Báo cáo thực hành KTMT tuần 11

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Assignment 1

1. Code

```
.eqv IN_ADRESS_HEXA_KEYBOARD 0xFFFF0012
# receive row and column of the key pressed, 0 if not key pressed
# Eg. equal 0x11, means that key button 0 pressed.
# Eg. equal 0x28, means that key button D pressed.
.eqv OUT_ADRESS_HEXA_KEYBOARD 0xFFFF0014
.data
        nl: .asciiz “\n”
.text
main:
        li      $t1, IN_ADRESS_HEXA_KEYBOARD
        li      $t2, OUT_ADRESS_HEXA_KEYBOARD
        li      $t3, 0x01 # check row 4 with key C, D,E, F
        li      $t4, 0x02 # check row 4 with key C, D,E, F
        li      $t5, 0x04 # check row 4 with key C, D,E, F
        li      $t6, 0x08 # check row 4 with key C, D,E, F
        li      $t0, 0
polling:
        beq     $t0, 100, exit
        sb      $t3, 0($t1 ) # must reassign expected row
        lb      $a0, 0($t2) # read scan code of key button
        bne     $a0, $zero, print
```

```
        sb      $t4, 0($t1 ) # must reassign expected row
        lb      $a0, 0($t2) # read scan code of key button
        bne     $a0, $zero, print

        sb      $t5, 0($t1 ) # must reassign expected row
        lb      $a0, 0($t2) # read scan code of key button
        bne     $a0, $zero, print

        sb      $t6, 0($t1 ) # must reassign expected row
        lb      $a0, 0($t2) # read scan code of key button
        bne     $a0, $zero, print

        j       continue

print:
        li      $v0, 34 # print integer (hexa)
        syscall

        la      $a0, nl
        li      $v0, 4
        syscall
continue:
        addi    $t0, $t0, 1

sleep:
        li      $a0, 3000    # sleep 3s
        li      $v0, 32
        syscall
```

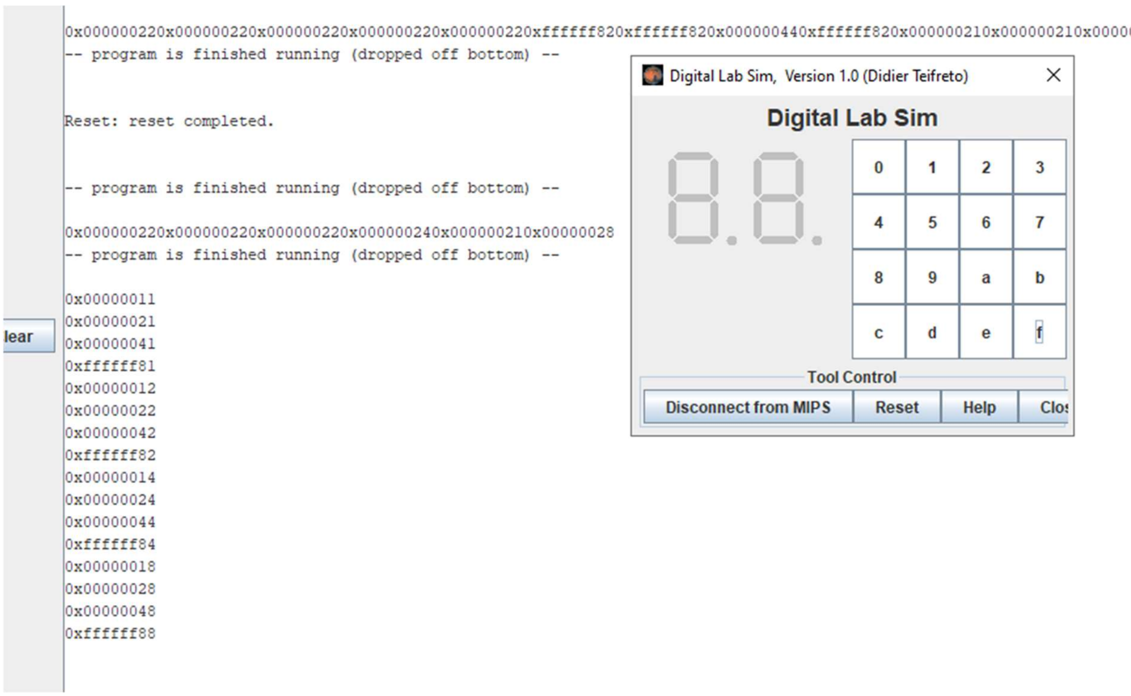
back_to_polling:

j polling # continue polling

exit:

2. Kết quả chạy

Nhập lần lượt từ nút 0 đến nút f, kết quả sẽ như thế này:



Kết quả là cột 16 số hexa ở dưới cùng tương ứng với 16 phím được bấm

Assignment 2

1. Code

.eqv IN_ADRESS_HEXA_KEYBOARD 0xFFFF0012

.data

Message: .asciiz "Canh bao! Co nguoi nao do da bam nhung nut nay!.\n"

#~~~~~~

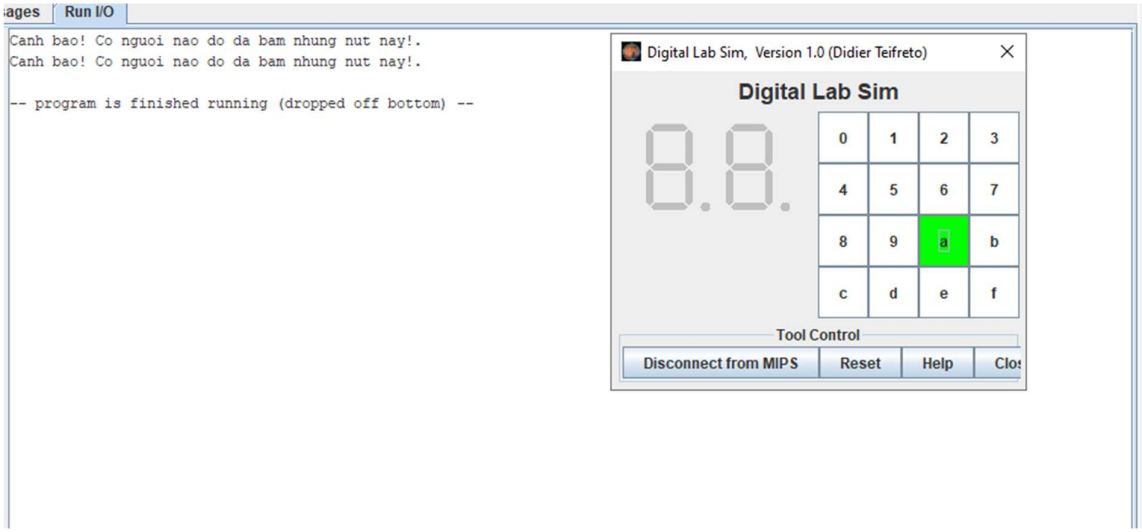
MAIN Procedure

#~~~~~~

```
.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 of = 1 to enable interrupt
        sb      $t3, 0($t1)
#---------------------------------------------------
# No-end loop, main program, to demo the effective of interrupt
#---------------------------------------------------
Loop:
        nop
        nop
        nop
        nop
        b       Loop          # Wait for interrupt
end_main:
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# GENERAL INTERRUPT SERVED ROUTINE for all interrupts
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~~~~~~~~~~~~~~~~~
.ktext 0x80000180
#---------------------------------------------------
# Processing
#---------------------------------------------------
IntSR:
```

```
        addi   $v0, $zero, 4              # show message
        la     $a0, Message
        syscall
#---------------------------------------------------
# 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
```

2. **Kết quả chạy**



Assignment 3

1. **Code**

```
.eqv IN_ADRESS_HEXA_KEYBOARD 0xFFFF0012
.eqv OUT_ADRESS_HEXA_KEYBOARD 0xFFFF0014
.data
```

```
Message: .asciiz "Key scan code "
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# 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)
#-----------------------------------------------------------
# Loop an print sequence numbers
#-----------------------------------------------------------
        xor     $s0, $s0, $s0               # count = $s0 = 0
Loop:
        addi    $s0, $s0, 1         # count = count + 1
prn_seq:
        addi    $v0,$zero,1
        add     $a0,$s0,$zero               # print auto sequence number
        syscall
prn_eol:
        addi    $v0,$zero,11
        li      $a0,'\n'            # print endofline
        syscall
```

```
sleep:
        addi   $v0,$zero,32
        li     $a0,500                  # sleep 0,5 s
        syscall
        nop                         # WARNING: nop is mandatory here.
        b Loop                           # Loop
end_main:
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# GENERAL INTERRUPT SERVED ROUTINE for all interrupts
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
.ktext 0x80000180
#---------------------------------------------------
# SAVE the current REG FILE to stack
#---------------------------------------------------
IntSR:
        addi   $sp,$sp,4     # Save $ra because we may change it later
        sw     $ra,0($sp)
        addi   $sp,$sp,4     # Save $at because we may change it later
        sw     $at,0($sp)
        addi   $sp,$sp,4     # Save $sp because we may change it later
        sw     $v0,0($sp)
        addi   $sp,$sp,4     # Save $a0 because we may change it later
        sw     $a0,0($sp)
        addi   $sp,$sp,4     # Save $t1 because we may change it later
        sw     $t1,0($sp)
        addi   $sp,$sp,4     # Save $t3 because we may change it later
        sw     $t3,0($sp)
```

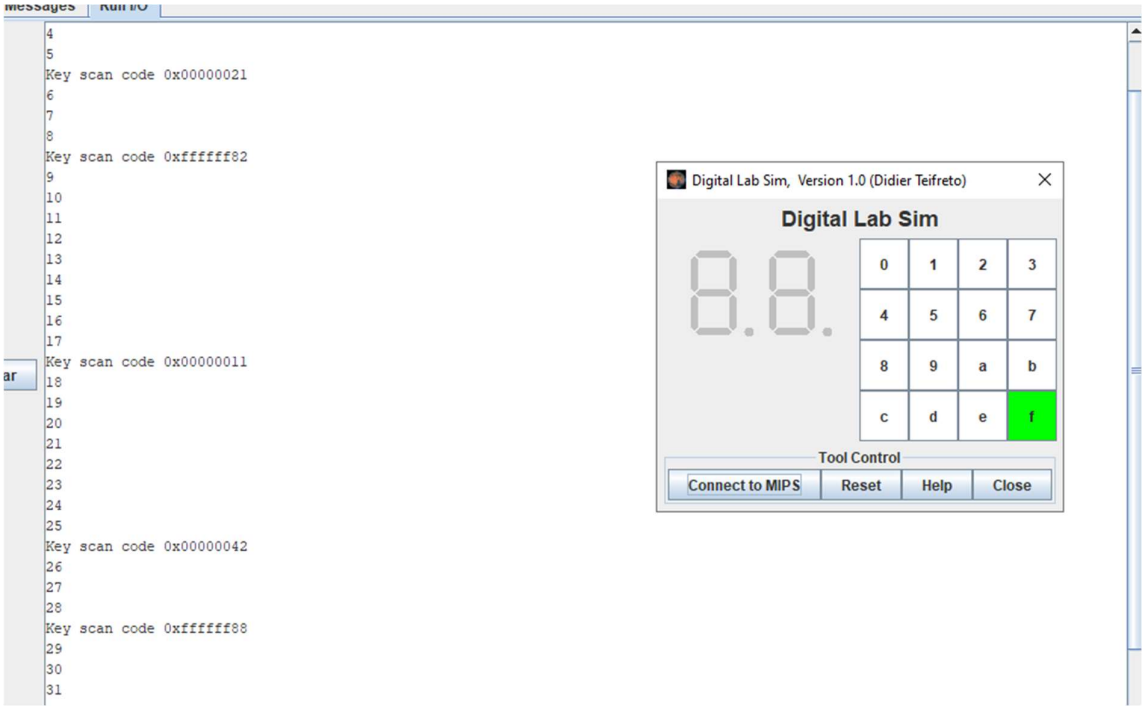
```
#---------------------------------------------------
# Processing
#---------------------------------------------------
prn_msg:
        addi   $v0, $zero, 4
        la     $a0, Message
        syscall
get_cod:
        li     $t1, IN_ADRESS_HEXA_KEYBOARD
        li     $t3, 0x81     # check row 4 and re-enable bit 7
        sb     $t3, 0($t1)   # must reassign expected row
        li     $t1, OUT_ADRESS_HEXA_KEYBOARD
        lb     $a0, 0($t1)
        bne    $a0, $zero, prn_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



prn_cod:
        li      $v0,34
        syscall
        li      $v0,11
        li      $a0,'\n'      # print endofline
        syscall
#-----------------------------------------------------
# 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
#-----------------------------------------------------
# RESTORE the REG FILE from STACK
#-----------------------------------------------------
restore:
        lw      $t3, 0($sp)  # Restore the registers from stack
```

```
        addi   $sp,$sp,-4
        lw     $t1, 0($sp)  # Restore the registers from stack
        addi   $sp,$sp,-4
        lw     $a0, 0($sp) # Restore the registers from stack
        addi   $sp,$sp,-4
        lw     $v0, 0($sp) # Restore the registers from stack
        addi   $sp,$sp,-4
        lw     $ra, 0($sp)  # Restore the registers from stack
        addi   $sp,$sp,-4
        lw     $ra, 0($sp)  # Restore the registers from stack
        addi   $sp,$sp,-4
return:
        eret                # Return from exception
```

2. Kết quả chạy

Nhập lần lượt phim 1, 7, 0, 6, f. Kết quả sẽ như thế này:



Assignment 4

1. Code

```
 .eqv IN_ADRESS_HEXA_KEYBOARD 0xFFFF0012
.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 "Ai do da bam cac nut nay!\n"
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
```

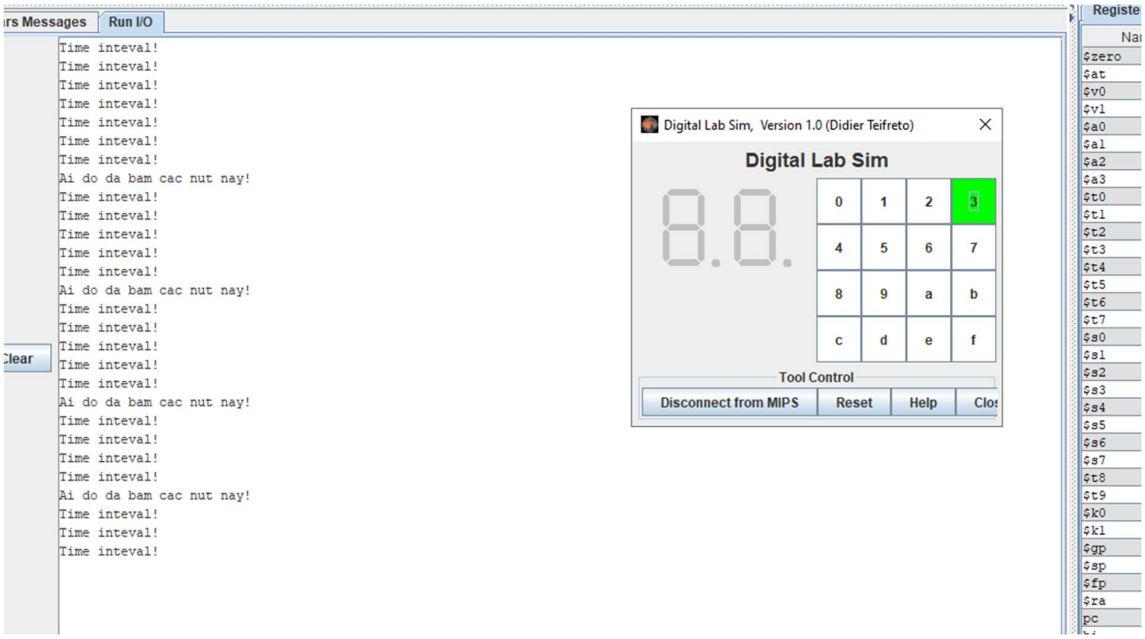
```
        nop
        nop
sleep:
        addi   $v0,$zero,32        # BUG: must sleep to wait for Time Counter
        li       $a0, 400              # sleep 0,4s
        syscall
        nop                  # WARNING: nop is mandatory here.
        b       Loop
end_main:
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# 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
        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
```

2. Kết quả chạy

Nhập lần lượt các phím 5, a, f, 3 (tổng số phím bấm là 4). Kết quả sẽ như thế này:



Assignment 5

1. Code

```
.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
```

2. Kết quả chạy