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,

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.
IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated