

TI-RSLK

Texas Instruments Robotics System Learning Kit



Module 14

Introduction: Real-time Systems



Introduction: Real-time Systems

Educational Objectives:

UNDERSTAND how to use priority interrupts for creating real-time systems

EXPLORE different techniques to interface switches

LEARN how to generate port interrupts on the GPIO input pins

DESIGN, BUILD & TEST A SYSTEM

Create a real-time system for collision detection

Prerequisites (Modules 8, 9, 10, and 13)

- Switch interfacing (Module 8)
- Time delays (Module 9)
- SysTick periodic interrupts (Module 10)
- Timer_A periodic interrupts (Module 13)

Recommended reading materials for students:

- Chapter 14, **Embedded Systems: Introduction to Robotics**, Jonathan W. Valvano, ISBN: 9781074544300, copyright © 2019

Previously we defined a **real-time system** as one with bounded latency. In other words, the **latency**, which is the time between when a service is requested and the time when service is initiated, is always less than small and acceptable limit. Depending on the situation, we could alternately define real time as having a bounded **response time**. For example, for collision detection on the robot, we define response time as the time between a collision (bump sensor hardware edge signifying a service is requested) and the time when the motors are stopped (service is complete). To make it real time, we will configure the bump sensors to request an interrupt on touch.

The basic approach to a system requiring multiple software tasks is to deploy multithreading. One software **thread** is the traditional main program, which runs most of the time. This thread will implement high-level strategy. Interrupts will be used to create additional threads. The SysTick periodic interrupt will measure data from the line sensor. In Module 13, we studied how to execute periodic tasks using Timer_A. In this module, we will learn how use edge-triggered interrupts generated by I/O pins.

Any of the pins on Ports 1 – 6 can request an interrupt. We can configure the interrupt request on a rise or a fall of the input signal. If the bump switches are interfaced with negative logic, then a falling edge signifies a collision has occurred. Interrupts communicate with other threads via global variables. When deploying multiple interrupts we use priority to sort out the order of service if multiple events coincide. This collision detection is a very high priority task and hence we will configure it as a high priority event.

In this lab, the collision will cause the motors to stop and also set a global error flag. The main program will recognize this event, and then do something appropriate, like back up the robot turn 90 degrees and continue forward again. In the lab, there will be an option to solve a very simple systems-level robotic challenge.

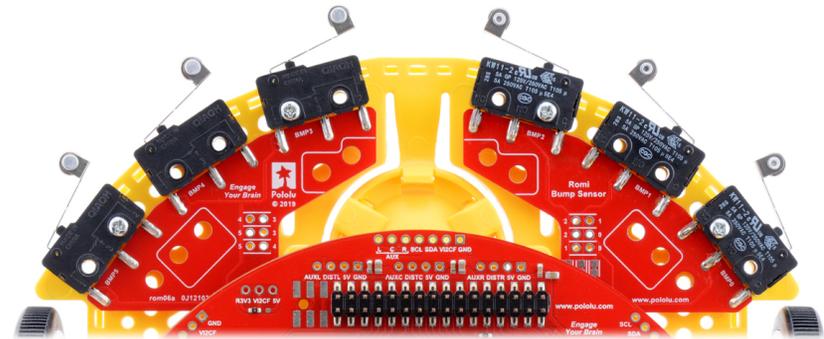


Figure 1. Bump sensors, positioned at the front of the robot.
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