模块 10

简介： 调试实时系统

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教学目标：

回顾 C 语言数组
理解 闪存的工作原理
探索 实时系统的调试技术
学习 如何使用 SysTick 生成周期性中断
接口 碰撞开关与机器人
设计、构建和测试
将输入数据存储到黑盒记录器中

需要预先学习的模块：模块 6，8 和 9

- GPIO 数字输入（模块 6）
- 开关和 LED （模块 8）
- SysTick 计时器（模块 9）

学生推荐阅读材料：

- Volume 1 Sections 2.7, 6.2, 6.9, 9.1, 9.2, 9.4, and 9.6
  Embedded Systems: Introduction to the MSP432 Microcontroller ISBN: 978-1512185676, Jonathan Valvano, copyright (c) 2017

- Volume 2 Sections 2.4, 3.9, 5.1, 5.4, and 5.7
  Embedded Systems: Real-Time Interfacing to the MSP432 Microcontroller, ISBN: 978-1514676585, Jonathan Valvano, copyright (c) 2017

在开发嵌入式系统时，系统验证是一项重要任务，特别是如果要在安全危急情况下部署系统。此外，在**实时系统（real-time system）**中，获得正确答案不仅重要，在正确的时间获得正确的答案也很重要。**延时（Latency）**是请求服务和启动服务之间的时间。类似的，**响应时间（response time）**是请求服务和服务完成之间的时间。实时系统是可以保证最坏情况延时的系统.。或者，如果响应时间存在上限，我们可以将系统分类为实时系统。

有些请求会定期发生，在此模块中，我们将使用 **SysTick 中断（SysTick interrupts）**定期执行任务。

该模块的第二个组件是为实时系统开发调试技术。**侵入性（Intrusiveness）**定义为调试代码本身改变被测系统性能的程度。断点、单步执行和 printf 输出具有很高的侵入性，因此不适合调试实时系统。相反，我们将学习如何将战略信息转储到数组中，提供与经典 printf 语句类似的观察，但是以最小的侵入方式。对于长时间的日志记录、调试数据，我们可以将数据转储到微控制器的 flash ROM 中。

在与该模块相关的实验中，你将把碰撞传感器与微控制器连接，参见图 1.这些开关将让你知道机器人是否以及在何处接触过障碍物。 将使用 SysTick 中断定期收集来自线传感器和碰撞传感器的数据。 使用中断来处理线传感器可提供处理器高效的解决方案。

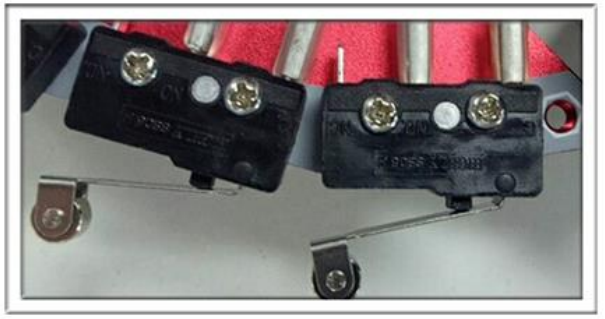

图 1 安装在机器人前部的碰撞传感器

需要多个软件任务的系统的基本方法是部署多线程。一个软件**线程（thread）**是传统的主程序，它大部分时间都在运行。中断将用于创建额外的线程。**中断（interrupt）**是由硬件触发的软件执行。在此模块中，SysTick 中断将定期执行软件任务。在模块 13 中，我们将使用计时器来创建 PWM 输出。 在模块 14 中，我们将使用边沿触发中断，以便在激活任何碰撞传感器时立即执行软件任务。

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