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LAB 11(2)

Assignment 4:

Mã nguồn:

```
# Assignment 4
.eqv IN_ADRESS_HEXA_KEYBOARD 0xFFFF0012
.eqv OUT_ADRESS_HEXA_KEYBOARD 0xFFFF0014
.eqv COUNTER 0xFFFF0013 # Time Counter
.eqv MASK_CAUSE_COUNTER 0x00000400 # Bit 10: Counter interrupt
.eqv MASK_CAUSE_KEYMATRIX 0x00000800 # Bit 11: Key matrix interrupt
.data
	msg_keypress: .asciiz "Someone has pressed a key: "
	msg_counter: .asciiz "Time inteval "
	msg_counter_endl: .asciiz "\n"
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# MAIN Procedure
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
.text
li $s7, 1
main:
 #-----------------------------------------------------------
 # Enable interrupts you expect
 #-----------------------------------------------------------
 # Enable the interrupt of Keyboard matrix 4x4 of Digital Lab Sim
	li $t1, IN_ADRESS_HEXA_KEYBOARD
	li $t3, 0x80 # bit 7 = 1 to enable
	sb $t3, 0($t1)
# Enable the interrupt of TimeCounter of Digital Lab Sim
	li $t1, COUNTER
	sb $t1, 0($t1)
 #-----------------------------------------------------------
 # Loop an print sequence number
 #-----------------------------------------------------------
Loop:
	nop
	nop
	nop
sleep:
	addi $v0,$zero,32 # BUG: must sleep to wait for Time Counter
	li $a0,200 # sleep 300 ms
	syscall
	nop # WARNING: nop is mandatory here.
	b Loop
end_main:
```

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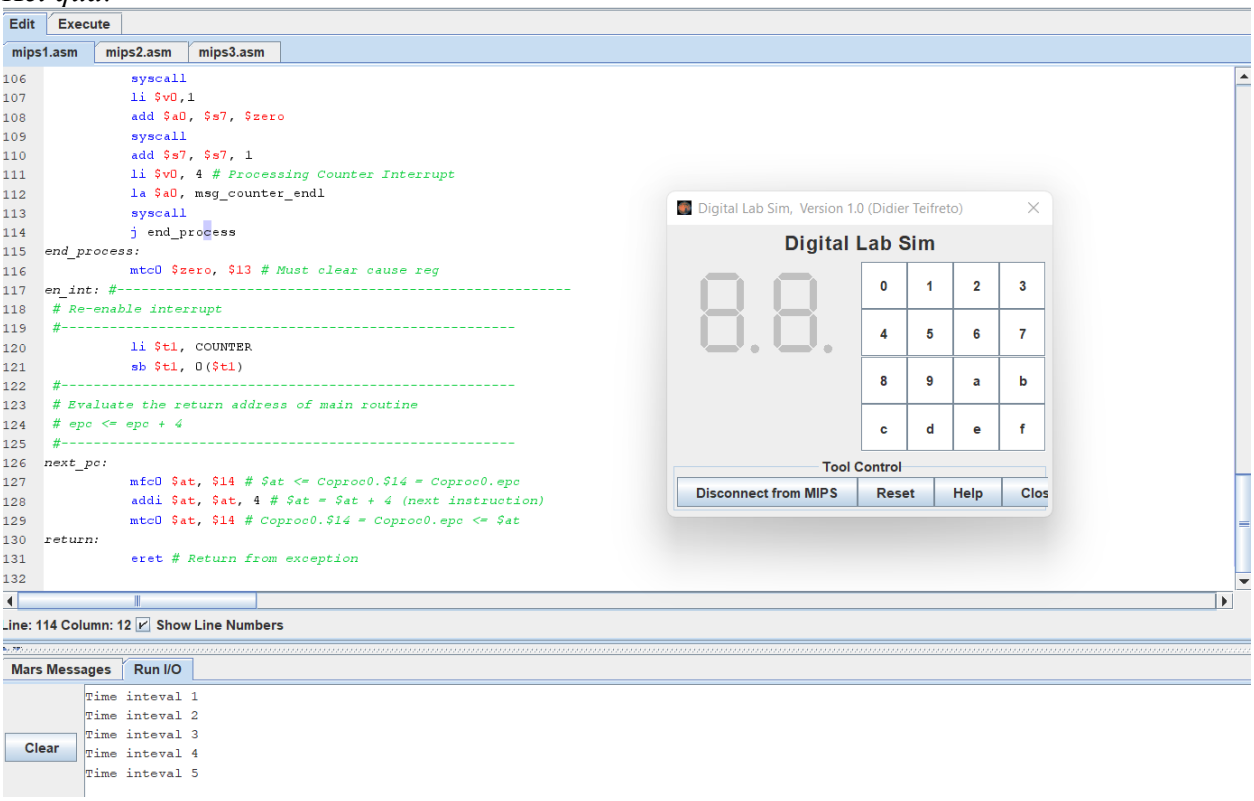
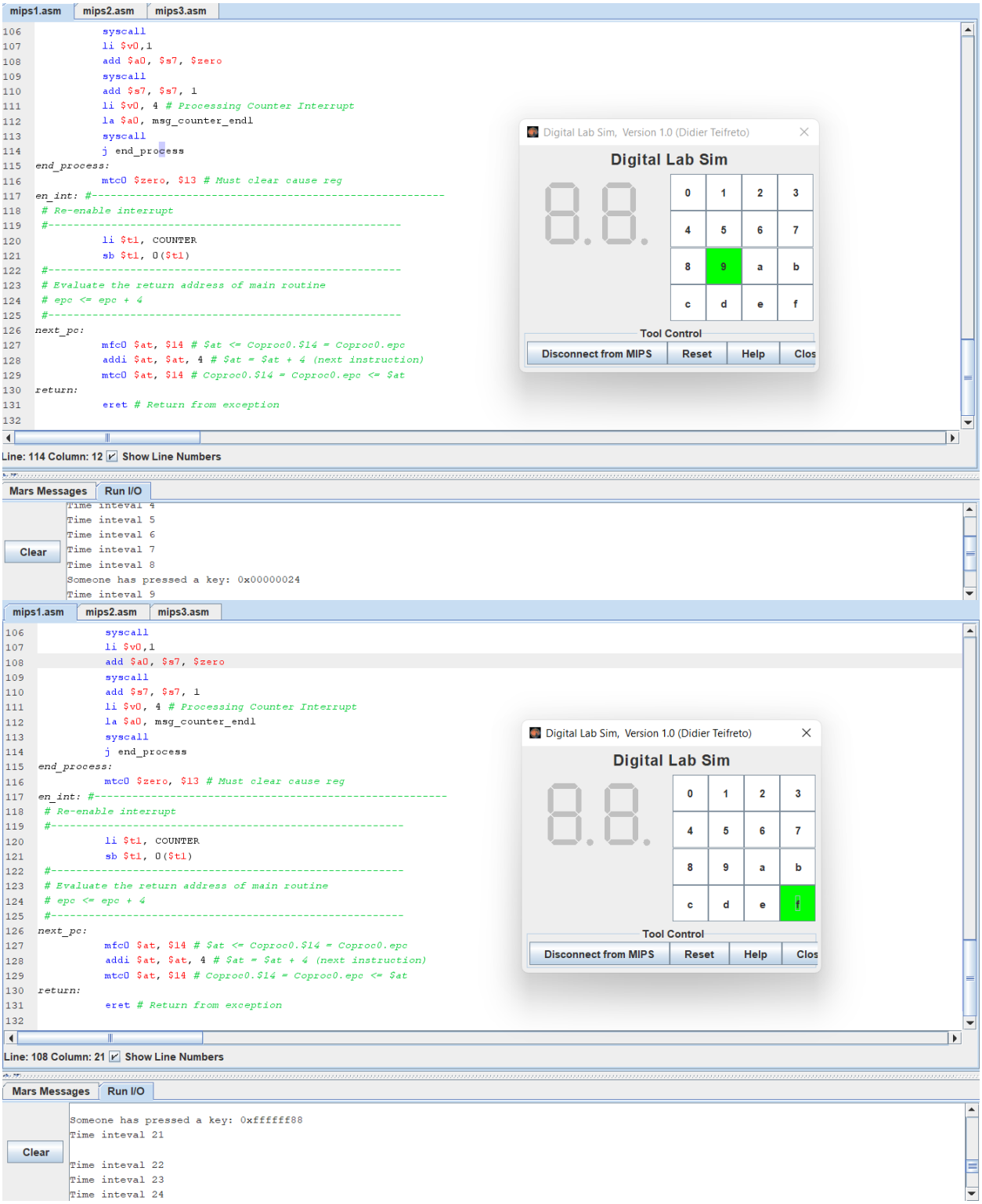
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# GENERAL INTERRUPT SERVED ROUTINE for all interrupts
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
.ktext 0x80000180
IntSR: #-----------------------------------------------------
 # Temporary disable interrupt
 #-----------------------------------------------------
dis_int:
        li $t1, COUNTER # BUG: must disable with Time Counter
        sb $zero, 0($t1)
 # no need to disable keyboard matrix interrupt
 #-----------------------------------------------------
 # Processing
 #-----------------------------------------------------
get_caus:
        mfc0 $t1, $13 # $t1 = Coproc0.cause
IsCount:
        li $t2, MASK_CAUSE_COUNTER# if Cause value confirm Counter..
        and $at, $t1,$t2
        beq $at,$t2, Counter_Intr
IsKeyMa:
        li $t2, MASK_CAUSE_KEYMATRIX # if Cause value confirm Key..
        and $at, $t1,$t2
        beq $at,$t2, Keymatrix_Intr
others:
        j end_process # other cases
Keymatrix_Intr:
        li $v0, 4 # Processing Key Matrix Interrupt
        la $a0, msg_keypress
        syscall
        li $t1, IN_ADRESS_HEXA_KEYBOARD
        li $t2, OUT_ADRESS_HEXA_KEYBOARD
inter_1:
        li $t3, 0x81 # check row 1 with key 0, 1, 2, 4
        sb $t3, 0($t1) # must reassign expected row
        jal inter
inter_2:
        li $t3, 0x82 # check row 2 with key 4, 5, 6, 7
        sb $t3, 0($t1) # must reassign expected row
        jal inter
inter_3:
        li $t3, 0x84 # check row 3 with key 8, 9, A, B
        sb $t3, 0($t1) # must reassign expected row
        jal inter
inter_4:
        li $t3, 0x88 # check row 4 with key C, D, E, F
```

```
        sb $t3, 0($t1) # must reassign expected row
        jal inter
after_inter_4:
        beq $a0, 0x0, prn_cod
        j next_pc
inter:
        lb $a0, 0($t2) # read scan code of key button
        bne $a0, 0x0, prn_cod
        jr $ra
prn_cod:
        li $v0,34
        syscall
        li $v0,11
        li $a0,'\n' # print endofline
        syscall
j end_process
Counter_Intr:
        li $v0, 4 # Processing Counter Interrupt
        la $a0, msg_counter
        syscall
        li $v0,1
        add $a0, $s7, $zero
        syscall
        add $s7, $s7, 1
        li $v0, 4 # Processing Counter Interrupt
        la $a0, msg_counter_endl
        syscall
        j end_process
end_process:
        mtc0 $zero, $13 # Must clear cause reg
en_int: #-----------------------------------------------------
 # Re-enable interrupt
 #-----------------------------------------------------
        li $t1, COUNTER
        sb $t1, 0($t1)
 #-----------------------------------------------------
 # Evaluate the return address of main routine
 # epc <= epc + 4
 #-----------------------------------------------------
next_pc:
        mfc0 $at, $14 # $at <= Coproc0.$14 = Coproc0.epc
        addi $at, $at, 4 # $at = $at + 4 (next instruction)
        mtc0 $at, $14 # Coproc0.$14 = Coproc0.epc <= $at
return:
        eret # Return from exception
```

Kết quả:


Edit
Execute
mips1.asm
mips2.asm
mips3.asm
syscall
li $v0,1
add $a0, $s7, $zero
syscall
add $s7, $s7, 1
li $v0, 4 # Processing Counter Interrupt
la $a0, msg_counter_endl
syscall
j end_process
end_process:
mtc0 $zero, $13 # Must clear cause reg
en_int: #
Re-enable interrupt
#
li $t1, COUNTER
sb $t1, 0($t1)
#
Evaluate the return address of main routine
epc <= epc + 4
#
next_pc:
mfc0 $at, $14 # $at <= Coproc0.$14 = Coproc0.epc
addi $at, $at, 4 # $at = $at + 4 (next instruction)
mtc0 $at, $14 # Coproc0.$14 = Coproc0.epc <= $at
return:
eret # Return from exception
Digital Lab Sim, Version 1.0 (Didier Teifreto)
Digital Lab Sim
0 1 2 3
4 5 6 7
8 9 a b
c d e f
Tool Control
Disconnect from MIPS
Reset
Help
Clos
Line: 114 Column: 12
Show Line Numbers
Mars Messages
Run I/O
Clear
Time inteval 1
Time inteval 2
Time inteval 3
Time inteval 4
Time inteval 5



- *Giải thích:*
  - Khi đang thực hiện vòng lặp mà có tín hiệu nhấn từ ma trận Lab Sim hoặc Khoảng thời gian lập tới giới hạn thì Chương trình sẽ thực hiện ngắt.

- Đầu tiên chương trình thực hiện so sánh và tìm ra nguyên nhân ngắt, nếu là vượt quá thời gian lặp thì sẽ in ra message còn nếu là tín hiệu nhấn từ Lab Sim thì sẽ in ra ký tự được nhấn (hệ cơ số 16).

Assignment 5:

Mã nguồn:

```
# Assignment 5
.eqv KEY_CODE 0xFFFF0004 # ASCII code from keyboard, 1 byte
.eqv KEY_READY 0xFFFF0000 # =1 if has a new keycode ?
 # Auto clear after lw
.eqv DISPLAY_CODE 0xFFFF000C # ASCII code to show, 1 byte
.eqv DISPLAY_READY 0xFFFF0008 # =1 if the display has already to do
 # Auto clear after sw
.eqv MASK_CAUSE_KEYBOARD 0x0000034 # Keyboard Cause
.text
        li $k0, KEY_CODE
        li $k1, KEY_READY

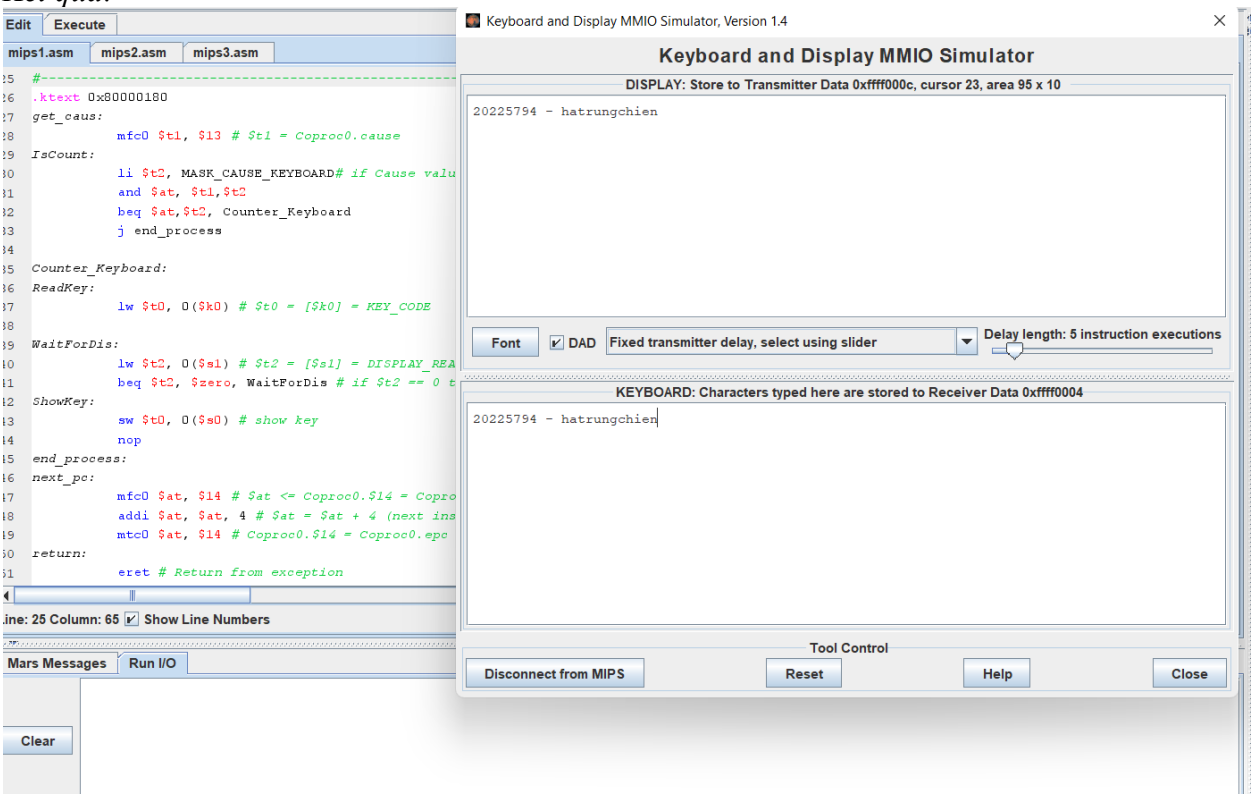
        li $s0, DISPLAY_CODE
        li $s1, DISPLAY_READY
loop:
        nop
WaitForKey:
        lw $t1, 0($k1) # $t1 = [$k1] = KEY_READY
        beq $t1, $zero, WaitForKey # if $t1 == 0 then Polling
MakeIntR:
        teqi $t1, 1 # if $t1 = 1 then raise an Interrupt
        j loop
#---------------------------------------------------------------
# Interrupt subroutine
#---------------------------------------------------------------
.ktext 0x80000180
get_caus:
        mfc0 $t1, $13 # $t1 = Coproc0.cause
IsCount:
        li $t2, MASK_CAUSE_KEYBOARD# if Cause value confirm Keyboard..
        and $at, $t1,$t2
        beq $at,$t2, Counter_Keyboard
        j end_process

Counter_Keyboard:
ReadKey:
        lw $t0, 0($k0) # $t0 = [$k0] = KEY_CODE

WaitForDis:
        lw $t2, 0($s1) # $t2 = [$s1] = DISPLAY_READY
        beq $t2, $zero, WaitForDis # if $t2 == 0 then Polling
```

```
ShowKey:
        sw $t0, 0($s0) # show key
        nop
end_process:
next_pc:
        mfc0 $at, $14 # $at <= Coproc0.$14 = Coproc0.epc
        addi $at, $at, 4 # $at = $at + 4 (next instruction)
        mtc0 $at, $14 # Coproc0.$14 = Coproc0.epc <= $at
return:
        eret # Return from exception
```

Kết quả:



- Giải thích:

Ngắt mềm được thực thi khi có một phím bất kỳ được nhấn.

- Dòng lệnh 17 -> 21 thực hiện điều này
- Khi mà có một phím được nhập vào từ KEYBOARD thì biến t1 sẽ bằng 1 (KEY_READY đã sẵn sàng)
- Mà câu lệnh dòng 21 " teqi $t1, 1 ": tức là khi biến t1 = 1 thì ngắt mềm sẽ được thực thi