University of Dhaka

Department of Computer Science and Engineering

CSE-3113:

Microprocessor and Assembly Language Lab

Lab Report 4

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1 Objectives

The objectives of this lab is to understand and have familiarize with register based assembly programming for Cortex M4 processor for arithmetic operation.

2 Lab Tasks

2.1 Question 1

Write an assembly language to perform all the logical operations (AND,OR,NOR,NAND,XOR,XNOR) on two 16-bit variables. Repeat it for two 32-bit variables.

Listing 1: Adding 3 NumbersLogical operations on two 16-bit variables

```
        AREA lab4, CODE, READONLY
        ENTRY
        EXPORT main
        EXPORT problem_1_16


X EQU 0x1234
Y EQU 0x4321
P EQU 0x10000000
Q EQU 0x10000000

main
    MOV r0, #X
    MOV r1, #Y
    BL problem_1_16
stop B stop

problem_1_16
    AND r2, r0, r1 ;AND
    ORR r3, r0, r1 ;OR
    MVN r4, r3 ; NOR
    MVN r5,r2; NAND
    EOR r6, r0, r1 ; Bitwise XOR
    MVN r2, r2 ; Bitwise NOT
    MVN r3, r1 ; Bitwise NOT
    ORR r7, r2, r3 ; Bitwise XNOR
        BX lr;

        BX lr;
        END
```

Listing 2: Logical operations on two 32-bit variables

```
        AREA lab4, CODE, READONLY
        ENTRY
        EXPORT main
        EXPORT problem_1_32

X EQU 0x1234
Y EQU 0x4321
P EQU 0x10000000
Q EQU 0x10000000
main
    MOV r0, #X
    MOV r1, #Y

    BL problem_1_32
stop B stop

problem_1_32
    AND r2, r0, r1 ;AND
    ORR r3, r0, r1 ;OR
    MVN r4, r3 ; NOR
    MVN r5, r2; NAND
    EOR r6, r0, r1 ; Bitwise XOR
    MVN r2, r2 ; Bitwise NOT
    MVN r3, r1 ; Bitwise NOT
    ORR r7, r2, r3 ; Bitwise XNOR

        BX lr;
        END
```

2.2 Question 2

Write an assembly language to perform all the shift operations (LSR, ASR, LSL) on a 32-bit variable.

Listing 3: Perform all the shift operations on 32-bit variable.

```
        AREA lab4, CODE, READONLY
        ENTRY
        EXPORT main
        EXPORT problem_2

X EQU 0x1234
Y EQU 0x4321
P EQU 0x10000000
Q EQU 0x10000000

main
    MOV r0, #P
    MOV r1, #Q
    BL problem_2

stop B stop

problem_2
      ASR r1,r0,#1
      LSL r2,r0,#1
         LSR r3,r0,#1

         BX lr;
        END
```

2.3 Question 3

Write an assembly language to perform all the arithmetic operations (Addition, Subtraction, Division and Multiplication) on two variables. Restrict input values to avoid overflow. Repeat the same operations to handle overflow.

Listing 4: Perform all the arithmetic operations on two variables.

```
        AREA lab4, CODE, READONLY
        ENTRY
        EXPORT main
        EXPORT problem_3

X EQU 0x1234
Y EQU 0x4321
P EQU 0x10000000
Q EQU 0x10000000
main
    MOV r0, #P
    MOV r1, #Q
    BL problem_3

stop B stop
problem_3
         ADDS r2,r0,r1; addition
         BVX handle_overflow
         SUBS r3,r0,r1; subtraction
         BVX handle_overflow
         DIVS r4,r0,r1; signed division
         BVX handle_overflow
         MULS r5,r0,r1; multiplication
         BVX handle_overflow
         BX lr;
handle_overflow
        B srop
        END
```

2.4 Question 4

Write an assembly language program to find the average of n numbers.

Listing 5: Find the average of n numbers

```

        AREA Avrg, CODE, READONLY
        ENTRY
        EXPORT main
main
        MOV r1, #0              ; Sum
        LDR r2, =numbers    ; Load the address of the numbers array
        LDR r3, =0x0005     ; n
        LDR r4, =0x0005
loop
        LDR r5, [r2], #4
        ADD r1, r1, r5
        SUBS r3, r3, #1     ; Decrement n and update the flags
        BNE loop            ; Repeat until n = 0

        SDIV r0, r1, r4    ; Divide the sum by n

Stop B Stop
numbers DCD 1, 2, 3, 0,9    ; Array of numbers
        END
```

2.5 Question 5

Write an assembly language program to find the largest among n different numbers.

Listing 6: Find the largest among n different numbers

```
                   AREA Largest, CODE, READONLY
                ENTRY
                EXPORT main
                EXPORT fnd_max
main
                MOV r1, #0          ; Maximum numbe
                BL fnd_max
Stop B Stop
fnd_max
                LDR r2, =numbers    ; Load the address of the numbers array
                LDR r3, =0x0005    ; Load the value of n
loop
                LDR r4, [r2], #4    ; Load next nmbr
                CMP r4, r1
                BGT update_max
                SUBS r3, r3, #1     ; Decrement n and update the flags
                BNE loop            ; while n>0
update_max
                MOV r1, r4
                SUBS r3, r3, #1
                BNE loop
                BX LR ;return to main function
numbers DCD 1,5,3,4,7    ; Array of numbers
        END

        .
```

2.6 Question 6

Write an assembly language program to find the average of n numbers using function call

Listing 7: Find the largest among n different numbers

```
        AREA Avrg, CODE, READONLY
        ENTRY
        EXPORT main
        EXPORT fnd_avg
main
        MOV r1, #0              ; Sum
        LDR r2, =numbers    ; Load the address of the numbers array
        LDR r3, =0x0005     ; n
        LDR r4, =0x0005
        BL fnd_avg
Stop B Stop
fnd_avg

loop
        LDR r5, [r2], #4
        ADD r1, r1, r5
        SUBS r3, r3, #1
        BNE loop
        SDIV r0, r1, r4
        BX LR
numbers DCD 1, 2, 3, 0,9
        END
```

References

[1] Documentation – arm developer. https://developer.arm.com/documentation/ddi0439/b/CHDDIGAC. [Online; accessed 2023-01-31].

[2] Nucleo-F446RE. https://www.st.com/en/evaluation-tools/nucleo-f446re.html. [Online; accessed 2023-01-31].