EE22016 : Microprocessor Theory and Lab

Lab Experiment # 5

ARM Assembly - Computations in ARM

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1 Introduction

1.1 Aim of the Experiment

The aim of the experiment is:

1. Learn the architecture of ARM processor
2. Learn basics of ARM instruction set, in particular the ARM instructions pertaining to computations
3. Go through example programs
4. Write assembly language programs for the given set of (computational) problems

1.2 Equipments

To perform this experiment the following components are required

- KEIL 5 IDE for ARM
- Flashmagic software for programming flash memory
- ARM 7 Hardware Kit
- USB to serial converter
- Serial Cross cabel

1.3 Concepts Required

The contents of the book Welsh especially from the chapter 6. And the structure of ARMarchitecture

- A large array of uniform register
- A load/store model of data-processing where operations can only operate on registers and not directly on memory. This requires that all data be loaded into registers before an operation can be preformed, the result can then be used for further processing or stored back into memory
- A small number of addressing modes with all load/store addresses begin determined from register and instruction fields only.
- A uniform fixed length instruction (32 bit)

In addition to these traditional features of a RISC system the ARM provides a number of additional features

1. Separate arithmatic logic unit and shifter giving additional control over dataprocessing to maximise execution speed.
2. Auto increment and auto decrement addressing modes to improve the operationof program loops.
3. Conditional execution of instructions to reduce pipeline flushing and thus increaseexecution speed.

1.4 Overview of KEIL software

Keil u Vision is an IDE directed towards code development for multiple platforms like AVR, ARM, CORTEX-M, C166, C251, C51 and 8051 based MCU architectures manufactured by various companies .Whereas Atmel Studio is a Visual Basic and .NET Framework based IDE which only supports AVR and ARM architecture based MCU's only by Atmel.

1.5 Problems

The problems we need to solve in the experiment are:

1. Compute the factorial of a given number using ARM processor through assembly programming
2. Combine the low four bits of each of the four consecutive bytes beginning at LIST into one 16-bit halfword. The value at LIST goes into the most signicant nibble of the result. Store the result in the 32-bit variable RESULT.
3. Given a 32 bit number. identify whether it is even or odd.

2 Computing the factorial of a given number

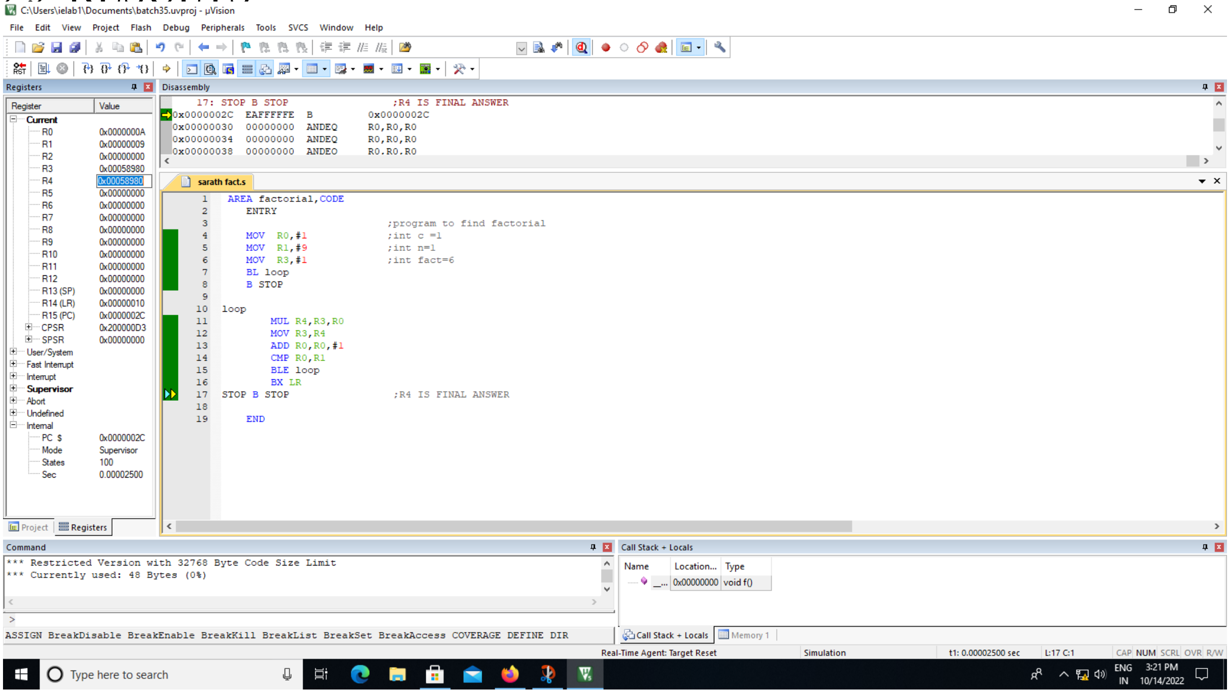
2.1 Code

```
AREA factorial,CODE
    ENTRY
                                             ;program to find factorial
    MOV   R0,#1                              ;int c =1
    MOV   R1,#6                              ;int n=1
    MOV   R3,#1                              ;int fact=6
    BL loop
    B STOP
loop
        MUL R4,R3,R0
        MOV R3,R4
        ADD R0,R0,#1
        CMP R0,R1
        BLE loop
        BX LR
STOP B STOP                                   ;R4 IS FINAL ANSWER

    END
```

Listing 1: Code for giving out factorial of a given number

2.2 RESULTS



3 Combine the last nibble of 4 number to create a 16 bit halfword

3.1 Flow Chart

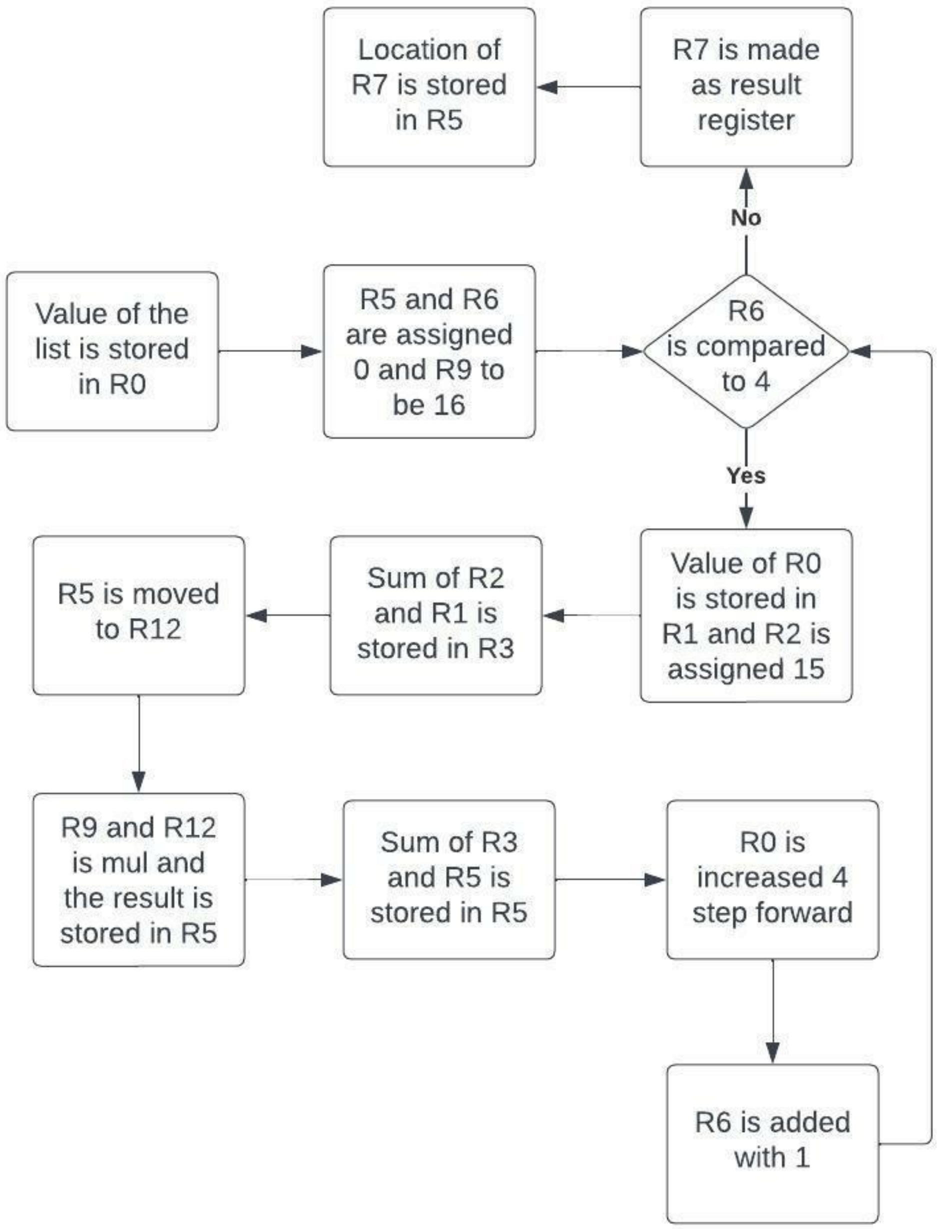


Figure 3: Flow chart to create a halfword from the LSB nibbles

3.2 CODE

```
AREA Program,CODE,READONLY
Entry
    LDR R0, =LIST
    MOV R5, #0
    MOV R6, #0
    MOV R9, #16
Loop
    CMP R6, #4
    BEQ done
    LDR R1, [R0]
    MOV R2, #15
    AND R3, R2, R1
    MOV R12, R5
    MUL R5, R12, R9
    ADD R5, R5, R3
    ADD R0, R0, #4
    ADD R6, R6, #1
    B Loop
done
    LDR R7, =Result
    STR R5, [R7]

    SWI &11

LIST DCD &2D3F, &5F53, &1234, &0987
    align

 AREA DataRam,DATA,READWRITE
Result DCD 0
    END
```

Listing2:code for the question

3.2 Results Images

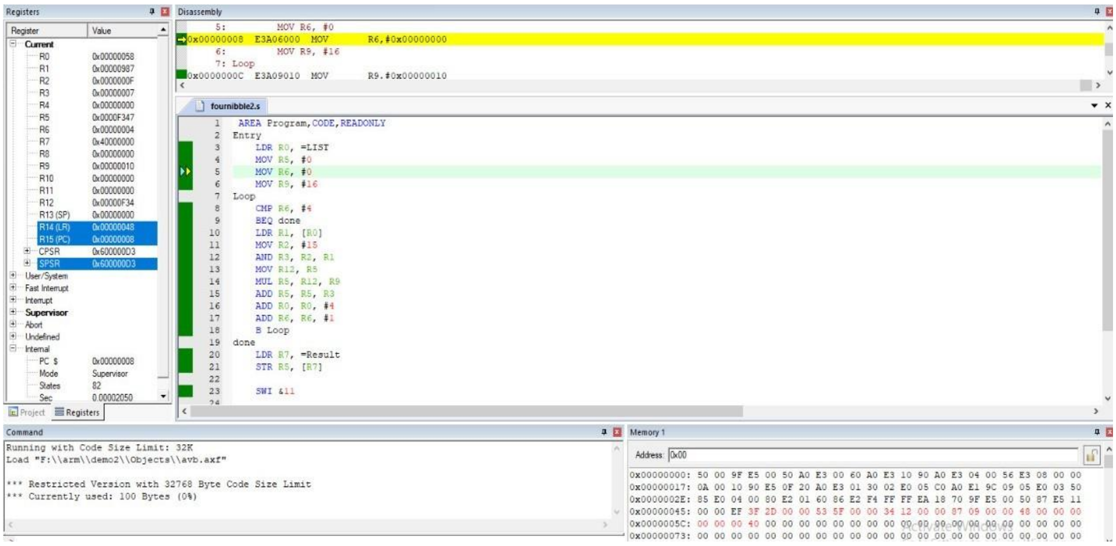


Figure 4: Result Image

4 Figuring whether a given number is even or odd

4.1 Flow Chart

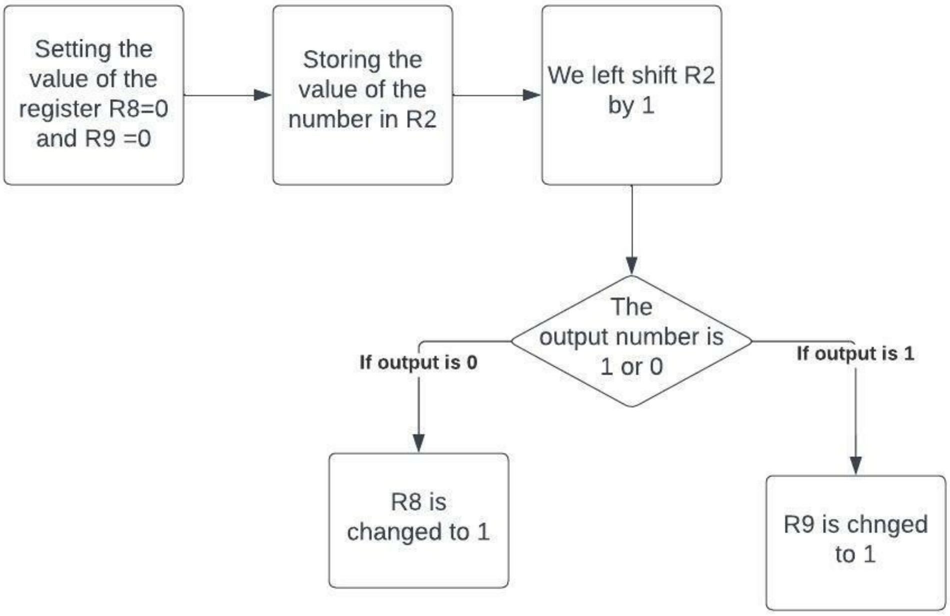


Figure 5: Flow Chart for 4 finding whether a given number is even or odd

4.2 Code

```
AREA evenODD, CODE, READONLY
ENTRY
MOV R8,#0 ; For storing even numbers MOV R9,#0 ; For storing odd
numbers
NEXT
LDR R2,=0x44444444 ; Take 1st number
LSRS R2,#1 ;Shift number to right
 BCC EVEN ; If C=0 go to even
ADD R9,#1 ; IF C=1 R9=R9+1
BAL XX ;ALways Jump

EVEN
ADD R8,#1
 END
```

4.3 Result Images

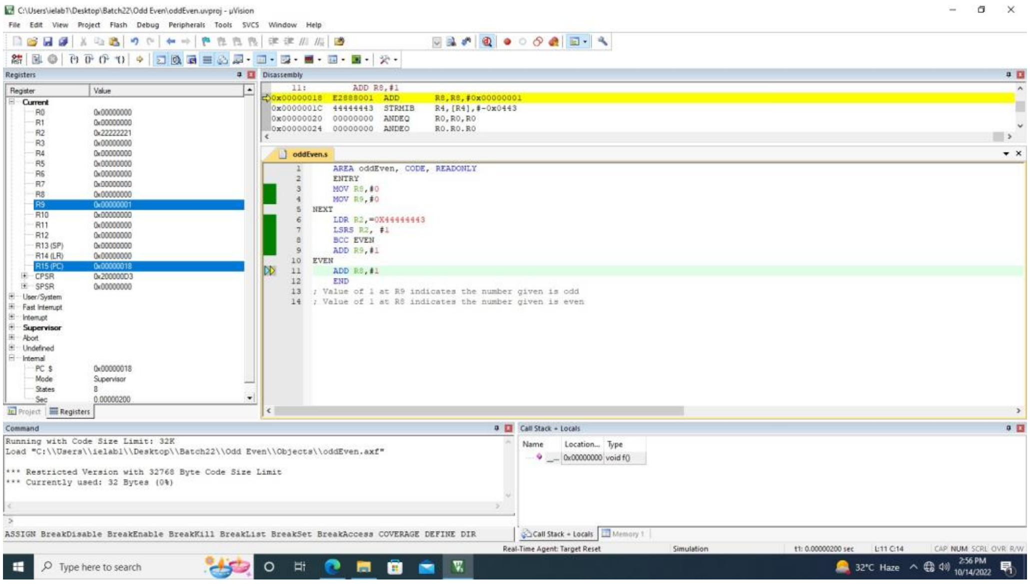


Figure 6: Result for odd number

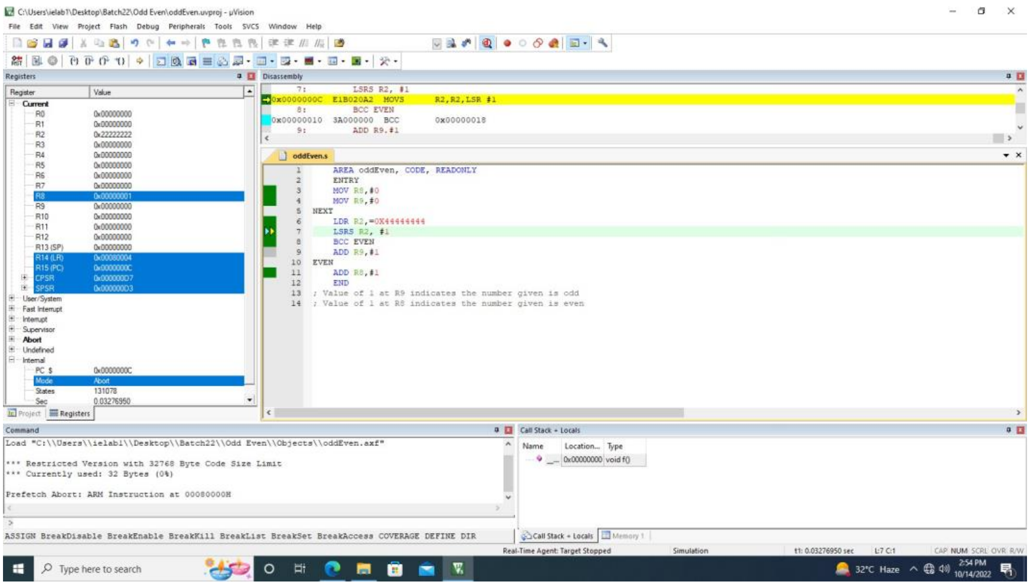


Figure 7: Result for even number

5 Inference

In the above experiment we wrote the code for the given program in the Assembly Program which can be used to directly manipulate hardware, access specialized processor instructions,or evaluate critical performance issues.

6 Learning Outcomes

- We learnt to write code in the assembly language

- We used the KEIL software to run the program
- We also learnt about how to debug the instruction
- We also learnt about various instruction which we can use in the ARM AssemblyLanguage Program