SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF INFORMATION TECHNOLOGY

COURSE NAME: 19IT301 COMPUTER ORGANIZATION AND ARCHITECTURE

II YEAR/ III SEM

Unit 1 : BASIC STRUCTURE OF COMPUTERS Topic 6:

Addressing Modes

Addressing Modes

The different ways in which the location of an operand is specified in an instruction are referred to as **addressing modes.**

Different Addressing modes

- Implied
- Immediate
- Register
- Direct/Absolute
- Indirect
- Index
- Relative
- Autoincrement
- Autodecrement

Effective Address (EA)

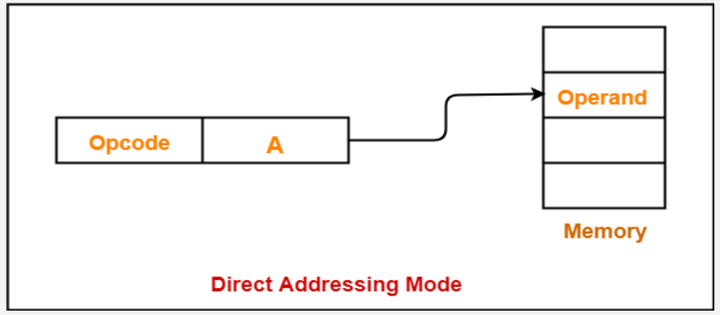
- In the addressing modes that follow, the instruction does not give the operand or its address explicitly.
- Instead, it provides information from which an effective address (EA) can be derived by the processor when the instruction is executed.
- The **effective address** is the location of an operand which is stored in memory.

Move LOC, R0 EA = LOC

Addressing Modes

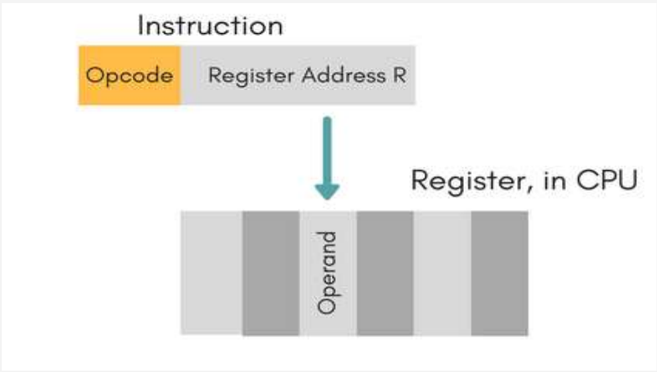
- Implied
  - Instructions that comprise only an opcode without an operand
  - Ex: INCA

- Immediate mode
  - The use of a **constant** in “MOV 5, R1” or “MOV #5, R1” i.e. R1 ← 5



- Absolute (Direct) Address – Implementation of **variables**
  - Operand is in a memory location
  - E.g. Move LOC, R1

- Register Mode
  - Indicate register holds the operand



Indirection and Pointers

- Indirect Addressing – Instruction provides information from which memory address of operand determined

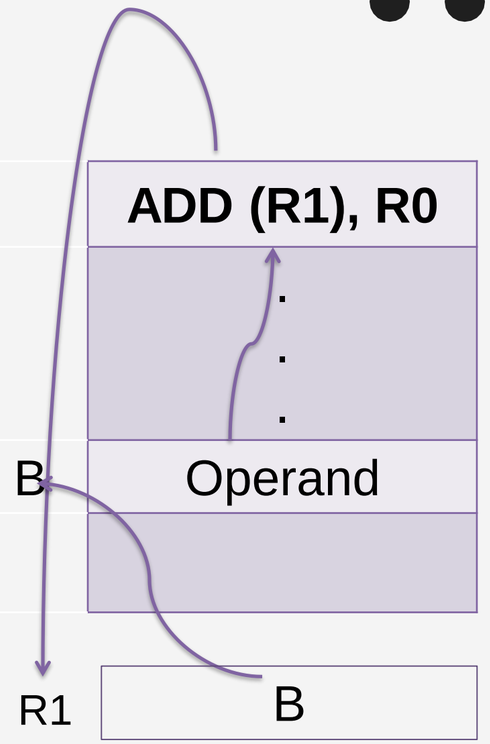
- EA of the operand is the contents of register or memory location whose address appears in the instruction.

Indirect addressing through a general purpose register:

  - Indicate the register (e.g. R1) that holds the address of the variable (e.g. B) that holds the operand

    ADD (R1), R0

  - The register or memory location that contain the address of an operand is called a **pointer**

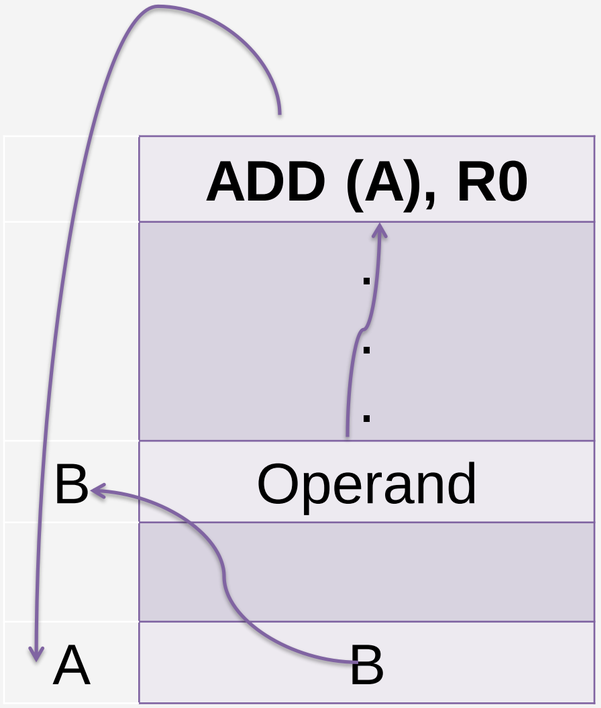


Indirection and Pointers

Indirect addressing through a memory location:

- Indicate the memory variable (e.g. A)that holds the address of the variable (e.g. B) that holds the operand

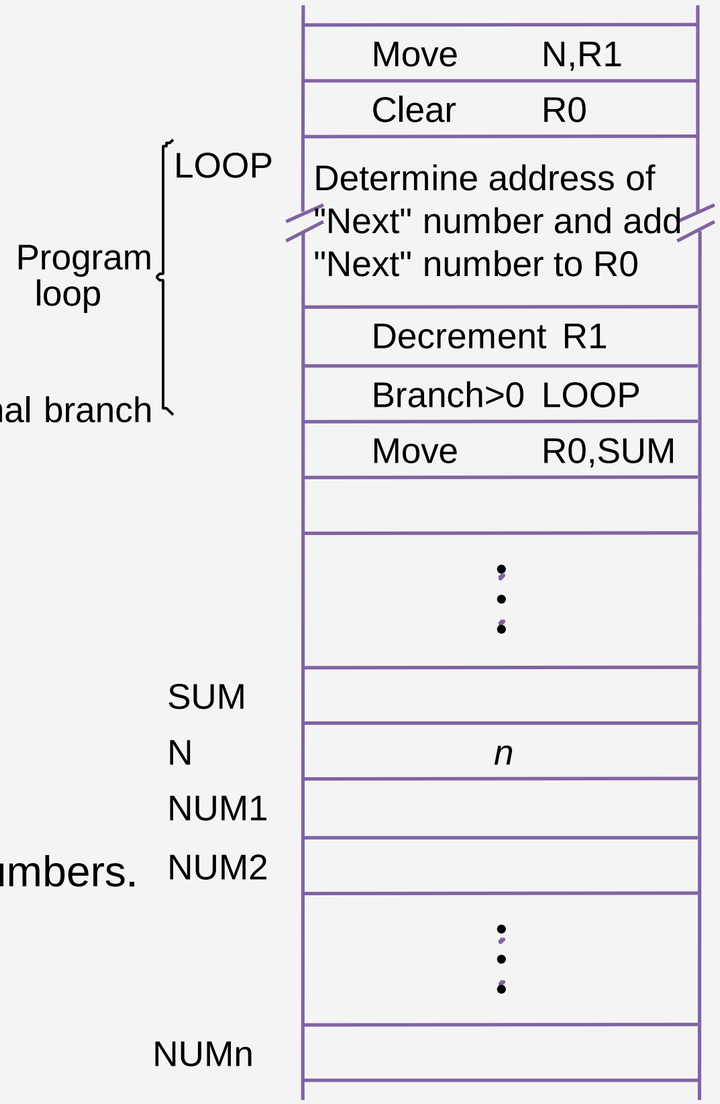
  ADD (A), R0



Indirect Addressing Example

Addition of N numbers

```
        Move     N,R1          ; N = Numbers to add
        Move     #NUM1,R2      ; R2= Address of 1st no.
        Clear    R0            ; R0 = 00
Loop :  Add      (R2), R0      ; R0 = [NUM1] + [R0]
        Add      #4, R2        ; R2= To point to the  next
                               ; number
        Decrement    R1        ; R1 = [R1] -1
        Branch>0     Loop; Check if R1>0 or not if
                               ; yes go to Loop
         Move    R0, SUM       ; SUM= Sum of all no.
```



Using a loop to add *n* numbers.

Example

Addition of N numbers

```
1.              Move        N,R1          ; N = 3
2.              Move        #NUM1,R2      ; R2= 10000H
3.              Clear       R0            ; R0 = 00
4. Loop :       Add         (R2), R0      ; R0 = 10 + 00 = 10
5.              Add         #4, R2        ; R2 = 10004H
6.              Decrement   R1            ; R1 = 2
7.              Branch>0    Loop          ; Check if R1>0 if
                                          ; yes go to Loop
8.              Move        R0, SUM             ; SUM=
```

Example

Addition of N numbers

```
1.            Move          N,R1          ; N = 3
2.            Move          #NUM1,R2      ; R2= 10000H
3.            Clear         R0            ; R0 = 00
4. Loop :     Add           (R2), R0      ; R0 = 20 + 10 = 30
5.            Add           #4, R2        ; R2 = 10008H
6.            Decrement     R1            ; R1 = 1
7.            Branch>0      Loop          ; Check if R1>0 if
                                          ; yes go to Loop
8.            Move          R0, SUM             ; SUM=
```

Example

Addition of N numbers

```
1.            Move          N,R1                ; N = 3
2.            Move          #NUM1,R2            ; R2= 10000H
3.            Clear         R0                  ; R0 = 00
4. Loop :     Add       (R2), R0            ; R0 = 30 + 30 = 60
5.            Add           #4, R2              ; R2 = 1000CH
6.            Decrement     R1                  ; R1 = 0
7.            Branch>0      Loop                ; Check if R1>0 if
                                                  ; yes go to Loop
8.             Move         R0, SUM                 ; SUM= 60
```

Indexing and Arrays

- Useful in lists and arrays
- Index mode: The EA of the operand is generated by adding a constant value to the contents of a register.
- Symbolic representation

  X(Ri) ;X= constant value

  EA= X + (Ri)
- X defined as offset or displacement

Two ways of using Index mode

Address	Memory
	Add 20(R1), R2
	. . . .
10000	
	. . . .
10020	Operand

Offset=20

R1	10000

Offset is given as a Constant

Address	Memory
	Add 10000(R1), R2
	. . . .
10000	
	. . . .
10020	Operand

Offset=20

R1	20

Offset is in the index register

Example: Indexing and Arrays

- Array

List of students marks

Address	Memory	Comments
N	n	No. of students
LIST	Student ID1	Student 1
LIST+4	Test 1	
LIST+8	Test 2	
LIST+12	Test 3	
LIST+16	Student ID2	Student 2
LIST+20	Test 1	
LIST+24	Test 2	
LIST+28	Test 3	

```
        Move #LIST, R0
        Clear R1
        Clear R2
        Clear R3
        Move N, R4
Loop :  Add 4(R0), R1
        Add 8(R0), R2
        Add 12(R0),R3
        Add  #16, R0
        Decrement       R4
        Branch>0 Loop
        Move        R1, SUM1
        Move        R2, SUM2
        Move        R3, SUM3
```

Program to find the sum of marks of all subjects and store it in memory.

- Indexed addressing used in accessing test marks from the list

Relative Addressing

- Relative mode – the effective address is determined by the index mode using the program counter in place of the general-purpose register.
- X(PC) – note that X is a signed number
- Commonly used to specify target address in branch instruction

  Branch>0 LOOP
- This location is computed by specifying it as an offset from the current value of PC.
- Branch target may be either before or after the branch instruction, the offset is given as a signed num.

Relative addressing mode - Example

Addition of N numbers

```
                Move      N,R1            ; N = Numbers to add
                Move      #NUM1,R2        ; R2= Address of 1st no.
                Clear     R0              ; R0 = 00
1000 Loop:      Add       (R2), R0        ; R0 = [NUM1] + [R0]
1004            Add       #4, R2          ; R2= To point to the  next number
1008            Decrement      R1         ; R1 = [R1] -1
1012            Branch>0       Loop; Check if R1>0 or not if
                                          ; yes go to Loop
1016            Move      R0, SUM         ; SUM= Sum of all no.
```

- PC = 1016
- To branch to Loop (1000), offset X = -16
- X(PC) = -16(1016) = -16 + 1016 =1000

Additional Modes

- Autoincrement mode – the effective address of the operand is the contents of a register specified in the instruction. After accessing the operand, the contents of this register are automatically incremented to point to the next item in a list.
- (Ri)+. The increment is 1 for byte-sized operands, 2 for 16-bit operands, and 4 for 32-bit operands.
- Autodecrement mode: -(Ri) – decrement first and used as an EA

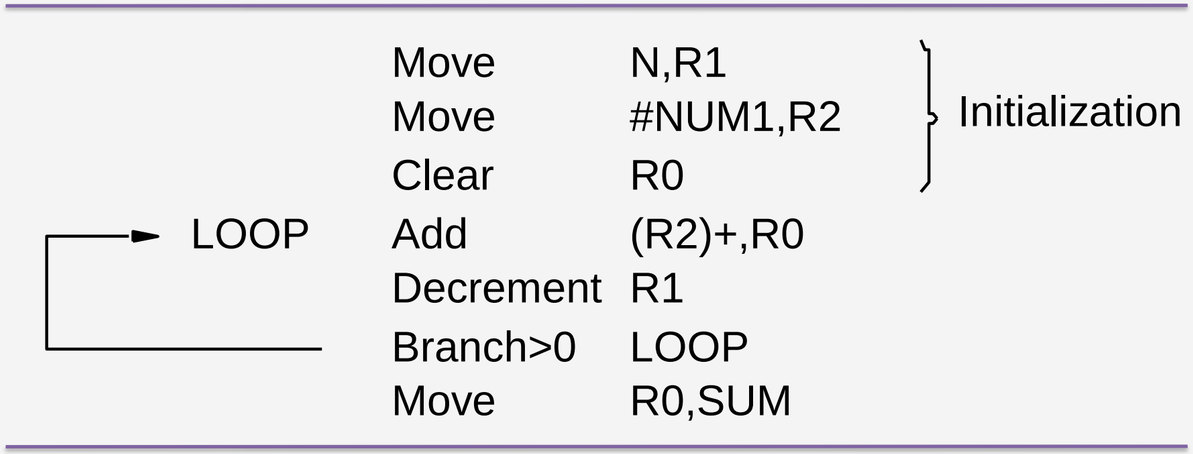


Figure 2.16. The Autoincrement addressing mode used in the program of Figure 2.12.

Summary

Name	Assembler syntax	Addressing function
Immediate	#Value	Operand = Value
Register	R*i*	EA = R*i*
Absolute (Direct)	LOC	EA = LOC
Indirect	(R*i*) (LOC)	EA = [R*i*] EA = [LOC]
Index	X(R*i*)	EA = [R*i*] + X
Relative	X(PC)	EA = [PC] + X
Autoincrement	(R_i) +	EA = [R_i] Increment R*i*
Autodecrement	– (R_i)	Decrement R_i EA = [R_i]

Generic Addressing Modes

Assessment

1. The instruction, Add #45,R1 does _____

a) Adds the value of 45 to the address of R1 and stores 45 in that address

b) Adds 45 to the value of R1 and stores it in R1

c) Finds the memory location 45 and adds that content to that of R1

d) None of the mentioned

2. Which addressing mode execute its instructions within CPU without the necessity of reference memory for operands?

a. Implied Mode b. Immediate Mode

c. Direct Mode d. Register Mode

3. The addressing mode/s, which uses the PC instead of a general purpose register is _____

a) Indexed with offsetb) Relative c) Direct

d) Both Indexed with offset and direct

Assessment

4. The addressing mode, where you directly specify the operand value is _____

a) Immediate b) Direct c) Definite d) Relative

5. _____ addressing mode is most suitable to change the normal sequence of execution of instructions.

a) Relative b) Indirect c) Index with Offset d) Immediate

Answers

1. B
2. D
3. B
4. A
5. A

Thank You