README-CompSysCode

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1 Overview

The `CompSysCode` directory contains examples for computer systems, both software (computer programs) and hardware (circuits specified in a hardware description language). There are two subdirectories:

- `circuits` contains examples of synchronous digital circuits specified in the Hydra hardware description language. To run the circuit simulations, enter the `Circuits` directory and follow the `README-Circuits` document.
- `programs` contains several programs in Sigma16 assembly language, as well as their translations to machine language. These programs can be executed using the Sigma16 app `https://jtod.github.io/home/Sigma16/`. The programs in the Core subdirectory can also be used as input to the M1 processor circuit; this is documented in `Circuits/README-Circuits`.

It is helpful to experiment with simulating a circuit in order to understand how it works. `CompSysCode/Circuits/README-Circuits.html` explains how to run the circuit simulations.

Keep the entire directory structure intact, as there are references between many of the files.

2 Installation

There are three steps to install the system: install ghc, Hydra, and CompSysCode.

2.1 Install ghc

- Install ghc from `https://www.haskell.org/ghcup/`. On Macintosh or Linux, click *Installation*. On Windows, follow the instructions *To install on Windows*.

- Check that ghc is installed and working: enter `ghc --version` and `cabal --version`.

2.2 Install Hydra

- Go to `https://github.com/jtod/Hydra`. Under **Releases** (in the right side of the page), click **Latest** and then under **Assets** download the source code, which is available in both zip and tar.gz format.
- Unzip the file, which will produce a directory (folder) with a name like `Hydra-VERSION.zip` (for example, `Hydra-3.5.2.zip`).
- Enter the directory and install:
  - `cd Hydra-3.5.2`
  - `cabal install --lib`
- The language is described in the Hydra User Guide, which can be found in the installation directory and also the github page

2.3 Unzip CompSysCode

- Obtain `CompSysCode.zip`.
- Unzip the file and put it anywhere in your user space. You don't need to compile or install anything.

> Keep the entire `CompSysCode` package intact, even if you don't plan to use parts of it. Leave the structure of the directory unchanged: don't delete anything or move parts of it around. However, it's fine to create new subdirectories and files.
> The reason you shouldn't move or delete any of the files is that the source code modules have a hierarchical structure that corresponds to the structure of the directories and subdirectories. If you move the subdirectories around, or delete some of them, you may get error messages.
> All the commands that run circuits assume that your shell is in `CompSysCode/Circuits`. The commands won't work if you're in a different directory.

2.4 Test the installation

The circuit simulations run in an interactive shell; it is a text interface, not a graphical user interface. All commands must be executed in the

`CompSysCode/Circuits` directory. If you cd into a subdirectory, the Hydra module imports won't work.

Test the installation by entering this command, which will run a simulation of a binary multiplier circuit:

```
ghc -e main Arithmetic/MultiplyRun
```

3 Adding new programs and circuits

It is recommended that you put any new circuits that you define into `CompSysCode/Circuits/UserCircuits`. Similarly, it is recommended that you put any new programs into `CompSysCode/Programs/Sigma16/Core/Us`. More information about adding new circuits is given in `CompSysCode/Circuits/README-Circuits.html`

```
cd CompSysCode/Circuits
```

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