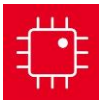




模块 3

简介：ARM Cortex M 架构



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教学目标：

回顾 Cortex M 架构

理解 寄存器，存储器，汇编指令

探索 逻辑和算数函数的汇编实现

学习 函数如何执行，数据存储在何处

设计、构建和测试部件

红外测距传感器的非线性转换函数

需要预先学习的模块（模块 1）

- 使用 CCS 在 LaunchPad 上进行编程（模块 1）

推荐阅读材料：

- Volume 1 Section 1.7, Chapter 3, and Section 5.3
Embedded Systems: Introduction to the MSP432 Microcontroller
ISBN: 978-1512185676, Jonathan Valvano, copyright (c) 2017

或

- Volume 2 Sections 1.1, 2.1, and 2.5
Embedded Systems: Real-Time Interfacing to the MSP432 Microcontroller, ISBN: 978-1514676585, Jonathan Valvano, copyright (c) 2017

在本课程中，我们将使用带有 MSP432 微控制器的开发板，MSP432 芯片中包含了一个 Cortex-M 架构的处理器内核，以及一系列从 MSP430 低功耗处理器中衍生出的输入/输出外设。**处理器架构**指的是处理器中的内核、RAM、ROM 以及输入输出端口之间相互组合的方式。见图 1。

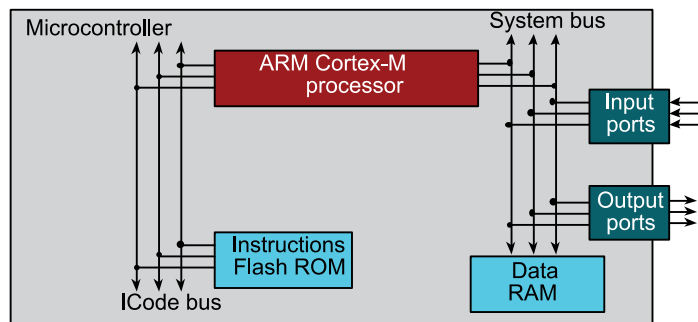


图 1. ARM Cortex M 微控制器架构

本模块将简要介绍 Cortex M 微控制器。尽管我们一般都使用 C 语言来对嵌入式系统进行编程，但我们仍需要对微控制器内软件代码执行的过程有一些了解。了解这些底层细节有助于我们进行顶层软件开发时做出更明智的决定。举几个例子证明这种好处：全局变量 vs 局部变量，数字 vs 指针，计算过程中的数值溢出，做除法和右移运算时的数据丢失，定点数 vs 浮点数运算，以及中断。

有两个原因决定了我们在学习嵌入式处理器时必须学习汇编语言。某些情况下，我们希望优化我们的代码，使它的执行速度最大化或是占用存储空间最小化，此时我们可以在关键代码部分用汇编语言来编写以达到这种目的。另外一个更重要的原因是，通过阅读由我们的 C 语言代码生成的汇编代码，我们可以真正理解软件是如何工作的。基于这种理解之上，我们可以评估、调试和优化我们的系统。因此本模块的目标不是让您精通汇编语言，而是让您能够看懂由 C 语言编译器所生成的汇编代码。

汇编器 (assembler) 是把汇编语言（人类可以阅读）转化成机器语言（机器可以执行）的工具。一般来说，一句汇编语言会转化成一句机器语言指令，这种翻译过程是浅显易懂的。汇编语言代码可以揭露出处理器架构的细节。

链接器 (linker) 是用来把一个工程中各个软件组件连接起来的工具。在 CCS 中，**build** 命令会同时执行汇编和链接两个步骤。在嵌入式系统中，**加载器 (loader)** 会将机器代码加载到处理器的 flash ROM 中。我们将代码放在 ROM 中是因为 ROM 中的信息在掉电之后仍会保持。在 CCS 中，**debug** 命令会完成加载操作并打开调试器。

调试器是一组硬件和软件工具的集合，可以用来验证系统是否正常运行。一个优秀的调试器应具备控制和观察两个功能。

在本模块的实验环节中，您将开发和测试一个汇编函数，该函数通常会被机器人用来进行数值计算。该函数的具体功能是将传感器传入的数据经过 ADC 转换后，换算成机器人和墙壁之间的距离。在开发和测试这个函数的过程中，您将体会到 Cortex-M 处理器是如何执行软件代码的。

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