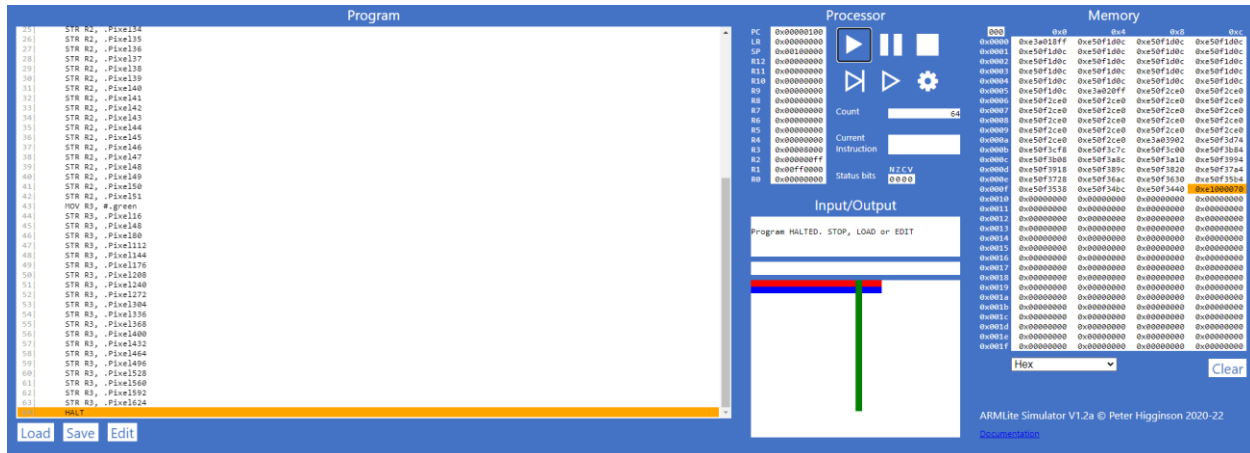


## Lab 9 – Computer Systems (Mohamed Shafi Uzman Fassy - 102608927)

### 9.1.1 -

a) b)

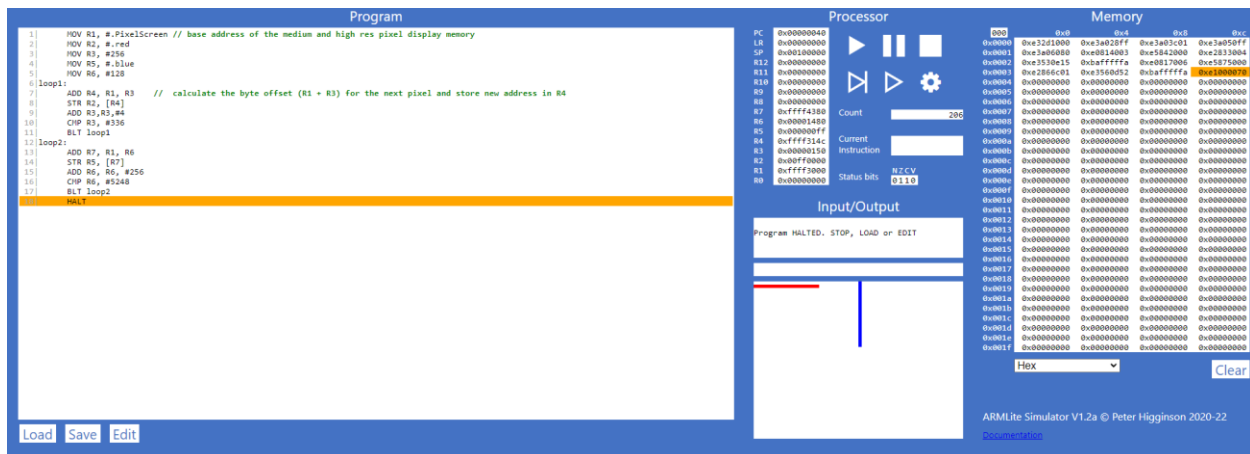


### 9.1.2 -

### 9.1.3 –

Because it's storing the memory location into Register 4 and storing the value from Register 2 to the memory location in Register 4.

a) b) c)



## 9.2.1

The screenshot shows a MIPS simulator interface. The main window is titled "Program" and contains the following assembly code:

```

1 | MOV R1, #.PixelScreen
2 | MOV R2, #.red
3 | MOV R3, #0
4 | loop:
5 |   STR R2, [R1 + R3]
6 |   ADD R3, R3, #4
7 |   CHP R3, #80
8 |   BLT loop
9 |   HALT

```

The "Processor" panel on the right shows the following registers and values:

PC	0x00000020
LR	0x00000000
SP	0x00100000
R12	0x00000000
R11	0x00000000
R10	0x00000000
R9	0x00000000
R8	0x00000000
R7	0x00000000
R6	0x00000000
R5	0x00000000
R4	0x00000000
R3	0x00000050
R2	0x00ff0000
R1	0xffff3000
R0	0x00000000

The "Input/Output" panel shows the status: "Program HALTED. STOP, LOAD or EDIT".

## 9.2.2

The screenshot shows a MIPS simulator interface. The main window is titled "Program" and contains the following assembly code:

```

1 | MOV R1, #.PixelScreen
2 | MOV R2, #.red
3 | MOV R4, #0
4 | loop1:
5 |   MOV R3, #0
6 |   loop2:
7 |     ADD R5, R3, R4
8 |     STR R2, [R1 + R5]
9 |     ADD R3, R3, #4
10 |    CHP R3, #80
11 |    BLT loop2
12 |    ADD R4, R4, #256
13 |    CHP R4, #2560
14 |    BLT loop1
15 |    HALT

```

The "Processor" panel on the right shows the following registers and values:

PC	0x00000034
LR	0x00000000
SP	0x00100000
R12	0x00000000
R11	0x00000000
R10	0x00000000
R9	0x00000000
R8	0x00000000
R7	0x00000000
R6	0x00000000
R5	0x0000094c
R4	0x00000a00
R3	0x00000050
R2	0x00ff0000
R1	0xffff3000
R0	0x00000000

The "Input/Output" panel shows the status: "Program HALTED. STOP, LOAD or EDIT".

## 9.3.1 –

a) .ALIGN 256 is used to ensure that the next instruction would be aligned to a word address that is divisible by 256.

b) c)

Program

```
1 | .ALIGN 256
2 | arrayLength: 10
3 | arrayData: 9
4 | 8
5 | 7
6 | 6
7 | 5
8 | 4
9 | 3
10 | 2
11 | 1
12 | 0
13 | HALT
14 | MOV R1, #20
15 | LDR R0, [R1]
16 | HALT
```

Load Save Edit

Processor

PC	60
LR	4
SP	1048576
R12	0
R11	0
R10	0
R9	0
R8	0
R7	0
R6	0
R5	0
R4	0
R3	0
R2	0
R1	20
R0	5

▶ || ◻

◀ ▶ ⚙

Count

Current

Instruction

Status bits **NZCV**  
**0000**

Input/Output

Program HALTED. STOP, LOAD or EDIT

9.3.2 & 9.3.3 –

Program

```
1 | .ALIGN 256
2 | arrayLength: 10
3 | arrayData: 9
4 | 8
5 | 7
6 | 6
7 | 5
8 | 4
9 | 3
10 | 2
11 | 1
12 | 0
13 | HALT
14 | loop:
15 | ADD R1, R1, #4
16 | ADD R2, R2, #1
17 | LDR R3, [R1]
18 | ADD R0, R0, R3
19 | CMP R2, #10
20 | BLT loop
21 | HALT
```

Load Save Edit

Processor

PC	76
LR	4
SP	1048576
R12	0
R11	0
R10	0
R9	0
R8	0
R7	0
R6	0
R5	0
R4	0
R3	0
R2	10
R1	40
R0	45

▶ || ◻

◀ ▶ ⚙

Count

Current

Instruction

Status bits **NZCV**  
**0110**

Input/Output

Program HALTED. STOP, LOAD or EDIT

## 9.4.1 –

**Program**

```

1 MOV R2, #arrayData
2 MOV R3, #reversearrayData
3 SUB R1, R2, #4
4 LDR R1, [R1]
5 subloop:
6 SUB R1, R1, #1
7 ADD R3, R3, #4
8 CMP R1, #0
9 BGT subloop
10 MOV R2, #arrayData
11 SUB R1, R2, #4
12 LDR R1, [R1]
13 loop:
14 SUB R3, R1, #1
15 LDR R4, [R2]
16 ADD R2, R2, #4
17 SUB R3, R3, #4
18 STR R4, [R3]
19 CMP R1, #0
20 BGT loop
21 ALLOW 256
22 arrayLength: 10
23 arrayData: 29
24 28
25 27
26 26
27 25
28 24
29 23
30 22
31 21
32 20
33 reversearrayData: 0
34 0
35 0
36 0
37 0
38 0
39 0
40 0

```

**Processor**

PC: 0  
LR: 0  
SP: 1048576  
R12: 0  
R11: 0  
R10: 0  
R9: 0  
R8: 0  
R7: 0  
R6: 0  
R5: 0  
R4: 0  
R3: 0  
R2: 0  
R1: 0  
R0: 0

Count: 0  
Current Instruction: 0  
Status bits: NZCV 0000

**Input/Output**

Stop done, edit & Submit, RUN/STEP or alter memory

**Memory**

Addr	Dec	Hex	Dec	Hex	Dec	Hex
0x0000	3818925889	3818925995	3795980292	3851489280		
0x0001	3795914753	3800248324	3813736448	3405774843		
0x0002	3818925889	3795980292	3851489280	3795914753		
0x0003	3851567104	3800176692	3796054020	3859514864		
0x0004	3813736448	3405774848	0	0		
0x0005	0	0	0	0		
0x0006	0	0	0	0		
0x0007	0	0	0	0		
0x0008	0	0	0	0		
0x0009	0	0	0	0		
0x000a	0	0	0	0		
0x000b	0	0	0	0		
0x000c	0	0	0	0		
0x000d	0	0	0	0		
0x000e	0	0	0	0		
0x000f	0	0	0	0		
0x0010	10	29	28	27		
0x0011	26	25	24	23		
0x0012	22	21	20	19		
0x0013	21	22	23	24		
0x0014	25	26	27	28		
0x0015	29	20	21	22		
0x0016	23	24	25	26		
0x0017	27	28	29	0		
0x0018	0	0	0	0		
0x0019	0	0	0	0		
0x001a	0	0	0	0		
0x001b	0	0	0	0		
0x001c	0	0	0	0		
0x001d	0	0	0	0		
0x001e	0	0	0	0		
0x001f	0	0	0	0		

Decimal (unsigned) Clear

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## 9.4.2 –

**Program**

```

1 MOV R2, #arrayData
2 MOV R3, #arrayData
3 SUB R1, R2, #4
4 LDR R1, [R1]
5 subloop:
6 SUB R1, R1, #1
7 ADD R3, R3, #4
8 CMP R1, #0
9 BGT subloop
10 MOV R2, #arrayData
11 SUB R1, R2, #4
12 LDR R1, [R1]
13 loop:
14 SUB R3, R1, #2
15 LDR R4, [R2]
16 ADD R2, R2, #4
17 SUB R3, R3, #4
18 LDR R5, [R3]
19 STR R4, [R5]
20 STR R5, [R2 - 4]
21 CMP R1, #0
22 BGT loop
23 HALT
24 ALLOW 256
25 arrayLength: 10
26 arrayData: 29
27 28
28 27
29 26
30 25
31 24
32 23
33 22
34 21
35 20

```

**Processor**

PC: 84  
LR: 0  
SP: 1048576  
R12: 0  
R11: 0  
R10: 0  
R9: 0  
R8: 0  
R7: 0  
R6: 24  
R5: 24  
R4: 25  
R3: 280  
R2: 280  
R1: 0  
R0: 0

Count: 93  
Current Instruction: 0  
Status bits: NZCV 0100

**Input/Output**

Program HALTED. STOP, LOAD or EDIT

**Memory**

Addr	Dec	Hex	Dec	Hex	Dec	Hex
0x0000	3818925889	3818929985	3795980292	3851489280		
0x0001	3795914753	3800248324	3813736448	3405774843		
0x0002	3818925889	3795980292	3851489280	3795914754		
0x0003	3851567104	3800176692	3796054020	3851636736		
0x0004	3859514864	3842114820	3813736448	3405774838		
0x0005	3794879932	0	0	0		
0x0006	0	0	0	0		
0x0007	0	0	0	0		
0x0008	0	0	0	0		
0x0009	0	0	0	0		
0x000a	0	0	0	0		
0x000b	0	0	0	0		
0x000c	0	0	0	0		
0x000d	0	0	0	0		
0x000e	0	0	0	0		
0x000f	0	0	0	0		
0x0010	10	20	21	22		
0x0011	23	24	25	26		
0x0012	27	28	29	0		
0x0013	0	0	0	0		
0x0014	0	0	0	0		
0x0015	0	0	0	0		
0x0016	0	0	0	0		
0x0017	0	0	0	0		
0x0018	0	0	0	0		
0x0019	0	0	0	0		
0x001a	0	0	0	0		
0x001b	0	0	0	0		
0x001c	0	0	0	0		
0x001d	0	0	0	0		
0x001e	0	0	0	0		
0x001f	0	0	0	0		

Decimal (unsigned) Clear

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