Võ Anh Khôi 20225870 week13

Bài 4

```
.eqv  IN_ADRESS_HEXA_KEYBOARD      0xFFFF0012
.eqv  COUNTER                      0xFFFF0013       # Time Counter
 .eqv OUT_ADRESS_HEXA_KEYBOARD     0xFFFF0014
.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 code: "
msg_counter: .asciiz "Time inteval!\n"

#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# MAIN Procedure
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
.text
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 numbers
    #---------------------------------------------------------
Loop:  nop
    nop
    nop
sleep:  addi   $v0,$zero,32   # BUG: must sleep to wait for Time Counter
    li    $a0,400      # sleep 300 ms
    syscall
    nop              # WARNING: nop is mandatory here.
    b     Loop
end_main:

#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# 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
```

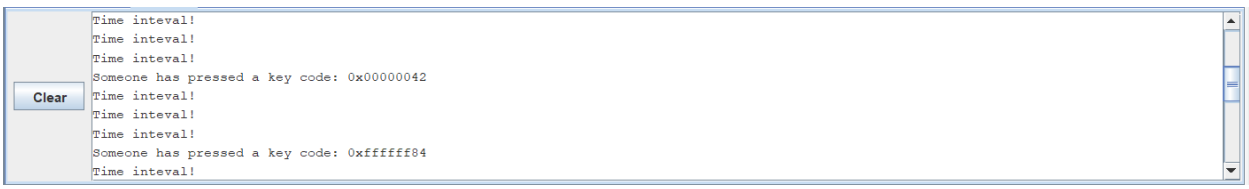
```
    #---------------------------------------------------------
    # Processing
    #---------------------------------------------------------
get_caus:mfc0  $t1, $13          # $t1 = Coproc0.cause
IsCount:li   $t2, MASK_CAUSE_COUNTER# if Cause value confirm Counter..
    and  $at, $t1,$t2
    beq  $at,$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
    get_cod:



    li    $t1,  IN_ADRESS_HEXA_KEYBOARD
    li    $t3,  0x82   # check row 4 and re-enable bit 7
    sb    $t3,  0($t1)   # must reassign expected row
    li    $t1,  OUT_ADRESS_HEXA_KEYBOARD
    lb    $a0,  0($t1)
    bne  $a0, $zero, prn_cod

    li    $t1,  IN_ADRESS_HEXA_KEYBOARD
```

```
    li    $t3,  0x84    # check row 4 and re-enable bit 7
    sb    $t3,  0($t1)  # must reassign expected row
    li    $t1,  OUT_ADRESS_HEXA_KEYBOARD
    lb    $a0,  0($t1)
    bne  $a0, $zero, prn_cod

        li    $t1,  IN_ADRESS_HEXA_KEYBOARD
    li    $t3,  0x88    # check row 4 and re-enable bit 7
    sb    $t3,  0($t1)  # must reassign expected row
    li    $t1,  OUT_ADRESS_HEXA_KEYBOARD
    lb    $a0,  0($t1)
    bne  $a0, $zero, prn_cod

    li    $t1,  IN_ADRESS_HEXA_KEYBOARD
    li    $t3,  0x81    # check row 4 and re-enable bit 7
    sb    $t3,  0($t1)  # must reassign expected row
    li    $t1,  OUT_ADRESS_HEXA_KEYBOARD
    lb    $a0,  0($t1)
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
    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 khi chạy chương trình

Bấm các nút với 6 và b thì kết quả thu được



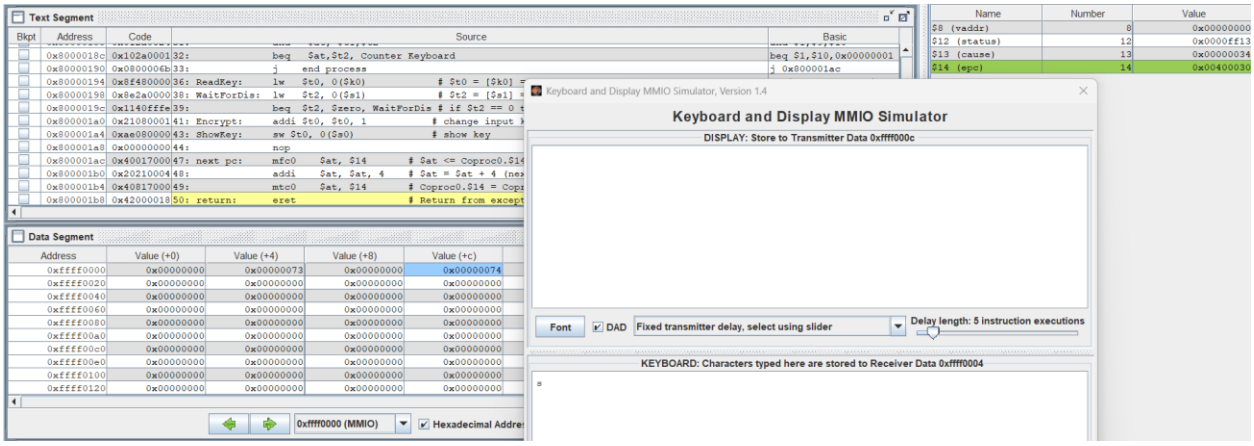
Khi bấm vào digital lab sim và chạy thì nếu không bấm nút nào sau 1 khoảng thời gian qui định sẽ hiện chữ time interval hoặc nếu có bấm 1 nút nào đó thì sẽ hiện dòng someone has pressed a key code : và sau đó đọc code của nút đã bấm

Bài 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 $t0 = 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

Encrypt:     addi $t0, $t0, 1         # change input key

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



Sau khi chạy chương trình thì chương trình nhận được interrupt từ bàn phím được hiện ở $13 là 0x34, kí tự được nhập và lưu ở địa chỉ 0xffff4004 mã 0x73 là kí tự ‘s’ sau đó ký tự được encrypt lưu ở địa chỉ 0xffff400c mã 0x74 là kí tự ‘t’ sau đó $14 trả về địa chỉ trước khi interrupt và tiếp tục chạy chương trình