Programming Low-Cost Hardware Using Simulink

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Simulink Support for Low-Cost Hardware

- **What does that mean?**
  - Simulink supports a selection of low-cost hardware via Simulink Hardware Support Packages

- **What is a Simulink Hardware Support Package?**
  - A library of Simulink blocks that allow you to generate programs that run on selected hardware
  - It’s downloadable and it’s free!

- **How do I get it? How does it work?**
  - Let’s go do it!
  - I will use Raspberry Pi Support from Simulink as my example
Agenda

- Introduction to Raspberry Pi
- Software Setup
  - Installation of Simulink Support Package for Raspberry Pi
- Hardware Setup
  - Test that hardware is connected and working
- Build and run model
  - Image Inversion
- Examples
  - Object detection
  - Barcode reader
- Wrap-up
Introduction to Raspberry Pi

- **What is it?**
  - Credit-card sized, low-cost, single-board computer with audio and video input/output, designed for teaching

- **Who created it?**

- **What are the specs?**
  - Broadcom® system-on-a-chip which includes an ARM®11 processor running at 700 MHz with 512 MB RAM
  - Peripheral connectivity for stereo audio and digital video (1080p) and supports USB and Ethernet.
  - It measures 85.6mm x 56mm x 21mm, with a little overlap for the SD card and connectors. It weighs 45g.

“Overall real world performance is something like a 300MHz Pentium 2”
Introduction to Raspberry Pi

- What’s the difference between Model A and Model B?
  - Model A has 256MB RAM, one USB port and no Ethernet (network connection).
  - Model B has 512MB RAM, 2 USB ports and an Ethernet port.
  - MathWorks only supports Raspberry Pi Model B

- How much does it cost?
  - Approximately $35 US for the Raspberry Pi Model B
  - Cases, peripherals, and starter bundles are available

- OK, where do I get one?
  - Premier Farnell/Element 14 and RS Components

- For more info: http://www.raspberrypi.org/faqs
Software Setup

- **What software do I need?**
  
  - **MathWorks Software:**
    - MATLAB and Simulink (including Student Version) Release R2013a, or later
      
      Note: Raspberry Pi support is available on 32-bit and 64-bit Microsoft Windows only

  - **Compiler (for MathWorks software):**
    - See [Supported and Compatible Compilers](http://www.mathworks.com/support/compilers/)
      
      For my 64-bit Windows 7 installation, I am using [Microsoft Windows SDK 7.1](http://www.mathworks.com/support/compilers/) (available at no charge)

  - **Simulink Support Package for Raspberry Pi Hardware**
Simulink Support Package for Raspberry Pi Hardware

- **What is it?**
  - A set of Simulink blocks that allow you to generate programs that run on a Raspberry Pi
  - It’s downloadable and it’s free!

- **Where do I get it?**
  - Get from the MATLAB Toolstrip: Add-Ons → Get Hardware Support Packages
  - Get from the MATLAB Command Line: `>> targetinstaller`
Simulink Support Package for Raspberry Pi Hardware

- **Installation Process:**
  - The Support Package Installer will lead you through the installation process and install all the software you need to run on a Raspberry Pi from Simulink

Let’s go get it!
Summary: Simulink Support Package for Raspberry Pi Hardware

- Support Package Installer installs all the software elements you need to connect to and run on a Raspberry Pi

- Requires MathWorks Account Login
  - (but don’t worry if you don’t have one, you can create one when you get to the screen)

- Firmware onto SD card
  - need to do this on the first installation
Hardware Setup

- **What hardware do I need?**
  - Raspberry Pi Model B
  - Power cable (Micro USB-B needed by Raspberry Pi)
    - Multiple options; I use USB-A to Micro USB-B cable for power
  - Ethernet cable
  - SD Card
    - MicroSD card that sockets into SD shell will also work
  - Open SD Card port (on host computer)
    - Need port to write firmware on SD Card / Micro SD card
      - Can use native port or USB-based device
  - Open Ethernet port (on host computer)
    - Option: Can use USB-Ethernet dongle
  - Case (nice to have)
  - USB Webcam (UVC compatible)
Hardware setup

- Connect Raspberry Pi
  - Plug in USB Ethernet Adapter to PC, and Ethernet cable into adapter and Raspberry Pi
  - Plug USB webcam into Raspberry Pi
  - Insert SD card (which may be a carrier for SD micro) into Raspberry Pi
  - Attach USB power cable – USB A to PC, and USB micro B to power port on Raspberry Pi
    - Wait a minute for Raspberry Pi to boot

Let’s go test it!
Summary: Simulink + Raspberry Pi Testing

- Check for Support Package Installation
  - Simulink Support Package for Raspberry Pi Hardware should be in your Simulink Library
  - Can also type at MATLAB Command line: `raspberrypilib`

- Test your connection (PC to Raspberry Pi)
  - Type at the MATLAB command line: `!ping ip.add.re.ss`
  - You should see the result:
Summary: Simulink + Raspberry Pi Testing (con’t)

- Open Raspberry Pi Image Inversion model: raspberrypi_inversion

- Click Tools -> Run on Target Hardware -> Options
  - Check to make sure Target hardware = Raspberry Pi.
  - Also check the IP address.

- Click Run button
  - We used the “External” simulation mode.
  - External mode allows you to tune parameters and monitor signals in the model while the application is running on hardware.
  - You can use “Deploy to Hardware” button if you want to run on the hardware with no interaction from the host.

- The model is now running on the Raspberry Pi
Two Examples

- **Object Detection**
  - Locate and mark the center of green object

- **Barcode scanner**
  - Scan barcode and output numerical digits
Simulink Hardware Support

Selected Simulink Supported Hardware:
- Arduino® Uno, Due, Mega 2560 and Nano ($30-$70)
  - Also support for Ethernet and WiFi Shields
- LEGO® MINDSTORMS® EV3 and NXT ($350)
- Raspberry Pi Model B ($40)
- BeagleBoard-xM ($150) and PandaBoard ($180)
- Samsung GALAXY Android Devices ($50-$500)
- Gumstix® Overo hardware ($180)

Simulink Hardware Support works in MATLAB and Simulink Student Suite!

http://www.mathworks.com/hardware-support/home.html
Simulink Support for Arduino Due / LEGO MINDSTORMS EV3

- Simulink block libraries and examples
- Get and install the same way!
Discover how MATLAB and Simulink can be used with LEGO, Arduino, Raspberry Pi, and more…

www.makerzone.mathworks.com
Next Steps

- Check out the other talks and booths at the MATLAB Virtual Conference

- Visit the Hardware Support website and browse all the different hardware that is supported by MATLAB, Simulink and other MathWorks products

- Visit MakerZone to learn about cool projects and how to get started