
CSCI 260

Homework 2 – Control

As mentioned in class, the only branch-related instructions you can use this semester are `beq`, `bne`, `j`, `slt`, and `slti`.

Background

For this homework, you wish to write a robotic arm controller. The controller has one arm and one motor for each of the five fingers (we will refer to the pinky as finger 0 and the thumb as finger 4, with others in order). Our hardware uses a scheme called memory-mapped I/O, whereby the hardware interprets accesses to particular memory locations as signals to the hardware device. In this case, the following I/O operations (and more) are supported:

- Initialize: write a 0 to memory location 0xABCD1230. This will also close all fingers completely.
- Ready: Every initialization operation must be followed by this (once) to ensure that the arm is ready to receive commands. The arm sets memory location 0xABCD1234 to at least 287 when it is ready to receive instructions. In other words, the program must wait for this location to become ≥ 287 .
- Open finger k by .01 radians: set bit k of memory location 0xABCD1238.

Due to mechanical issues, successive openings of the same finger must be separated by at least 4 ms., to avoid motor slippage.

Assignment

1. Draw a CFG and write a MIPS program to open the middle and index fingers thumb completely (*i.e.*, 3.14 radians). To ensure smooth motion, the program will open each arm by .01 radians at a time instead of opening one finger completely and then the next. Since we don't have a way to implement time delays, you can simply write `delay 4` to indicate a delay of 4 ms.

Submissions without a CFG will not be graded.

2. Consider a CPU needing 3 cycles for branch instructions, 4 cycles for `addi`, and 5 cycles for memory instructions. The clock rate is 2 GHz. Consider the following [abstracted] program:

```
    addi  $t2,$zero,m  # m is some immediate
L:    512 memory instructions (that don't affect $t2)
    addi  $t2,$t2,-1
    bne   $t2,$zero,L
```

- (a) Pick a value of m such that the above program has execution time $4+\epsilon$ ms.
- (b) Is this value of m realizable on the MIPS ISA? Explain.

Submission

Two sheets, same rules as usual.