Experiment No. 04

Aim- Design an implementation of pass I of two pass assembler

Requirement- Java

Theory - The one-pass assembler cannot resolve forward references of data symbols. It requires all data symbols to be defined prior to being used. A two-pass assembler solves this dilemma by devoting one pass to exclusively resolve all (data/label) forward references and then generate object code with no hassles in the next pass. If a data symbol depends on another and this another depends on yet another, the assembler resolved this recursively.

It generates instructions by evaluating the mnemonics (symbols) in operation field and find the value of symbol and literals to produce machine code. Now, if assembler do all this work in one scan then it is called single pass assembler, otherwise if it does in multiple scans then called multiple pass assembler. Here assembler divide these tasks in two passes:

Pass-1:

- Define symbols and literals and remember them in symbol table and literal table respectively.
- Keep track of location counter
- Process pseudo-operations
- Assign addresses to all statements in the program.
- Save the values (addresses) assigned to all labels (including label and variable names) for use in Pass 2 (deal with forward references).
- Perform some processing of assembler directives (e.g., BYTE, RESW, these can affect address assignment)

The Pseudo Code for Pass 1

Pass 1:

```
begin
  read first input line
  if OPCODE = 'START' then
     begin
        save #[OPERAND] as starting address
        initialize LOCCTR to starting address
        write line to intermediate file
        read next input line
     end {if START}
  else
     initialize LOCCTR to 0
  while OPCODE ≠ 'END' do
     begin
        if this is not a comment line then
           begin
              if there is a symbol in the LABEL field then
                 begin
```

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Code-

```
import java.util.*;
import java.lang.*;
import java.io.*;

class pass1
{
   public static void main(String []args)
   {
      BufferedReader reader;
      int lc=0,sti=0,di=0,i,j,li=0;
      int[][] symtab = new int[100][3];
      int[][] littab = new int[100][3];
      String[] sym = new String[100];
      String[] data = new String[100];
      try
      {
         reader = new BufferedReader(new FileReader("prg.txt"));
         String line = reader.readLine();
         String[] words = line.split("\\s+");
         //System.out.println(sym[0]+" "+symtab[0][0]);
         while (!words[1].equals("END"))
         {
            if(!words[0].equals(""))
            {
               if(words[1].equals("START"))
               {
                  sym[sti] = words[0];
```

```
            symtab[sti][0] = 0;
            symtab[sti][1] = 1;
            symtab[sti][2] = 0;
            sti++;
            //System.out.println("in1");
        }
        else if(words[1].equals("EQU"))
        {
            sym[sti] = words[0];
            if(words[2].equals("*")) symtab[sti][0] = lc;
            else symtab[sti][0] = Integer.parseInt(words[2]);
            symtab[sti][1] = 1;
            symtab[sti][2] = 1;
            sti++;
            //System.out.println("in2");
        }
        else if(words[0].equals("SAVE"))
        {
            sym[sti] = words[0];
            symtab[sti][0] = lc;
            symtab[sti][1] = 4;
            symtab[sti][2] = 0;
            sti++;
            String[] lcw = words[2].split("F");
            int ds = Integer.parseInt(lcw[0]);
            lc+= (ds*4);
            //System.out.println("in3");
        }
        else
        {
            sym[sti] = words[0];
            symtab[sti][0] = lc;
            symtab[sti][1] = 4;
            symtab[sti][2] = 0;
            sti++;
            if(words[0].equals("LOOP")) lc+=4;
            //System.out.println("in4");
        }
    }
    else if(words[1].equals("USING"))
    {
        line = reader.readLine();
        words = line.split("\\s+");
        //System.out.println("in11");
        //System.out.println(words[0]);
        continue;
    }
    else if(words[1].equals("LTORG"))
    {
        //System.out.println(lc+" "+words[1]);
```

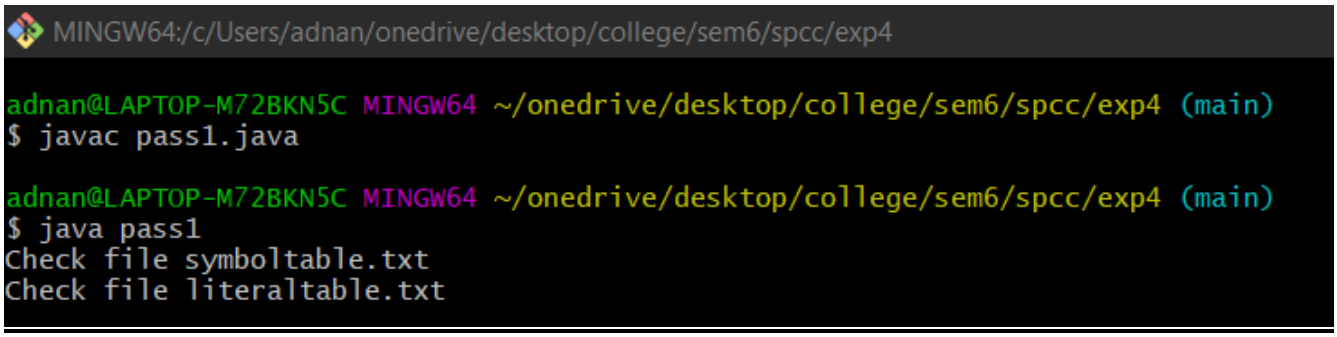
```
                while(lc%8!=0) lc++;
                for(i=0;i<di;i++)
                {
                    littab[li][0] = lc;
                    littab[li][1] = 4;
                    littab[li][2] = 0;
                    lc+=4;
                    li++;
                }
                //System.out.println("in12");
            }
            else
            {
                String[] opr = words[2].split(",");
                //System.out.println(lc+" "+words[1]);
                //System.out.println(opr[0]+" "+opr[1]);
                for(i=0;i<opr.length;i++)
                {
                    if(opr[i].charAt(0) == '=')
                    {
                        data[di] = opr[i];
                        di++;
                    }
                }
                if(words[1].charAt(words[1].length()-1) == 'R') lc+=2;
                else lc+=4;
                //System.out.println("in13");
            }
            //System.out.println(words[1]);
            line = reader.readLine();
            words = line.split("\\s+");
            //System.out.println(sym[sti-1]+" "+symtab[sti-1][0]+" "+symtab[sti-1][1]+"
"+symtab[sti-1][2]);
            //System.out.println(data[di-1]+" "+littab[di-1][0]+" "+littab[di-1][1]+" "+littab[di-
1][2]);
            //System.out.println(words[0]);
        }
        reader.close();
        //System.out.println("-----------------------------------------------------------");
        //System.out.println("Symbol Table");
        //System.out.println("Symbol   Value   Length  Relocation(0-R;1-A)");
        //System.out.println("-----------------------------------------------------------");

        try(OutputStream fw = new FileOutputStream("symboltable.txt"))
        {
            for(i=0;i<sti;i++)
            {
                //BufferedWriter bw = new BufferedWriter(fw);
                String content = sym[i]+" "+symtab[i][0]+" "+symtab[i][1]+"
"+symtab[i][2]+System.getProperty("line.separator");
```

```
                //System.out.println(content);
                fw.write(content.getBytes(),0,content.length());
                //System.out.println(sym[i]+" "+symtab[i][0]+" "+symtab[i][1]+"
"+symtab[i][2]);
            }
        }
        catch (IOException e) { e.printStackTrace(); }
        System.out.println("Check file symboltable.txt");
        //System.out.println("----------------------------------------------------------");
        //System.out.println("Literal Table");
        //System.out.println("Literal   Value   Length  Relocation(0-R;1-A)");
        //System.out.println("----------------------------------------------------------");
        try(OutputStream fw = new FileOutputStream("literaltable.txt"))
        {
           for(i=0;i<di;i++)
           {
              //BufferedWriter bw = new BufferedWriter(fw);
              String content = data[i]+" "+littab[i][0]+" "+littab[i][1]+"
"+littab[i][2]+System.getProperty("line.separator");
              //System.out.println(content);
              fw.write(content.getBytes(),0,content.length());
              //System.out.println(sym[i]+" "+symtab[i][0]+" "+symtab[i][1]+"
"+symtab[i][2]);
           }
        }
        catch (IOException e) { e.printStackTrace(); }
        System.out.println("Check file literaltable.txt");
     }
     catch (IOException e) { e.printStackTrace(); }
  }
}
```

Output-

Execution:



Input File:

prg - Notepad

File Edit View

```
PRGAM2 START 0
         USING *,15
         LA    15,SETUP
         SR    TOTAL,TOTAL
AC       EQU   2
INDEX  EQU   3
TOTAL  EQU   4
DATABASE EQU 13
SETUP  EQU   *
         USING SETUP,15
         L     DATABASE,=A(DATA1)
         USING DATAAREA,DATABASE
         SR    INDEX,INDEX
LOOP   L     AC,DATA1(INDEX)
         AR    TOTAL,AC
         A     AC,=F'6'
         ST    AC,SAVE(INDEX)
         A     INDEX,=F'4'
         C     INDEX,=F'8000'
         BNE   LOOP
         LR    1,TOTAL
         BR    14
         LTORG
SAVE   DS    2000F
DATAAREA EQU *
DATA1  DC    F'01'
       END
```

Symbol Table and Literal Table:

symboltable - Notep...

File Edit View

```
PRGAM2 0 1 0
AC 2 1 1
INDEX 3 1 1
TOTAL 4 1 1
DATABASE 13 1 1
SETUP 6 1 1
LOOP 12 4 0
SAVE 64 4 0
DATAAREA 8064 1 1
DATA1 8064 4 0
```

Ln 1, Col 1 100% Wi

literaltable - Notepad

File Edit View

```
=A(DATA1) 48 4 0
=F'6' 52 4 0
=F'4' 56 4 0
=F'8000' 60 4 0
```

Ln 1, Col 1 100% Wind

Conclusion: We have successfully implemented Pass 1 of two pass Assembler