第5章 实验5: Hos-mips 操作系统的构建与运行

前面 4 个实验在 Nexys 4 DDR FPGA 开发板上搭建了一个基于 MIPSfpga 处理器的完整的嵌入式计算机硬件平台,该硬件平台包含一个标准 MIPS 处理器以及必要的接口设备。从本章开始,进入本书的第二部分,将在前面搭建的 MIPSfpga 硬件平台上运行一个小型的操作系统——Hos-mips。

5.1 实验目的

在本实验中,将学习在自己的个人计算机上安装并构建(build)Hos-mips 操作系统的环境,以及将生成的镜像下载到 MIPSfpga 硬件平台并使其运行起来的方法。假设实验使用的个人计算机上安装了 Windows 操作系统(Windows 7 或 Windows 10)。对于安装了 Mac OS 的用户,可以将以下介绍的安装过程中的软件替换为对应的 Mac OS 上的软件即可。

5.2 实验内容

Hos-mips 操作系统的构建涉及较多的软件工具,其中包括 Cygwin、Vivado、交叉编译器(MIPS MTI)、PuTTY、OpenOCD 等。Vivado、交叉编译器(MIPS MTI)以及 OpenOCD 的安装已经在前面做过介绍。在本实验中,只介绍 Cywin 的安装(见 5.2.1 节),并在安装完成后构建并运行 Hos-mips 操作系统(见 5.2.2 节和 5.2.3 节)。

5.2.1 安装开发环境

1. Cygwin 的安装

Cygwin 是一个在 Windows 环境下运行的类 Linux 环境,它能够在 Windows 下提供 Linux 环境以及很多 Linux 工具。在本实验中,将用到 make、gcc、perl 这些基本工具。 make 用于解析 Hos-mips 的 makefile 文件,gcc 用于编译 Hos-mips 的源代码,perl 用于解 释执行 make 工具解析过程中 Hos-mips 自带的一些脚本程序。可以到 Cygwin 的官方网站 下载安装程序并进行安装,网址为 https://www.cygwin.com。

需要指出的是,应根据自己的运行环境选择安装文件。例如,在图 5-1 中,如果 Cygwin 的运行环境是 32 位的,就应下载 setup-x86.exe;如果其运行环境是 64 位的,就需要下载 setup-x86_64.exe。查看自己的个人计算机的运行环境是 32 位还是 64 位的任务比较简单, 而且能够在互联网上找到大量的介绍,所以就不再赘述了。

另外,Cygwin的不同版本也可能会有细微的差别(这里以 Cygwin 的 2.6.0 版本为例)。 但这些细微差别应该不会对后面的实验构成太大影响,因为只用到了它的几个基本软件包。

为了叙述方便,假设已经将 setup-x86_64.exe 文件放在 D:\Hos\tool-chains 目录中,并

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NOTE: The previous Cygwin version 2.5.2 was the last version supporting Windows XP and Server 2003.
For more information see the \underline{FAQ} .
Current Cygwin DLL version
The most recent version of the Cygwin DLL is <u>2.6.0</u> . Install it by running <u>setup-x86.exe</u> (32-bit) installation) or <u>setup-x86 64.exe</u> (64-bit) installation).
Use the setup program to perform a <u>fresh install</u> or to <u>update</u> an existing installation.
Note that individual packages in the distribution are updated separately from the DLL so the Cygwin DLL version is not useful as a general Cygwin distribution release number.
Support for Cygwin
For all Cygwin-related questions and observations, please check the resources available at this site, such as the <u>FAQ</u> , the <u>User's Guide</u> and the <u>mailing list archives</u> . If you've exhausted these

图 5-1 下载 Cygwin 的安装文件

希望将 Cygwin 安装在 D:\Hos\tool-chains\cygwin64 目录中。这里用到的环境是 64 位的 Windows 10 的专业版,其他开发环境(如 Windows 7 或者其他 32 位版本)的安装过程类似。现在开始安装过程,具体步骤如下:

(1) 双击 setup-x86_64.exe 文件,启动 Cygwin 的安装程序进行安装,弹出图 5-2 所示的 Cygwin 安装向导,单击"下一步"按钮。

🗲 Cygwin Setup	- 🗆 X
	Cygwin Net Release Setup Program This setup program is used for the initial installation of the Cygwin environment as well as all subsequent updates. Make sure to remember where you saved it. The pages that follow will guide you through the installation. Please note that Cygwin consists of a large number of packages spanning a wide variety of purposes. We only install a base set of packages by default. You can always run this program at any time in the future to add, remove, or upgrade packages as necessary.
	Setup.exe version 2.876 (64 bit) Copyright 2000-2016 http://www.cygwin.com/
	< 上一步(<u>B</u>) 下一步(<u>N</u>) > 取消

图 5-2 Cygwin 安装向导

(2) 选择 Install from Internet 单选按钮,即从网络安装,如图 5-3 所示,单击"下一步" 按钮。

(3) 接下来选择安装目录以及安装包的缓存目录(注意,目录名中不要出现空格),如图 5-4 所示。

(4)单击"下一步"按钮,再选择安装源。需要注意的是,可以根据自己的网络连接状况选择是否使用代理,并找到最合适的安装源。这里选择的是位于教育网的镜像(http://mirrors.neusoft.edu.cn),如图 5-5 所示。

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O Install from Local Directory			
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图 5-3 选择从网络安装 Cygwin

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图 5-5 选择 Cygwin 的安装源

(5)单击"下一步"按钮,Cygwin的安装程序会从网络下载基本的安装文件,并弹出如图 5-6 所示的界面。实际上,这个界面给出的是即将安装到 D:\Hos\tool-chains\cygwin64 目录(注意,目录名中不要出现空格)的 Cygwin 的软件包,且只包含最基本的部分。该默认 配置并不包括即将要用到的软件工具,所以,需要在这里安装额外的软件包。

(6) 首先安装 make 软件包,方法是在图 5-6 所示界面的 Search 文本框中输入 make,并 在界面中间的安装列表刷新后,单击 Devel 前的已,并在展开的列表中单击 make. The GNU version of the 'make' utility 前的 Skip,直到该处显示即将安装的 make 软件工具的版本为 止,如图 5-7 所示。此时,千万不要单击"下一步"按钮,因为还有其他软件包需要安装。

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图 5-6 Cygwin 的默认配置

(7) 在 Search 文本框中输入 gcc,并选择其 Devel 中的 gcc-core: GNU Compiler Collection (C, OpenMP)和 gcc-g++: GNU Compiler Collection (C++)两个选项,如图 5-8 所示。

(8) 接下来选择安装 perl。同样在 Search 文本框中输入 perl,展开 Interpreters,并选择 perl:Perl programming language interpreter,如图 5-9 所示。

(9) 完成以上步骤后,就可以单击"下一步"按钮,并开始真正的 Cygwin 下载和安装了。

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图 5-7 在 Cygwin 中选择安装 make

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	€ Skip	ηία	nja	589k	gcc-tools-epoch2-automake: (gcc-special) a tool
	€ Skip	nja	nja	6k	gccmakedep: X Makefile dependency tool for GCC
	€ Skip	nja	nja	34k	imake: X Imake legacy build system
4	04.1-1	\boxtimes		414k	make: The GNU version of the 'make' utility
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图 5-7 (续)

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•Skip ** · 248k cygin32=gcc-lkplus: COC for Cygvin 32bit toolchain (C:llf Plus) •Skip ** · 15,128k cygin32=gcc-fortran: OCC for Cygvin 32bit toolchain (G:pomMF) •Skip ** · 0,346k cygin32=gcc-fortran: OCC for Cygvin 32bit toolchain (Fortran) •Skip ** · 0,328k cygin32=gcc-fortran: OCC for Cygvin 32bit toolchain (Fortran) •Skip ** · 0,228k cygin32=gcc-fortran: OCC for Cygvin 32bit toolchain (Objective-C) •Skip ** · 0,228k cygin32=gcc-fort cygin 32bit toolchain (Objective-C) •Skip ** · 0,306k djgp-gcc-dat: GCC for Cygvin 32bit toolchain (Objective-C++) •Skip ** · 13,501k djgp-gcc-fortran: OCC for DJGFP toolchain (C) •Skip ** · 0,290k djgp-gcc-fortran: OCC for DJGFP toolchain (C) •Skip ** · 0,290k djgp-gcc-cobic: COC for DJGFP toolchain (C) •Skip ** · 0,290k djgp-gcc-cobic: COC for DJGFP toolchain (C) •Skip ** · 0,290k djgp-gcc-cobic: COC for DJGFP toolchain (C) •Skip ** · 0,490k djgp-gcc-cobic: COC for DJGFP toolchain (D) •Skip ** · 14,550k gcc-dai: GUC Conpiler Collection (Ca) •Skip ** · 14,550k g		€Skip		nja	nja	13, 200k	cygwin32-gcc-ada: GCC for Cygwin 32bit toolchain (Ada)			
•Skip ** 15.12% cygrin32gcc-core: 000 for Cygrin 32bit toolchain (6, 0pendF) •Skip ** 6.34% cygrin32gcc-tortran: 000 for Cygrin 32bit toolchain (0+tran) •Skip ** 9.62% cygrin32gcc-tortran: 000 for Cygrin 32bit toolchain (0+tran) •Skip ** 5.12% cygrin32gcc-tortran: 000 for Cygrin 32bit toolchain (0bjective-C) •Skip ** 5.13% cygrin32gcc-tojit+1 000 for Cygrin 32bit toolchain (0bjective-C)+ •Skip ** 5.33% cygrin32gcc-tojit+1 000 for Cygrin 32bit toolchain (0bjective-C)+ •Skip ** 7.920% djgp-gcc-creat: 000 for DJGPF toolchain (Cortran) •Skip ** 8.279% djgp-gcc-reitran: 000 for DJGPF toolchain (Cortran) •Skip ** 8.279% djgp-gcc-reitran: 000 for DJGPF toolchain (0bjective-C) •Skip ** 8.279% djgp-gcc-reitran: 000 for DJGPF toolchain (0bjective-C) •Skip ** 8.279% djgp-gcc-reitran: 000 for DJGPF toolchain (0bjective-C) •Skip ** 8.279% djgpp-gcc-reitran: 000 for DJGPF toolchain (0bjective-C) •Skip ** 5.98% djgpp-gcc-reitran:		O Skip		nja	nja	248k	cygwin32-gcc-cilkplus: GCC for Cygwin 32bit toolchain (Cilk Plus)			
•Skip ** * 6.34%c cygrin32=gcc-fortran: COC for Cygrin 32bit toolchain (Fortran) •Skip ** 9.62%c cygrin32=gcc-bjc: COC for Cygrin 32bit toolchain (C++) •Skip ** 5.12%c cygrin32=gcc-bjc: COC for Cygrin 32bit toolchain (Objective-C) •Skip ** 5.12%c cygrin32=gcc-bjc: COC for Cygrin 32bit toolchain (Objective-C) •Skip ** 5.38%c cygrin32=gcc-bjc: COC for Cygrin 32bit toolchain (Objective-C++) •Skip ** 5.38%c cygrin32=gcc-bjc: COC for DJGPF toolchain (A) •Skip ** 7.92%c djgp-gcc-dit: COC for DJGPF toolchain (C++) •Skip ** 8.27%c djgp-gcc-bjc: COC for DJGPF toolchain (C++) •Skip ** 8.27%c djgp-gcc-bjc: COC for DJGPF toolchain (Portran) •Skip ** 5.08%c ggp-gcc-bjc: COC for DJGPF toolchain (C++) •Skip ** 5.08%c gcc-dai: COC for DJGPF toolchain (Objective-C) •Skip ** 5.40%c djgp-gcc-cbjc: COC for DJGPF toolchain (Objective-C++) •Skip ** 24.4%gcc-clkpus; CMU Conpiler Collection (Ca) •Skip ** 24.4%gcc-cckpus; CMU Conpiler Collection (Ca) •Skip ** 24.4%gcc-cckpus; CMU Conpiler Collection (C3) •Skip ** 24.4%g		😯 Skip		nja	n/a	15, 128k	cygwin32-gcc-core: GCC for Cygwin 32bit toolchain (C, OpenMP)			
• Skip ** ** • 9.62% cygrin2=gcc-grit: CCC for Cygrin 22bit toolchain (C++) • Skip ** * 5.12% cygrin2=gcc-grit: CCC for Cygrin 32bit toolchain (Objective-C) • Skip ** 5.38% cygrin3=gcc-grit: CCC for Cygrin 32bit toolchain (Objective-C++) • Skip ** 5.38% cygrin3=gcc-grit: CCC for Cygrin 32bit toolchain (Objective-C++) • Skip ** 13.501k djgpr=gcc-grit: CCC for DJGPF toolchain (C+) • Skip ** 6.290k djgpr=gcc-grit: CCC for DJGPF toolchain (C+) • Skip ** 6.290k djgpr=gcc-grit: CCC for DJGPF toolchain (C+) • Skip ** 5.087k djgpr=gcc-grit: CCC for DJGPF toolchain (C+) • Skip ** 5.087k djgpr=gcc-grit: CCC for DJGPF toolchain (Objective-C+) • Skip ** 5.087k djgpr=gcc-grit: CCC for DJGPF toolchain (Objective-C+) • Skip ** 5.087k djgpr=gcc-grit: CCC for DJGPF toolchain (Objective-C+) • Skip ** 5.087k djgpr=gcc-grit: COC for DJGPF toolchain (Objective-C+) • Skip ** 5.087k djgpr=gcc-grit: COC for DJGPF toolchain (Objective-C) • Skip ** 5.448k ggcc-gcad: CUC Conpiler Collection (Cil Plue) •		😯 Skip		nja	nja	6, 346k	cygwin32-gcc-fortran: GCC for Cygwin 32bit toolchain (Fortran)			
•Skip ** ** 5.12%k cygrin32=gcc-objc: 00C for Cygrin 32bit toolchain (0bjective-C) •Skip ** 5.38%k cygrin32=gcc-objc: 00C for Cygrin 32bit toolchain (0bjective-C++) •Skip ** 5.38%k cygrin32=gcc-objc: 00C for DJGPF toolchain (0bjective-C++) •Skip ** 7.320k djgp-gcc-cate: 00C for DJGPF toolchain (0bjective-C++) •Skip ** 7.320k djgp-gcc-gcreate: 00C for DJGPF toolchain (C++) •Skip ** 8.279k djgp-gcc-gc+:: 00C for DJGPF toolchain (C++) •Skip ** 5.38%k (ggp-gcc-bjc:: 00C for DJGPF toolchain (0bjective-C) •Skip ** 5.38%k (ggp-gcc-cbjc:: 00C for DJGPF toolchain (0bjective-C) •Skip ** 5.38%k (ggp-gcc-bjc:: 00C for DJGPF toolchain (0bjective-C) •Skip ** 5.38%k (ggp-gcc-cbjc:: 00C for DJGPF toolchain (0bjective-C) •Skip ** 5.38%k (ggp-gcc-cbjc:: 00C for DJGPF toolchain (0bjective-C) •Skip ** 14,556% gcc-abjc: 00C conpiler Collection (1k Plus) •Sisip ** 244% gcc-cityc: 00C conpiler Collection (C, OpengP) •Skip ** 6,642% gcc-fortran: 00U conpiler Collection (Fortran) •Skip ** 5,194% gcc-ob		😯 Skip		njis	nja	9, 629k	cygwin32-gcc-g++: GCC for Cygwin 32bit toolchain (C++)			
•Skip ** 5.388k cywin32_scc-objc+*:0CC for Cygvin 32bit toolchain (dbjective-C++) •Skip ** 5.350k djgp-gcc-db(C) for Cygvin 32bit toolchain (dbjective-C++) •Skip ** 7.320k djgp-gcc-db(C) for DJGPF toolchain (dc) •Skip ** 6.290k djgp-gcc-dc(C) for DJGPF toolchain (Fortran) •Skip ** 6.290k djgp-gcc-fortran: COC for DJGPF toolchain (Fortran) •Skip ** 5.087k djgpp-gcc-fortran: COC for DJGPF toolchain (Fortran) •Skip ** 5.087k djgpp-gcc-fortran: COC for DJGPF toolchain (Fortran) •Skip ** 5.087k djgpp-gcc-fortran: COC for DJGPF toolchain (Objective-C) •Skip ** 5.087k djgpp-gcc-cobjc+: COC for DJGPF toolchain (Objective-C) •Skip ** 5.498k djgpp-gcc-cadi: GUU Conpiler Collection (Cal) •Skip ** 2.444k gcc-cal: GUU Conpiler Collection (Cil PIDF) •Skip ** 2.444k gcc-cal: GUU Conpiler Collection (C) Permit •Skip ** 2.444k gcc-cal: GUU Conpiler Collection (C) Permit •Skip ** 2.444k gcc-cal: GUU Conpiler Collection (C) Permit •Skip ** 6.424k gcc-cal: GUU Con		€Skip		njis	nja	5, 129k	cygwin32-gcc-objc: GCC for Cygwin 32bit toolchain (Objective-C)			
•Skip ** ** 13, 501k djgp-gc-cradk: 000 for DjGPF tolchain (Ada) •Skip ** * 7, 520k djgp-gc-cradk: 000 for DjGPF tolchain (C) •Skip ** 6, 290k djgp-gc-cratk: 000 for DjGPF tolchain (C) •Skip ** 6, 290k djgp-gc-cratk: 000 for DjGPF tolchain (C) •Skip ** 8, 279k djgp-gc-cratk: 000 for DjGPF tolchain (C) •Skip ** 8, 279k djgp-gc-cbjc: 000 for DjGPF tolchain (D) •Skip ** 5, 087k djgp-gc-cbjc: 000 for DjGPF tolchain (D) •Skip ** 5, 087k djgp-gc-cbjc: 000 for DjGPF tolchain (D) •Skip ** 5, 087k djgp-gc-cbjc: 000 for DjGPF tolchain (D) •Skip ** 5, 349k djgp-gc-cbjc: 000 for DjGPF tolchain (D) •Skip ** 5, 349k djgp-gc-cbjc: 000 conpiler Collection (Cill Plue) •Skip ** 244k gc-cristran: GND conpiler Collection (G) Pomp •G5.4.0-1 ** ** ** ** ** •G5.4.0-1 ** ** ** ** ** •G5.4.0-1 ** ** ** ** ** <		()Skip		nja	nja	5, 388k	cygwin32-gcc-objc++: GCC for Cygwin 32bit toolchain (Objective-C++)			
•Skip ** ** 7,920k djgp=scc=core: GCC for DJGPF toolchain (C) •Skip ** 6,290k djgp=scc=fst: GCC for DJGPF toolchain (C) •Skip ** 6,290k djgp=scc=fst: GCC for DJGPF toolchain (C) •Skip ** 5,087k djgp=scc=fst: GCC for DJGPF toolchain (C) •Skip ** 5,087k djgp=scc=bjc: GCC for DJGPF toolchain (C) •Skip ** 5,087k djgp=scc=bjc: GCC for DJGPF toolchain (Objective=C) •Skip ** 14,550k gcc=ada: GNU Compiler Collection (Ik Plus) •Skip ** 14,550k gcc=core: GNU Compiler Collection (C) PumpPD •Skip ** 244k gcc=core: GNU Compiler Collection (C, OpenPD) •Skip ** 0,44k gcc=core: GNU Compiler Collection (Fortran) •Skip ** 0,44k gcc=fortran: GNU Compiler Collection (Fortran) •Skip ** 0,42k gcc=fortran: GNU Compiler Collection (Fortran) •Skip ** 0,42k gcc=fortran: GNU Compiler Collection (G) •Skip ** 0,42k gcc=fortran: GNU Compiler Collection (Fortran) •Skip ** 5,194k gcc=fortic GNU Compiler collection (G) •Skip ** 6,194k gcc=fortran: GNU Compiler Collection (G) GNU C)		😯 Skip		njis	nja	13, 501k	djgpp-gcc-ada: GCC for DJGPP toolchain (Ada)			
• Skip ** ** 0.298k djgp=gcc=fortan: COC for DJGPF toolchain (Fortran) • Skip ** 8.278k djgp=gcc=fortan: COC for DJGPF toolchain (Fortran) • Skip ** 5.087k djgp=gcc=rbjc: COC for DJGPF toolchain (Objective=C) • Skip ** 5.087k djgp=gcc=rbjc: COC for DJGPF toolchain (Objective=C) • Skip ** 5.087k djgp=gcc=rbjc: COC for DJGPF toolchain (Objective=C) • Skip ** 5.498k djgp=gcc=rbjc: COC for DJGPF toolchain (Objective=C)+ • Skip ** 5.494k djgp=gcc=rbjc: COC for DJGPF toolchain (Objective=C)+ • Skip ** • 244k gcc=rbjle: COU Conpiler Collection (Cil Plus) • Skip ** • 0.414k gcc=rbire: GUU Conpiler Collection (C, OpengPP) • Skip ** • • • • Silip ** • • • • • • * </td <td></td> <td>© Skip</td> <td></td> <td>njis</td> <td>nja</td> <td>7, 926k</td> <td>djgpp-gcc-core: GCC for DJGPP toolchain (C)</td> <td></td> <td></td> <td></td>		© Skip		njis	nja	7, 926k	djgpp-gcc-core: GCC for DJGPP toolchain (C)			
•Skip • ** • ** • **		€Skip		nja	nja	6, 296k	djgpp-gcc-fortran: GCC for DJGPP toolchain (Fortran)			
OSkip ** ** 5,037k djgp=gcc=objc: GCC for DJGFP toolchain (Objective=C) OSkip ** 5,348k djgp=gcc=objc: GCC for DJGFP toolchain (Objective=C) OSkip ** 14,550k gcc=ata: GNU Compiler Collection (Ada) OSkip ** 244k gcc=displus: GNU Compiler Collection (Cilk Flux) OSkip ** 244k gcc=creare: GNU Compiler Collection (Cilk Flux) OSkip ** 0.44k gcc=fortran: GNU Compiler Collection (Cilk Flux) OSkip ** 0.44k gcc=fortran: GNU Compiler Collection (Cilk Flux) OSkip ** 0.42k gcc=fortran: GNU Compiler Collection (Fortran) OSkip ** 0.42k gcc=fortran: GNU Compiler Collection (Fortran) OSkip ** 0.5194k gcc=rbic: GNU Compiler Collection (Gbjective=C)		© Skip		njis	nja	8, 279k	djgpp-gcc-g++: GCC for DJGPP toolchain (C++)			
• Skip ** ** 5.34% djgp=gcc-objc+t: COC for DJGPF toolchain (Objective-C++) • OSkip ** 14.550k gcc-aata: GNU Conpiler Collection (Cal Ada) • OSkip ** 14.550k gcc-aata: GNU Conpiler Collection (Cal Plus) • OSkip ** 0.642k gcc-criticpus: GNU Conpiler Collection (Cil Plus) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Fortran) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Cbr) • OSkip ** 0.642k gcc-fortran: GNU Conpiler Collection (Cbr) • OSkip ** • 0.642k gcc-fortran: GNU Conpiler Collection (Cbr)		()Skip		nja	nja	5, 087k	djgpp-gcc-objc: GCC for DJGPP toolchain (Objective-C)			
OSkip ** ** 14,550k gcc-ada: CNU Compiler Collection (Ada) OSkip ** 244k gcc-cilkplus: GNU Compiler Collection (Cilk Plus) O5.4.0-1 ID <		😯 Skip		njis	nja	5, 349k	djgpp-gcc-objc++: GCC for DJGPP toolchain (Objective-C++)			
• Skip ** ** 244# gc-c-ilkplus; GW Compiler Collection (Cilk Flux) • 55.4.0-1 III III IIII Compiler Collection (C, OpenPP) • Skip ** ** 6,642k gc-corte: GW Compiler Collection (C, OpenPP) • 55.4.0-1 IIII •* ** 6,642k gc-corte: GW Compiler Collection (Fortran) • 55.19 ** • 5,194k gc-corbic: GW Compiler Collection (Green C) • 55.194k gc-corbic: GW Compiler Collection (Green C) • •		© Skip		njis	nja	14, 556k	gcc-ada: GNU Compiler Collection (Ada)			
••5.4.0-1 Image: Construction of the second se		€Skip		njis	nja	244k	gcc-cilkplus: GNU Compiler Collection (Cilk Plus)			
OSkip ## 6,642k gcc-fortran: GNU Compiler Collection (%ortran) OSkip ## 6,42k gcc-fortran: GNU Compiler Collection (%ortran) OSkip ## # 5,194k gcc-robic GNU Compiler Collection (%ortran)		9 5. 4.					gcc-core: GNU Compiler Collection (C, OpenMP)			
375.4.0-1 IM 25.748k gcc-g++: GNU Compiler Collection (C++) 375kip n≥ 5,194k gcc-objc: GNU Compiler Collection (Objective-C)		Skip		nja	nja	6, 642k	gcc-fortran: GNU Compiler Collection (Fortran)			
OSkip NA NA 5,194k gcc-objc: GNU Compiler Collection (Objective-C)		05.4.		×		<9.748k	gcc-g++: GNU Compiler Collection (C++)			
		()Skip		njis	nja	5, 194k	gcc-objc: GNU Compiler Collection (Objective-C)			

图 5-8 在 Cygwin 中选择安装 gcc

在安装的最后一个界面选择 Create icon on Desktop 复选框,如图 5-10 所示。

(10) 接下来,测试 Cygwin。双击桌面上的 Cygwin64 Terminal 图标,弹出图 5-11 所示的终端界面。

(11) 在图 5-11 所示的终端界面中,可以测试以前安装的软件包是否能够正常使用。分别输入 make 和 gcc 命令并按回车键,因为没有输入文件,这两个命令肯定会报错。但是,只要不出现"未找到命令"的错误,就不会影响以后的实验。

109 -

E Cygwin Setup - Select Packages					—		\times
Select Packages Select packages to install							• ^ •
View Category V Search Perl	<u>C</u> lear			<u>○ K</u> eep	● <u>C</u> urr	⊖Еѯр	_
Category New	Bin?	Src?	Size	Package			^
BAIL & Default							
🗉 Database 🕈 Default							
🗉 Debug 🏵 Default							
🗉 Devel 😌 Default							
🖽 Graphics 🕂 Default							
Interpreters @ Default							
95. 22. 2-1	\boxtimes		<. 449k	perl: Perl programming language interpreter	>		
()Skip	nja	nía	1k	perl autorebase: Perl programming language int	erpreter		
⊕ Skip	nja	nía	2, 877k	perl base: Perl programming language interpret	er		
ASkin	nia	nía	5, 574k	perl manpages: Perl programming language inter	oreter		
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⊞ Libs I Default			-,				_
T Net & Default							
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图 5-10 选择在桌面创建图标





(12) 最后,将 Cygwin 安装目录下的 bin 子目录(这里是 D:\Hos\tool-chains\cygwin 64\bin 目录)加入系统路径,方法是:在"开始"菜单中选择"控制面板"→"系统和安全"→

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"系统"→"高级系统设置"命令,当显示"系统属性"对话框后,单击"环境变量"按钮,在弹出的"环境变量"对话框中,单击"新建"按钮,如图 5-12 所示。在接下来弹出的"新建用户变量"对话框中,设置"变量名"为 Path,"变量值"为 D:\Hos\tool-chains\cygwin64\bin,如 图 5-13 所示。如果已经定义了 Path 环境变量,则可单击"编辑"按钮,然后添加 D:\Hos\tool-chains\cygwin64\bin 变量值。在设置完成后单击"确定"按钮,就将 Cygwin 加入了的开发环境。

系统属性 ×	环境变量	×
计算机名 硬件 高级 系统保护 远程	zhiyuan 的用户变量(U)
要进行大多数更改,你必须作为管理员登录。	交量	值
件能	JAVA_HOME	C:\Program Files\Java\jdk1.8.0_102
视觉效果,处理器计划,内存使用,以及虚拟内存	TEMP	%USERPROFILE%\AppData\Local\Temp %USERPROFILE%\AppData\Local\Temp
设置(S) 用户配置文件 与容录帐户相关的卓面设置	(系统变量(S)	新建(N) 编辑(E) 删除(D)
	变量	值 ^
设置(<u>E</u>)	ComSpec	C:\Windows\system32\cmd.exe
	IMGTEC USER H	C:\Users\zhiyuan\imgtec
启动和故障恢复	NUMBER_OF_PRO.	4
系统启动、系统故障和调试信息	OS	Windows_NT
	Path	C:\ProgramData\Oracle\Java\javapath;C:\P ¥
设置([]		新建(<u>W</u>) 编辑(I) 删除(I_)
环境变量(1)		确定取消

图 5-12 添加环境变量

新建用户变量	\times
変量名(№): Path g量値(½): D:\Hos\tool-chains\cygwin64\bin	确定取消

图 5-13 新建环境变量 Path

2. 下载 Hos-mips 源代码

接下来访问 https://github.com/mrshawcode/hos-mips,下载 Hos-mips 源代码。可以使用 git 工具对源代码进行复制(使用 clone 命令)。实际上,这也是较好的方法,因为这样可以跟踪自己对代码所做的所有改动。但是,如果不熟悉 git 工具,则可以单击 Download ZIP 按钮直接下载压缩包,并在本地进行解压操作,如图 5-14 所示。

现在,假设已经下载了 Hos-mips 源代码,并将其解压到 D:\Hos\hos-mips-master\目 录下(注意,目录名中不要出现空格)。hos-mips-master 目录的内容如图 5-15 所示。该目录 下的子目录及文件的说明见表 5-1。

C This repository Search	Pull requests Issues Gist	: 🔹 🖡 +- 🌉
F MrShawCode / hos-mips		Ounwatch ▼ 2 ★ Star 0
↔ Code ① Issues 0 ۩ Pull requests 0 ₪ P	rojects 0 🖽 Wiki 🥠 P	ulse 📊 Graphs 🗘 Settings
No description or website provided. — Edit		
3 commits 4 branches	🛇 0 releases	🎎 1 contributor 🎄 Apache-2.0
Branch: master Vew pull request		Create new file Upload files Find file Clone or download
MrShawCode temp		Clone with HTTPS ⑦ Use SSH
kernel	temp	Use Git or checkout with SVN using the web URL.
🖿 tools	initial version	https://github.com/MrShawCode/hos-mips.git
.gitignore	initial version	Open in Desktop Download ZIP
LICENSE	Initial commit	2 months ago
Makefile	temp	2 months ago
Makefile.config	temp	2 months ago
README.md	Initial commit	2 months ago

图 5-14 下载 Hos-mips 源代码

此电脑 > HDD (D:) > Hos > hos-mips-master						
	名称 ^	修改日期	类型	大小		
۴	.vscode	2016/11/29 15:31	文件夹			
٢	debug	2016/11/29 15:31	文件夹			
	kern-ucore	2016/11/29 15:31	文件夹			
	tool	2016/11/29 15:31	文件夹			
	user	2016/11/29 15:31	文件夹			
	🧃 .gitignore	2016/11/29 15:31	Git Ignore 源文件	1 KB		
	📄 Makefile	2016/11/29 15:31	文件	5 KB		
	🗎 Makefile.config	2016/11/29 15:31	XML Configurati	1 KB		
	README.md	2016/11/29 15:31	Markdown 源文件	1 KB		
	💿 run.bat	2016/11/29 15:31	Windows 批处理	1 KB		

图 5-15 解压后的 hos-mips-master 目录的内容

表 5-1	hos-mips-master 的子目录及文件的说明
AC 0 1	

文件/文件夹名称	说明
.vscode 目录	存放 VSCode 的配置文件
debug 目录	存放用于 Hos-mips 运行的工具程序和配置文件,例如 JTAG 的启动配置文件、用于显示 Hos-mips 运行结果的 PuTTY 串口终端以及 mips-mti-elf-gdb 调试程序的配置文件(startup-ucore.txt)等
kern-ucore 目录	Hos-mips 操作系统内核的源代码
tool目录	用于生成 sfs image 镜像的工具
user 目录	用户态代码

续表

文件/文件夹名称	说明	
.gitignore	用于 git 的配置文件(与后面的实验无关)	
Makefile	主 make 文件	
Makefile.config	主 make 文件的配置文件,通过该文件可配置交叉编译器等	
README.md	ME.md 对于 Hos-mips 编译与使用的简单说明文件	
run.bat	运行 Hos-mips 的批处理文件。在 make 命令执行后,如果成功生成了内核,则可以执行此批处理文件,在 Nexys 4 DDR FPGA 开发板上运行 Hos-mips	

至此,Hos-mips的环境配置就完成了。接下来,将构建 Hos-mips 内核,并在前面 4 个 实验所构造的 MIPSfpga 硬件平台上运行该操作系统。

5.2.2 构建 Hos-mips 镜像

本节使用 Cygwin 构建 Hos-mips 系统镜像。

启动 Cygwin,并进入 Hos-mips 源代码目录,如图 5-16 所示。这里需要注意的是, Cygwin 中使用的路径是 cygpath,而 Hos-mips 源代码目录(即 D:\Hos\hos-mips-master\) 对应的路径是/cygdrive/d/Hos/hos-mips-master,所以要转到该目录下,命令如下:

```
$cd /cygdrive/d/Hos/hos-mips-master
```



图 5-16 启动 Cygwin 并进入 Hos-mips 源代码目录

接下来,输入 make 命令开始构建系统镜像的过程。此时,应确定 Cygwin 以及交叉编译器所在的目录已经在系统路径中了。在构建过程中,如果出现找不到某命令的错误,一般是由于该命令对应的工具不在系统路径中。这时应检查是否已经正确设置了系统路径(例如,路径中是否出现了空格等)。构建时间需要一两分钟,取决于计算机的性能。构建成功后,会出现图 5-17 所示的界面。

为了进一步确保构建过程的正确性,可检查是否正确地生成了 Hos-mips 系统的镜像, 输入如下命令:

```
$ls ./obj/kernel/ucore-kernel-initrd -alh
```

执行该命令后,如果获得图 5-18 所示的结果,说明 Hos-mips 系统镜像已经构建成功,且 Hos-mips 系统镜像文件(ucore-kernel-initrd)的大小为 3.1MB。