MIPS PROCESSOR DESIGN

Course Name: EG 212 Computer Architecture – Processor

Design Group Number – 10

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INTRODUCTION

This report explores the fundamental concepts of an MIPS Processor through design and analysis. We have written three MARS simulations and designed a processor which takes the machine code from MARS and does the specified computations.

This report include these following files:

- armstrong.asm
- fib.asm
- quadratic.asm
- mips_processor.py

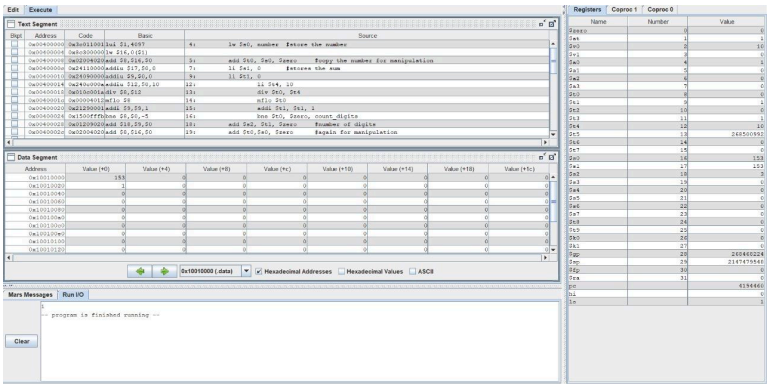
IMPLEMENTATION

Armstrong number:

The first MIPS program takes an integer and prints 1 if the given integer is an armstrong number, else 0. An Armstrong number is a number that is equal to the sum of its own digits each raised to the power of the number of digits.

Screenshot-

```
data
        number: .word 153
text
        lw $s0, number  #store the number
        add $t0, $s0, $zero     #copy the number for manipulation

        li $s1, 0       #stores the sum

        li $t1, 0

        count_digits:
                li $t4, 10
                div $t0, $t4
                mflo $t0
                addi $t1, $t1, 1
                bne $t0, $zero, count_digits

        add $s2, $t1, $zero     #number of digits
        add $t0,$s0, $zero      #again for manipulation

        calculate_sum:
                li $t4, 10
                div $t0, $t4
                mfhi $t1 #storing remainder
                mflo $t0
                add $t2, $s2, $zero
                li $t3, 1
```



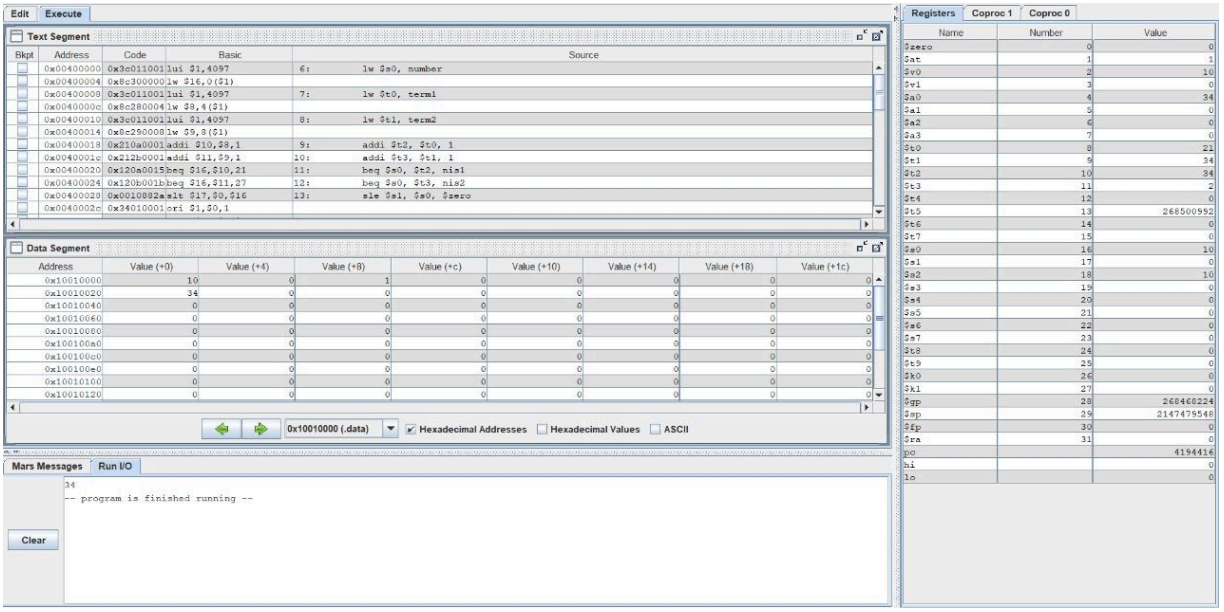
Fibonacci term:

The second MIPS program calculates and prints the given term of the Fibonacci sequence, where n is the integer input by the user. The Fibonacci sequence is a series of numbers where each number is the sum of the two preceding ones, starting with 0 and 1.

Screenshot –

armstrong.asm | fib.asm

```
1   .data
2           number: .word 10
3           term1: .word 0
4           term2: .word 1
5   .text
6           lw $s0, number
7           lw $t0, term1
8           lw $t1, term2
9           addi $t2, $t0, 1
10          addi $t3, $t1, 1
11          beq $s0, $t2, nis1
12          beq $s0, $t3, nis2
13          sle $s1, $s0, $zero
14          beq $s1, $t1, nisnegative
15          li $t2, 0         #fib3
16          li $s2, 2         #term counter
17
18          fib:
19                  add $t2, $t1, $t0
20                  add $t0, $t1, $zero
21                  add $t1, $t2, $zero
22                  addi $s2, $s2, 1
23                  bne $s2, $s0, fib
24          li $v0, 1
25          add $a0, $t1, $zero
26          syscall
27          lui $t5, 4097
```



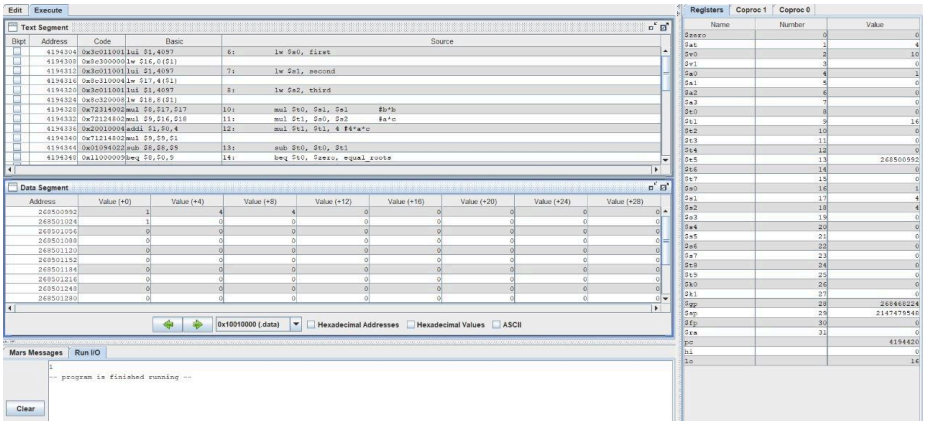
Number of Roots of Quadratic:

The third MIPS program takes three integers as input, representing the coefficients of a quadratic equation (ax^2 + bx + c = 0), and determines the number of real roots the quadratic equation has. Then, it prints the number of real roots of the given equation.

screenshot-

armstrong.asm | fib.asm | quardratic.asm

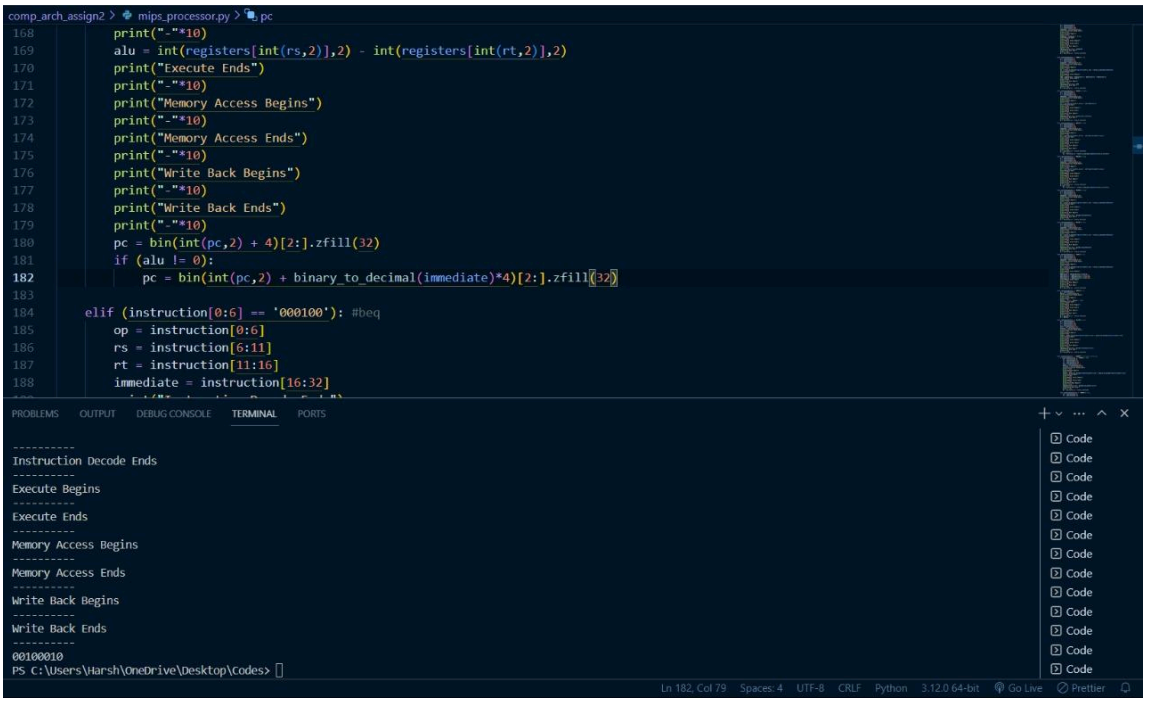
```
1   .data
2           first: .word 1
3           second: .word 4
4           third: .word 4
5   .text
6           lw $s0, first
7           lw $s1, second
8           lw $s2, third
9
10          mul $t0, $s1, $s1       #b*b
11          mul $t1, $s0, $s2       #a*c
12          mul $t1, $t1, 4 #4*a*c
13          sub $t0, $t0, $t1
14          beq $t0, $zero, equal_roots
15          slt $t1, $t0, $zero
16          beq $t1, 1, no_roots
17
18          real_roots:
19                  li $v0, 1
20                  li $a0, 2
21                  syscall
22                  lui $t5, 4097
23                  sw $a0, 32($t5)
24                  j exit
25
26          equal_roots:
27                  li $v0, 1
```

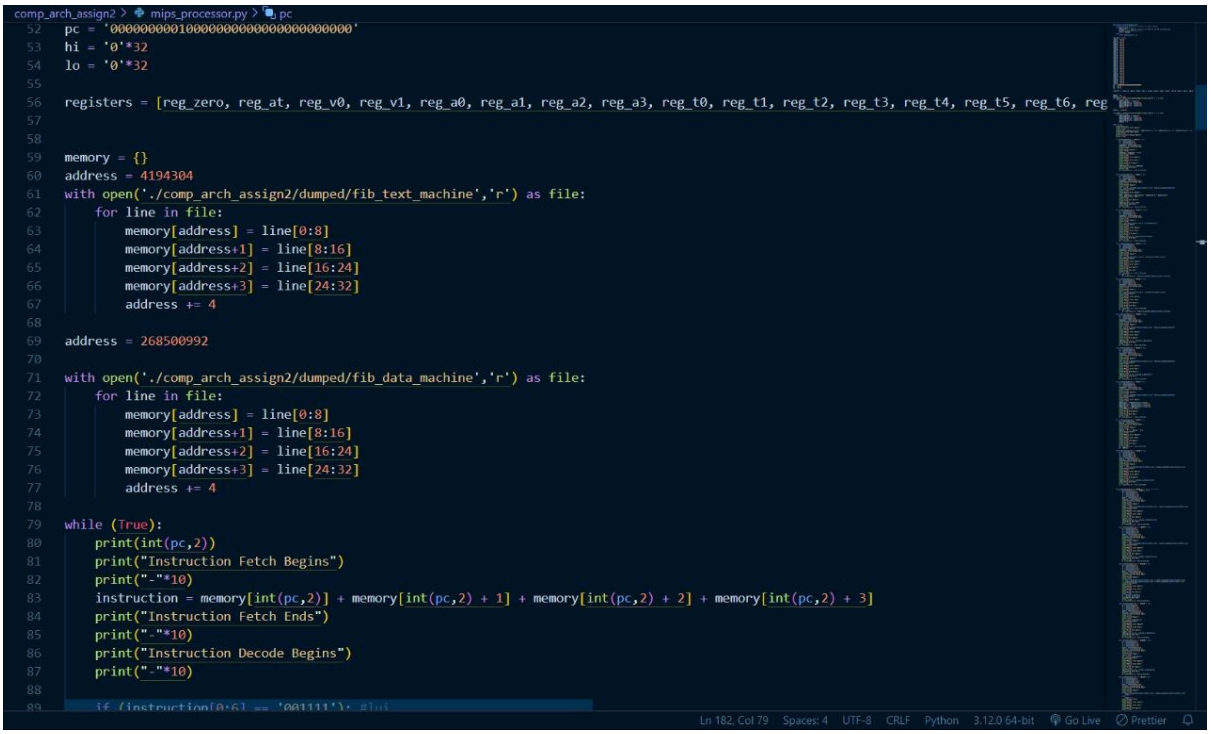


MIPS Processor:

The processor reads the machine code (data and text) dumped by MARS. It performs certain operations corresponding to different instruction opcodes. It also contains a memory that is used to depict system memory. We save the instructions in the memory and feed to the processor using a while loop. Each register is initialized as an empty string in the beginning.

Screenshot:(only a snippet of the original code)





Link:
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