register-level programming (GPIO)
  - Volatile & memory-mapped I/O
  - Bit manipulation techniques
  - **ST-HAL programming**
- **Peripheral Programming**
  - GPIO configuration & control
  - Timers and counters
  - **UART communication**
  - **SPI communication**
  - **I²C communication**
  - ADC interfacing
- **Sensor Interfacing**
  - Accelerometer
  - Temp and Humidity Sensor
  - LCD (I²C)
  - Misc. devices (LED, buzzer, switches)
- **Embedded Communication Protocols**
  - **RS-232**
  - **SPI**
  - **I²C**
- **Firmware Development & Debugging**
  - Development environment setup (IDE, toolchain)
  - Debugging with SWD
  - Logic analyzer usage for protocol debugging
  - **Complete ARM Cortex-M firmware project**

- **Prerequisites**
  - **C Programming:**
    - Proficiency in C syntax, pointers, memory management, structures, bit manipulation, and preprocessor directives
  - **Basic Electronics:**
    - Understanding of digital electronics, analog circuits, voltage levels, timing diagrams, and basic circuit analysis

❖Programmed Aim

- Develop ARM Cortex-M firmware with embedded communication protocols and sensor interfacing

❖Todays Agenda

- Development Environment Setup
- ARM Processor Family Overview

ARM Processor

- **What is ARM?**
  - ARM is a **processor architecture**, not a chip manufacturing company.
  - ARM **designs CPU cores** and licenses these designs to other companies, who then manufacture their own chips using ARM technology.
  - ARM processors are widely used because they offer **low power consumption** and **high performance efficiency**.
  - Due to these advantages, ARM processors are extensively used in **embedded systems, microcontrollers, and IoT devices**.

ARM Processor

❖ARM History

- **ARM started at Acorn Computers (1980s)**
  - They created the first ARM chip to make low-power home computers.
- **ARM became a separate company in 1990**
  - Formed by Acorn, Apple, and VLSI to focus only on processor design.
- **ARM's business model**
  - **ARM designs the processors, not the actual chips.** This means ARM only creates the architecture and the blueprint of how the CPU should work. The physical chips are manufactured by other companies who license ARM's designs and build their own silicon using it.
  - Examples of companies that make ARM-based chips include
    - **Apple (A-series and M-series),**
    - **Qualcomm (Snapdragon),**
    - **Samsung (Exynos), MediaTek,**
    - **STMicroelectronics (STM32), and NXP.**
- **ARM processors use RISC architecture**
  - RISC uses simple instructions, which makes ARM fast and power-efficient.

ARM Processor

- **ARM is Used Everywhere Today**
  - ARM processors are widely adopted across multiple technology domains due to their **power efficiency and flexibility**.
  - ARM processors power **more than 95% of smartphones** worldwide.
  - A large percentage of **embedded systems and IoT devices** are based on ARM architecture.
  - ARM processors are extensively used in **automotive electronics**, such as control units and infotainment systems.
  - ARM is also gaining popularity in **cloud servers and data centers** due to its energy-efficient design.

ARM Processor Families

- ARM processors are broadly classified into **three main families**, based on application requirements:
- **Cortex-A (Application Processors)**
  - Cortex-A processors are designed to run **high-level operating systems** such as Linux and Android.
  - They are used in **smartphones, tablets, and application processors**.
- **Cortex-R (Real-Time Processors)**
  - Cortex-R processors are designed for **real-time and safety-critical systems**.
  - They are commonly used in **automotive systems, hard disk controllers, and industrial control**.
- **Cortex-M (Microcontroller Processors)**
  - Cortex-M processors are designed for **microcontrollers and embedded systems**.
  - They offer **low power consumption, low cost, and deterministic real-time behavior**

Why Cortex-M for This Internship?

- Cortex-M processors are specifically designed for **microcontroller-based embedded systems**.
- They provide **deterministic real-time performance**, which is essential for hardware control.
- Cortex-M processors are **power-efficient and cost-effective**, making them ideal for embedded products.
- Most popular microcontrollers, including **STM32**, are based on **ARM Cortex-M cores**.

Thank you!

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