

COSE222 Computer Architecture

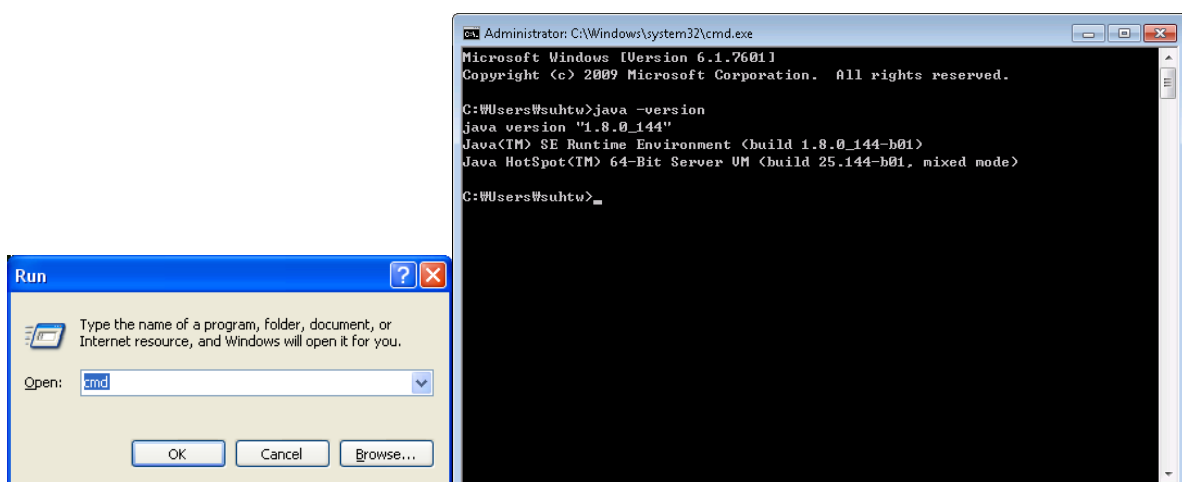
Cross-Compilation for MIPS using Eclipse - Updated on Sep. 10, 2017

Here, we are going to set up an environment to cross-compile C and/or MIPS Assembly code with Eclipse to generate the MIPS binary.

- Eclipse is a multi-language software development environment comprising an integrated development environment (IDE) and an extensible plug-in system. It is written primarily in Java and can be used to develop applications in Java and, by means of the various plug-ins, in other languages as well, including C, C++, COBOL, Python, Perl, PHP, and others. The IDE is often called Eclipse ADT for Ada, **Eclipse CDT for C**, Eclipse JDT for Java and Eclipse PDT for PHP. (Wikipedia)
- **Cygwin is a Unix-like environment and command-line interface for Microsoft Windows**. Cygwin provides native integration of Windows-based applications, data, and other system resources with applications, software tools, and data of the Unix-like environment. Thus it is possible to launch Windows applications from the Cygwin environment, as well as to use Cygwin tools and applications within the Windows operating context. (Wikipedia)
- To cross-compile with Eclipse, we need to have **Cygwin**, **MIPS cross-compiler**, and **Eclipse** installed. Eclipse also requires a **Java Runtime Environment (JRE)**

1. Java Runtime Environment (JRE) Setup

1. Check if the JRE is already installed on your PC.
 - Open a command prompt and type **java -version**
 - If the Java Runtime Environment (JRE) is not installed on your PC, you can download the JRE either from the following site or from the link below and install it yourself
 - <http://www.oracle.com/technetwork/java/javase/downloads/jre8-downloads-2133155.html>
 - http://esca.korea.ac.kr/teaching/cose222_CA/hw-sw-tools/jre-8u144-windows-x64.exe (64-bit)

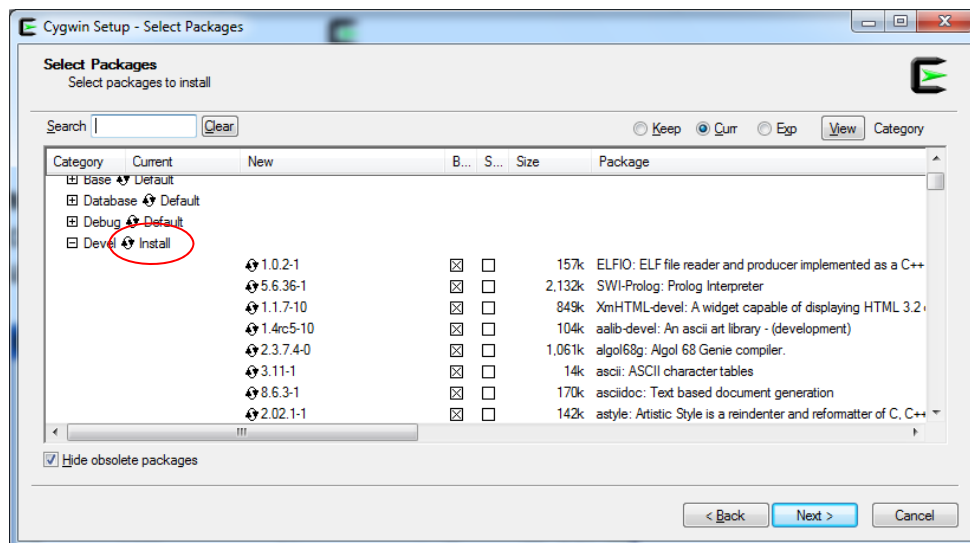


2. Cygwin Installation

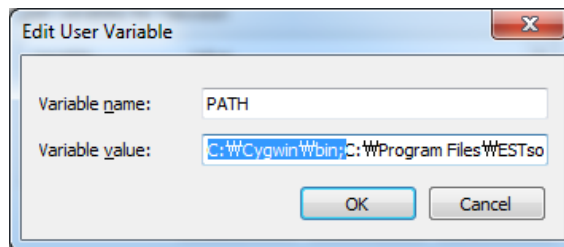
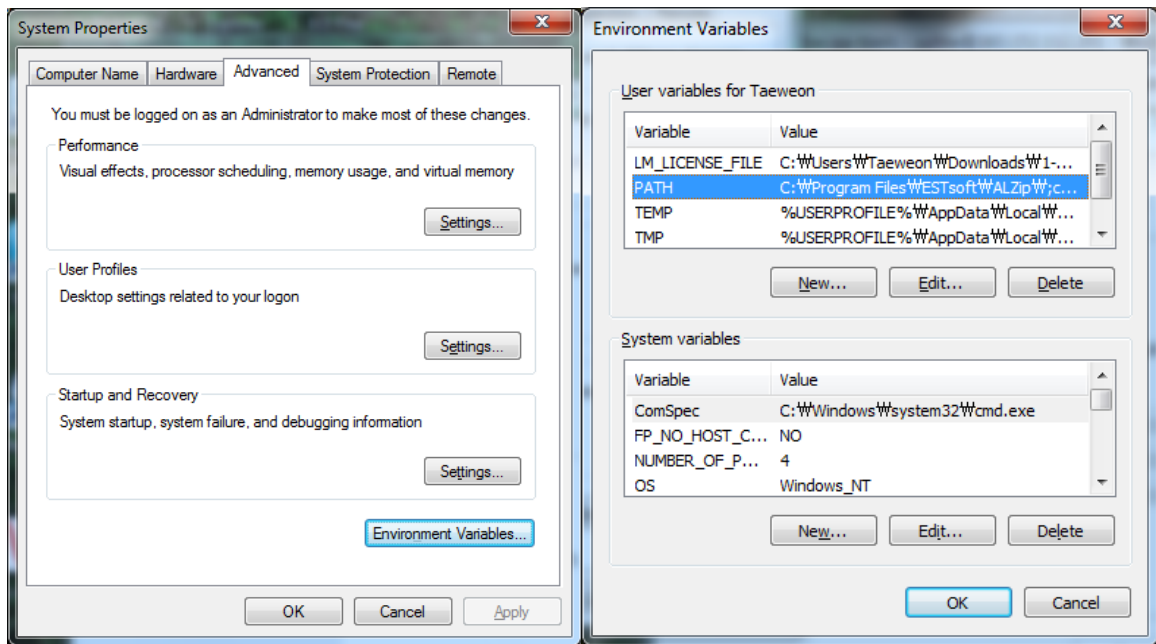
1. Follow the instructions below if Cygwin is not installed on your machine
2. Visit the Cygwin website at <http://www.cygwin.com/>
3. Click on **setup-x86.exe** (Install **Cygwin for 32-bit Windows**, **NOT** 64-bit)



4. Repeat the step 3
 - Change to **Install** next to **Devel**, and install it
 - i. It is going to install various compilers (such as gcc) and many useful commands (such as make) in Cygwin



5. Add **C:\cygwin\bin** to **PATH** environment variable in Windows
 - By doing this, you can run any commands found /usr/bin/ (in Cygwin) from anywhere in Windows
 - Click on **Environment Variables** under the **Advanced** tab



6. Invoke **Cygwin**

- Make sure you have installed appropriate files by running a command (**which make**) in the Windows command terminal – The **which** command finds the location where the **make** executable is located.



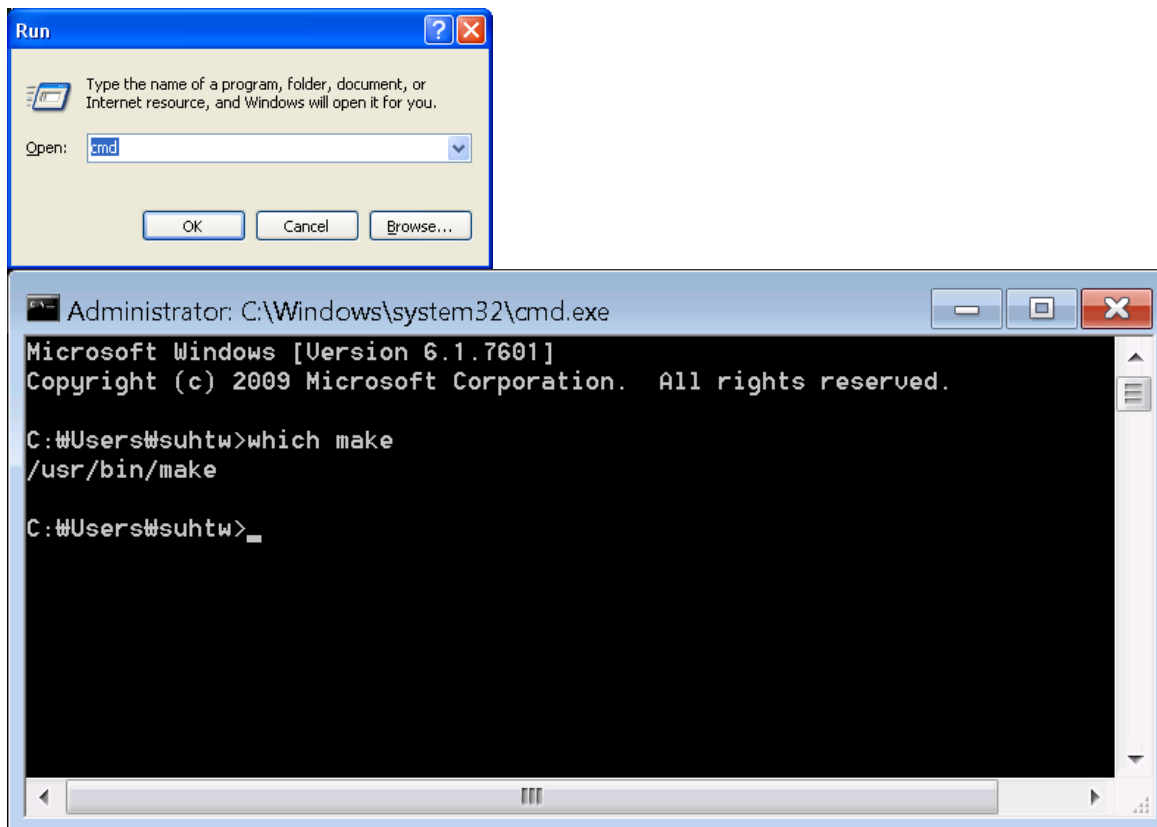
```

E ~
suhtw@suhtw-PC ~
$ which make
/usr/bin/make
suhtw@suhtw-PC ~
$

```

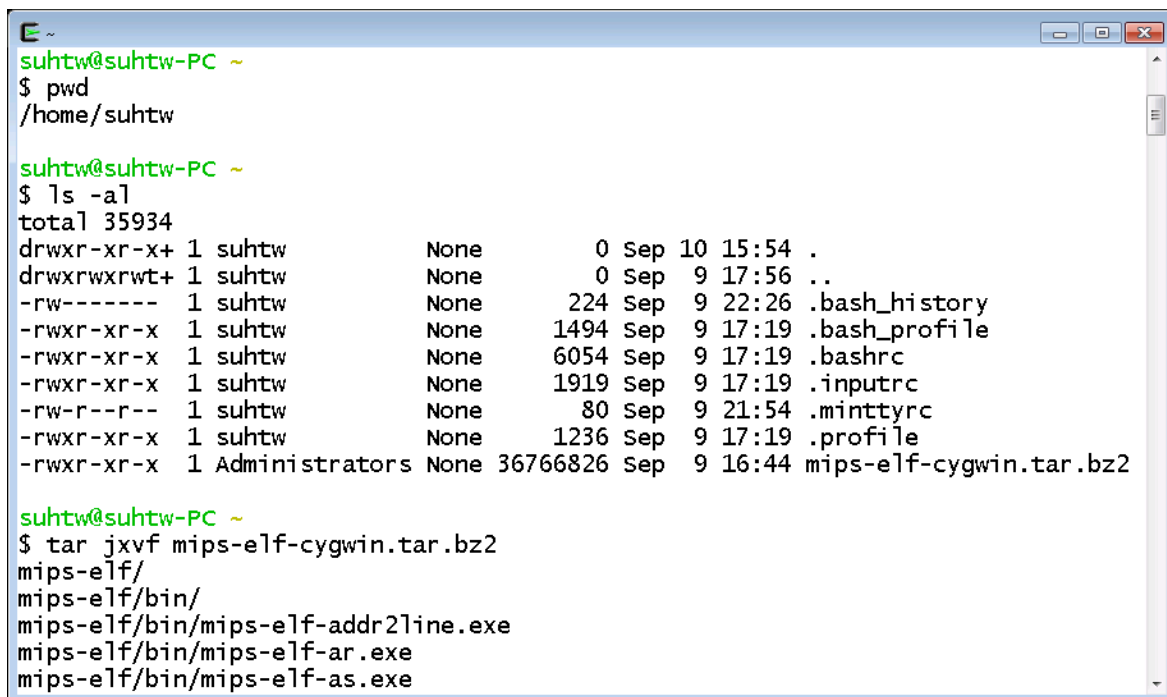
7. Invoke a Windows command terminal with **cmd**

- Make sure you have set up the Cygwin path correctly on Windows by running a command (**which make**) in the Windows command terminal.



3. MIPS Cross-Compiler Installation

1. Download the pre-built MIPS assembler and linker from
http://esca.korea.ac.kr/teaching/cose222_CA/hw-sw-tools/mips-elf-cygwin.tar.bz2
2. Copy the downloaded file to your Cygwin home directory
 - In my case, the directory is located at **D:\cygwin\home\suhtw**
3. Open a Cygwin shell
 - **Windows Start → All Programs → Cygwin → Cygwin Terminal**
4. Untar (Uncompress) it
 - `tar jxvf mips-elf-cygwin.tar.bz2`



```
suhtw@suhtw-PC ~
$ pwd
/home/suhtw

suhtw@suhtw-PC ~
$ ls -al
total 35934
drwxr-xr-x+ 1 suhtw      None      0 Sep 10 15:54 .
drwxrwxrwt+ 1 suhtw      None      0 Sep  9 17:56 ..
-rw----- 1 suhtw      None      224 Sep  9 22:26 .bash_history
-rwxr-xr-x  1 suhtw      None     1494 Sep  9 17:19 .bash_profile
-rwxr-xr-x  1 suhtw      None     6054 Sep  9 17:19 .bashrc
-rwxr-xr-x  1 suhtw      None     1919 Sep  9 17:19 .inputrc
-rw-r--r--  1 suhtw      None       80 Sep  9 21:54 .minttyrc
-rwxr-xr-x  1 suhtw      None     1236 Sep  9 17:19 .profile
-rwxr-xr-x  1 Administrators None 36766826 Sep  9 16:44 mips-elf-cygwin.tar.bz2

suhtw@suhtw-PC ~
$ tar jxvf mips-elf-cygwin.tar.bz2
mips-elf/
mips-elf/bin/
mips-elf/bin/mips-elf-addr2line.exe
mips-elf/bin/mips-elf-ar.exe
mips-elf/bin/mips-elf-as.exe
```

5. Change the directory and check if you have necessary files as shown in the above figure.
 - `cd mips-elf/bin`
 - `ls -l` // The MIPS assembler and linker are `mips-elf-as` and `mips-elf-ld`, respectively

```
~/mips-elf/bin
suhtw@suhtw-PC ~
$ pwd
/home/suhtw

suhtw@suhtw-PC ~
$ ls -l
total 35912
drwxr-xr-x 1 suhtw          None          0 Jun 26  2010 mips-elf
-rwxr-xr-x 1 Administrators None 36766826 Sep  9 16:44 mips-elf-cygwin.tar.bz2

suhtw@suhtw-PC ~
$ cd mips-elf/bin/

suhtw@suhtw-PC ~/mips-elf/bin
$ ls
mips-elf-addr2line.exe  mips-elf-gccbug          mips-elf-nm.exe
mips-elf-ar.exe        mips-elf-gcj.exe        mips-elf-objcopy.exe
mips-elf-as.exe        mips-elf-gcjh.exe       mips-elf-objdump.exe
mips-elf-c++.exe       mips-elf-gcov.exe       mips-elf-ranlib.exe
mips-elf-c++filt.exe   mips-elf-gfortran.exe   mips-elf-readelf.exe
mips-elf-cpp.exe       mips-elf-gjnih.exe      mips-elf-size.exe
mips-elf-g++.exe       mips-elf-jcf-dump.exe   mips-elf-strings.exe
mips-elf-gcc.exe       mips-elf-jv-scan.exe    mips-elf-strip.exe
mips-elf-gcc-4.1.1     mips-elf-ld.exe
```

4. Eclipse Setup

1. The Eclipse web page is located at <http://www.eclipse.org/>
2. Download **Eclipse IDE for C/C++ Developers** from the download page or from the class web at http://esca.korea.ac.kr/teaching/cose222_CA/hw-sw-tools/eclipse-cpp-luna-R-win32-x86_64.zip (64-bit)



3. Extract the zip to your local directory and then you will find the Eclipse icon
 - You may want to create a shortcut to Desktop

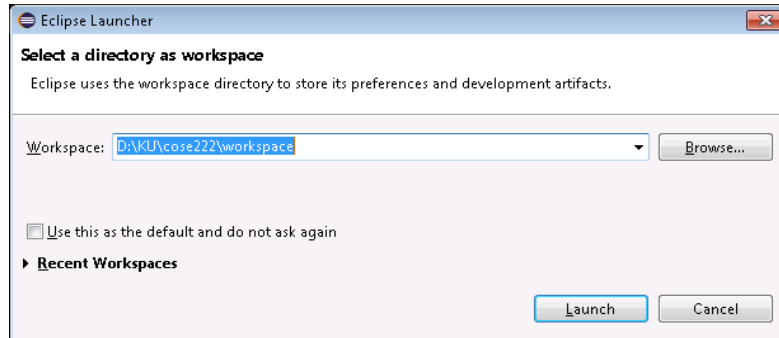


5. Download a simple C and a MIPS assembly code

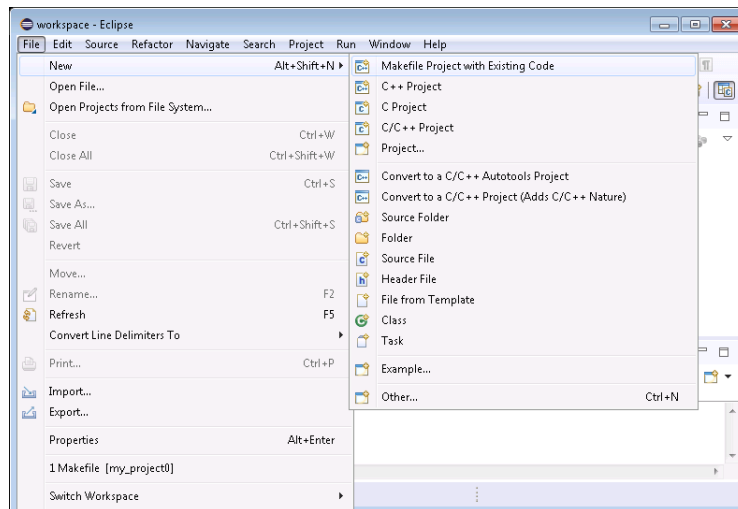
1. Download a simple C code and a sample MIPS assembly code from http://esca.korea.ac.kr/teaching/cose222_CA/hw-sw-tools/example.zip
2. Uncompress the code to a place where you want
 - In my case, I unzipped it to **D:\WKUWcose222WdemoWexample**

6. Cross-compiler MIPS code with Eclipse

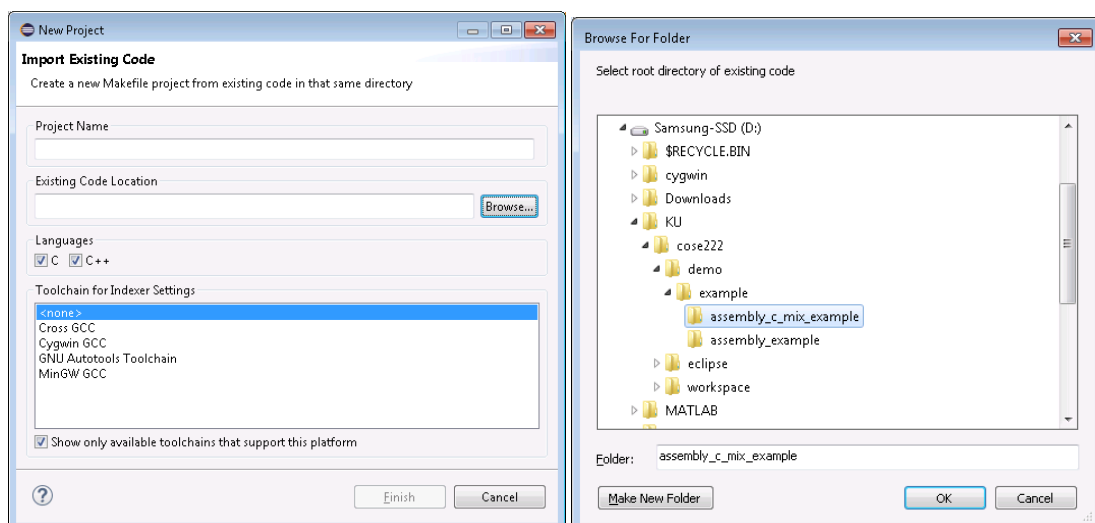
1. Double-click the Eclipse icon to invoke the tool
2. You can place a workspace anywhere you want
 - In my case, I created the workspace at **D:\WKU\cose222\workspace**

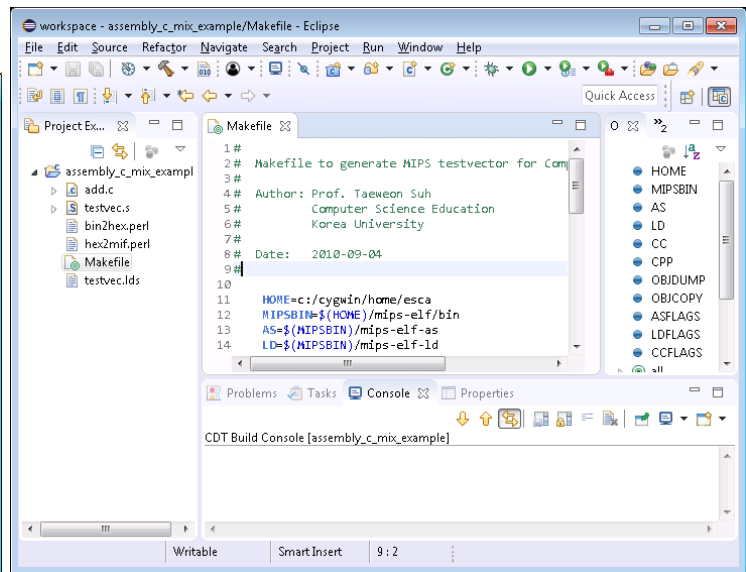
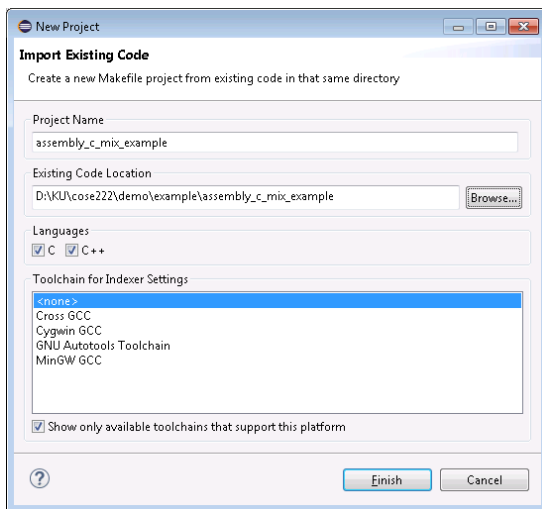


3. Create a new project by selecting **File** → **New** → **Makefile Project with Existing Code**



4. Click **Browse**, select **assembly_c_mix_example** from the downloaded code, and then press **finish**

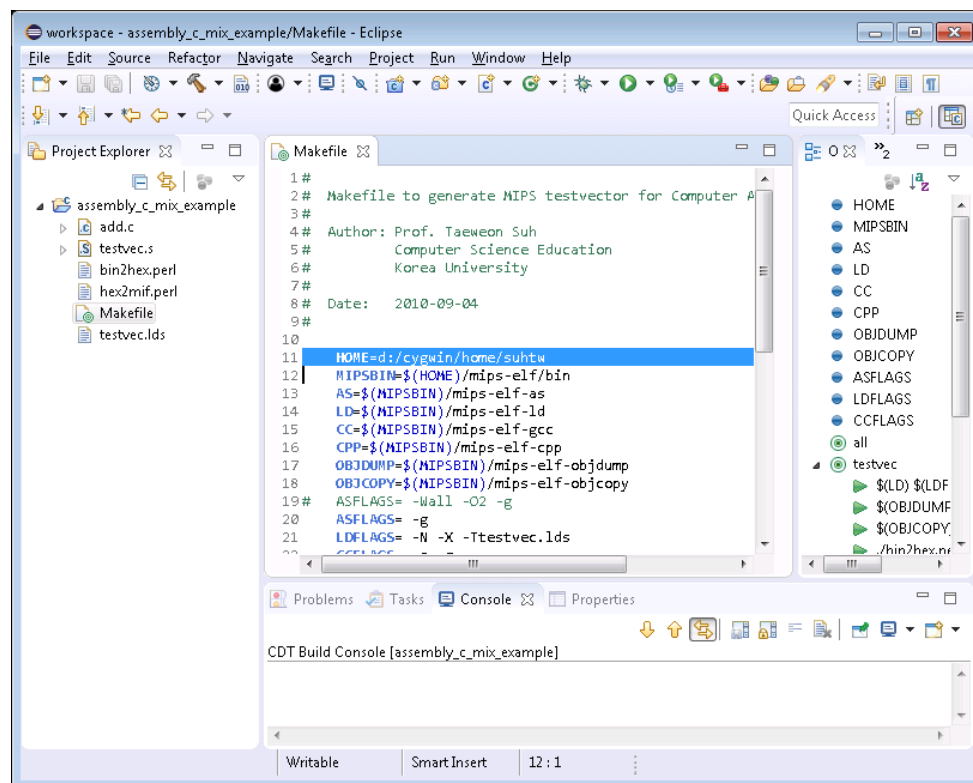




The created project has the following files.

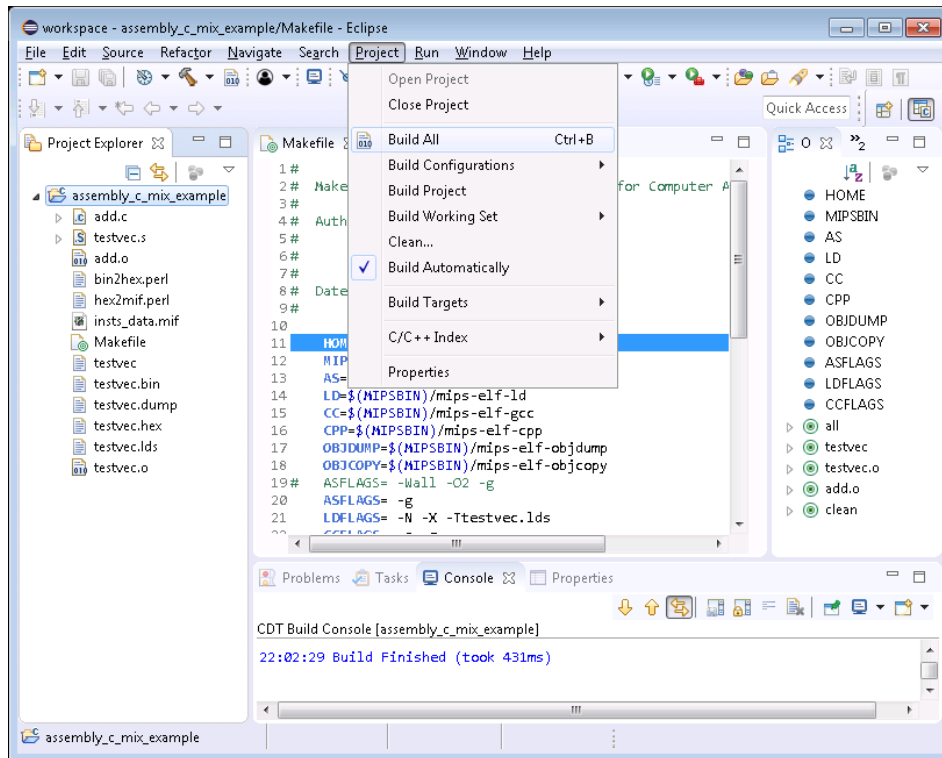
- Makefile // It contains the compilation steps
- testvec.s // MIPS assembly source code
- add.c // Super simple C code
- testvec.lds // linker script
- bin2hex.perl // perl script converting binary to hex format
- hex2mif.perl // perl script converting the hex to Altera FPGA memory-aware mif format

5. Change the HOME path in Makefile to the directory where you unzipped the cross-compiler



6. Compile the MIPS assembly code

- **Project** → **Build All**
- Check if you have the following files created
 - ✓ testvec: MIPS binary (executable)
 - ✓ testvec.dump: disassembled code of the executable
 - ✓ Insts_data.mif : instructions and data in hex to be placed in Altera FPGA memory



- Check out assembly and C source code
 - ✓ How does the assembly code call a C function?
- Check out the generated files
- Observe Makefile for the compilation steps