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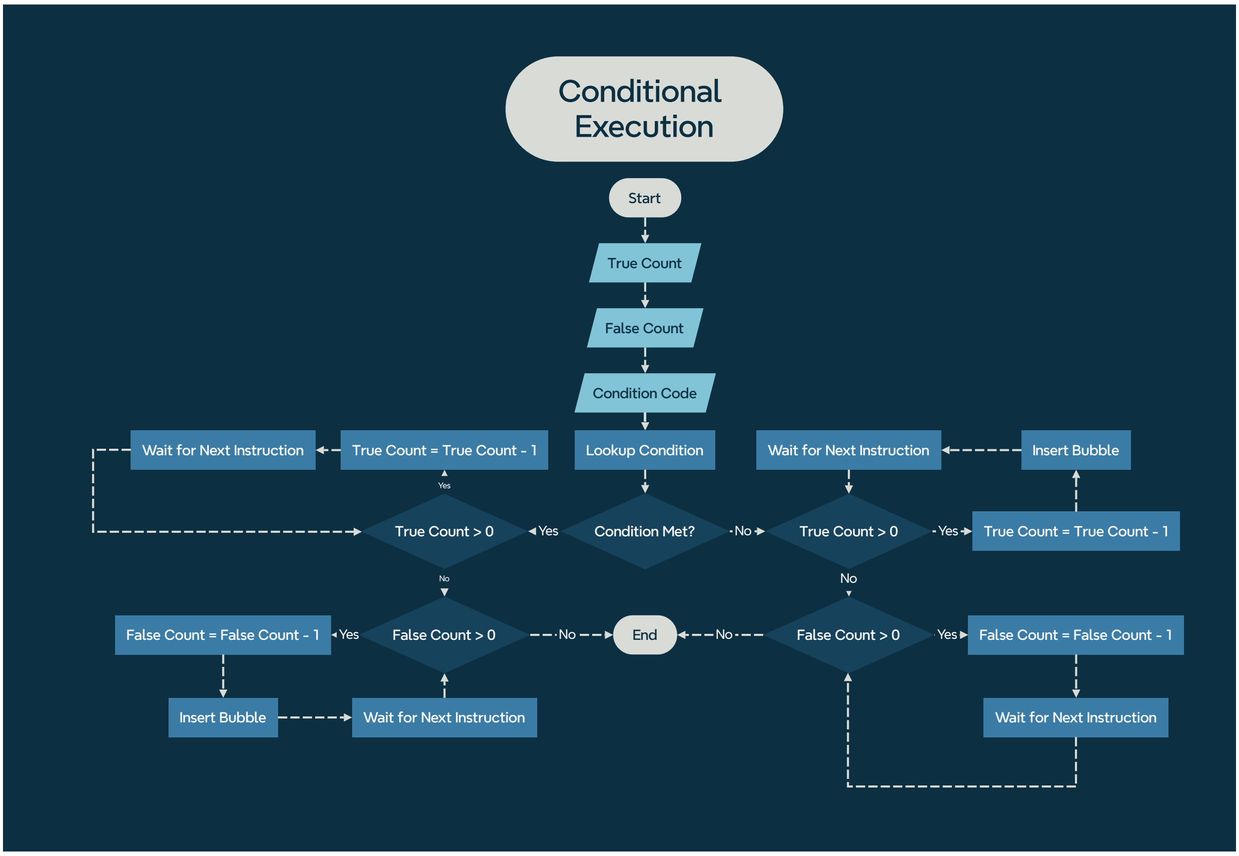
Assignment 5 - Conditional Execution

This assignment aims to implement conditional execution of instructions other than branches using the CEX instruction. This will allow the XM23P to execute conditional code in a way that is less expensive than branching.

Design

The design contains logic flowcharts detailing the conditional execution. A Data dictionary describing the instructions, PSW, and register file is also included.


Conditional Execution
Start
True Count
False Count
Condition Code
Wait for Next Instruction
True Count = True Count - 1
Lookup Condition
Wait for Next Instruction
Insert Bubble
Yes
True Count > 0
Yes
Condition Met?
No
True Count > 0
Yes
True Count = True Count - 1
No
No
False Count = False Count - 1
Yes
False Count > 0
No
End
No
False Count > 0
Yes
False Count = False Count - 1
Insert Bubble
Wait for Next Instruction
Wait for Next Instruction

Data Dictionary

```
IMEM            =   32*2^10{WORD}32*2^10
IMAR            =   ADDRESS
ICTRL           =   [READ|WRITE]
IMBR            =   WORD
IR              =   WORD
DMEM            =   64*2^10{BYTE}64*2^10
DMAR            =   ADDRESS
DCTRL           =   [READ|WRITE]
DMBR            =   WORD

REGFILE         =   3{WORD}3 + BP + LR + SP + PC
BP              =   WORD *Base Pointer*
LR              =   WORD *Link Register*
SP              =   WORD *Stack Pointer*
PC              =   WORD *Program Counter*

PSW             =   PRV_PRI + 4{DC}4 + FLT + CUR_PRI + V + SLP + N + Z + C
PRV_PRI         =   3{BIT}3 *Previous Priority*
DC              =   BIT     *Don't Care*
FLT             =   BIT     *Fault*
CUR_PRI         =   3{BIT}3 *Current Priority*
V               =   BIT     *Arithmetic overflow*
SLP             =   BIT     *Sleep State*
N               =   BIT     *Negative Result*
Z               =   BIT     *Zero Result*
C               =   BIT     *Carry*

START_ADDRESS   =   ADDRESS

INSTRUCTION     =   CODE + 1{PARAMETER}4
CODE            =   [0-20] *Contiguous encoding of instructions*
PARAMETER       =
[RC|WB|SOURCE|DESTINATION|BYTE|T_COUNT|F_COUNT|CONDITION_CODE]

RC              =   BIT
WB              =   BIT
SOURCE          =   3{BIT}3
DESTINATION     =   3{BIT}3

T_COUNT         =   [0-7]          *Number of instructions to execute if
condition is true*
F_COUNT         =   [0-7]          *Number of instructions to execute if
condition is false*
CONDITION_CODE  =   [#0000 - #1111] *Corresponds to execution condition*

ADDRESS         =   WORD
WORD            =   2{BYTE}2
BYTE            =   8{BIT}8
BIT             =   [0|1]
```

Testing

The following tests were implemented:

- Test 38: True Condition
- Test 39: False Condition
- Test 40: No True False
- Test 41: Branch

Each test may be run from a powershell terminal with the following command:

```
Get-Content '.\Path\To\Input\File' | '.\Path\To\Executable'
```

Test 38: True Condition

Purpose

Verify that the correct instructions are executed when the condition is true.

Configuration

.\tests\Execute_Tests\Input_Files\Test38.in

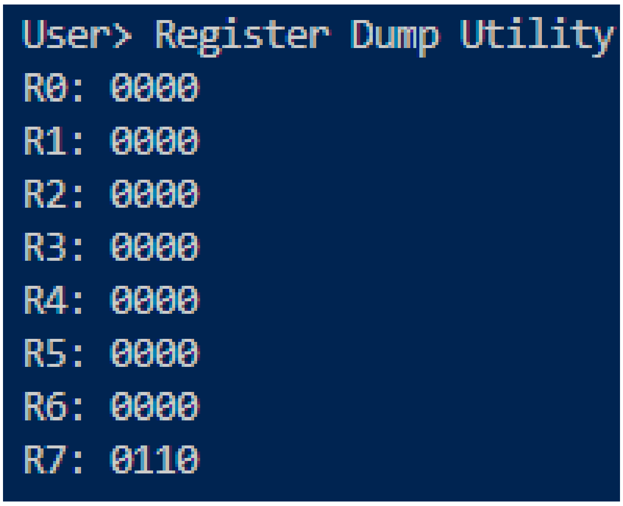
1. Test38_True_Condition.xme was loaded into the emulator.
2. `b 10a` was entered to set a breakpoint at address `#010a`
3. `d` was entered to enabled Debug Mode
4. `g` was entered to run the program
5. `r` was entered to dump the registers.

Expected Results

`R0` and `R1` should both be incremented to `#0000`.
Values of `#FFFF` and `FFFE` indicate incorrect conditional execution.

Results

The register contents correctly matched:



```
User> Register Dump Utility
R0: 0000
R1: 0000
R2: 0000
R3: 0000
R4: 0000
R5: 0000
R6: 0000
R7: 0110
```

Pass/Fail

Pass.

Test 39: False Condition

Purpose

Verify that the correct instructions are executed when the condition is false.

Configuration

.\tests\Execute_Tests\Input_Files\Test39.in

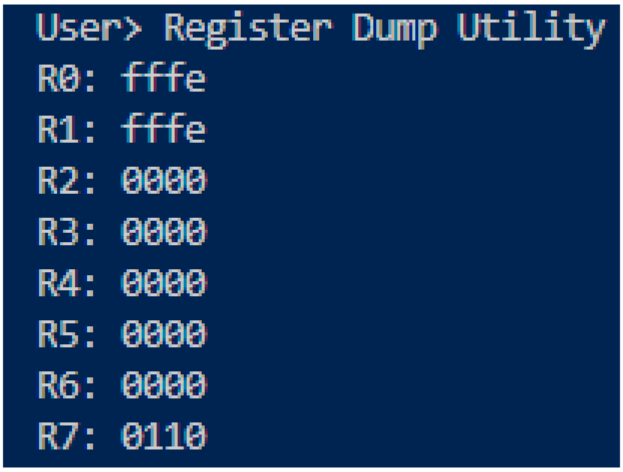
1. Test39_False_Condition.xme was loaded into the emulator.
2. `b 10a` was entered to set a breakpoint at address `#010a`
3. `d` was entered to enabled Debug Mode
4. `g` was entered to run the program
5. `r` was entered to dump the registers.

Expected Results

`R0` and `R1` should both be incremented to `#FFFE`.
Values of `#FFFF` and `0000` indicate incorrect conditional execution.

Results

The register contents correctly matched:



```
User> Register Dump Utility
R0: fffe
R1: fffe
R2: 0000
R3: 0000
R4: 0000
R5: 0000
R6: 0000
R7: 0110
```

Pass/Fail

Pass.

Test 40: No True False

Purpose

Ensure that control passes to the next instruction without bubbling if both True and False counts are zero.

Configuration

.\tests\Execute_Tests\Input_Files\Test40.in

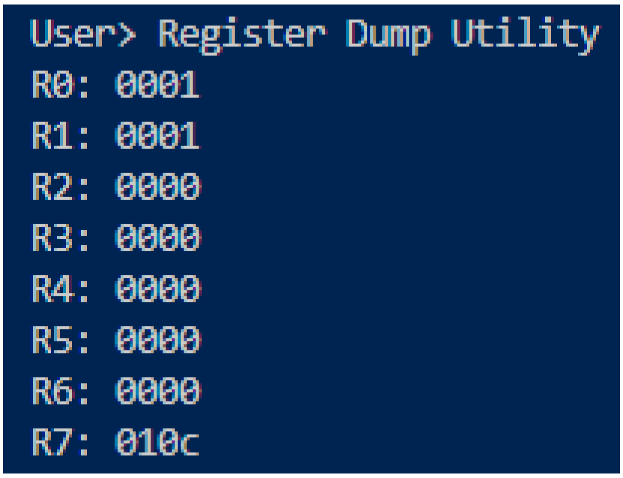
1. Test40_No_True_False.xme was loaded into the emulator.
2. `b 10c` was entered to set a breakpoint at address `#010c`
3. `d` was entered to enabled Debug Mode
4. `g` was entered to run the program
5. `r` was entered to dump the registers.

Expected Results

Registers `R0` and `R1` should both contain `#0001`.

Results

The register contents correctly matched:



```
User> Register Dump Utility
R0: 0001
R1: 0001
R2: 0000
R3: 0000
R4: 0000
R5: 0000
R6: 0000
R7: 010c
```

Pass/Fail

Pass.

Test 41: Branch

Purpose

Ensure the conditional execution state is reset whenever a branch is taken.

Configuration

.\tests\Execute_Tests\Input_Files\Test41.in

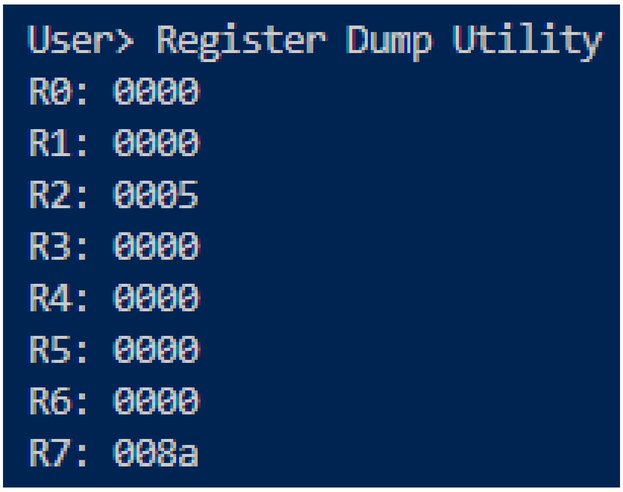
1. Test41_CEX_Branch.xme was loaded into the emulator.
2. `b 8a` was entered to set a breakpoint at address `#008a`
3. `d` was entered to enabled Debug Mode
4. `g` was entered to run the program
5. `r` was entered to dump the registers.

Expected Results

`R2` should contain `#0005`.
If `R0` holds a value other than `#0000` an issue occurred with the conditional execution.

Results

The register contents correctly matched:



```
User> Register Dump Utility
R0: 0000
R1: 0000
R2: 0005
R3: 0000
R4: 0000
R5: 0000
R6: 0000
R7: 008a
```

Pass/Fail

Pass.