EEL 4744C: Microprocessor Applications

Lecture 4

S/W Design and 68HC12 Programming

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Reading Assignment

- Software and Hardware Engineering: Chapter 3, 8, 9 (New version)
  
  Or
  
  - Microcontrollers and Microcomputers: Chapter 6
  
  &
  
  - Software and Hardware Engineering: Chapter 6 (Old version)

Software Design

- Means designing the software before writing the program code
- The general approach is to learn the instruction set and the syntax first, without too much design
- As you become familiar with the processor, work on designing the solution, rather than just coding the solution
- Designing the software is more than just writing the software!

Use Flowcharts to Plan Program Structure

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IF-THEN Flow Structure

Example: IF-THEN

<table>
<thead>
<tr>
<th>Pseudocode</th>
<th>Assembly Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF (A&lt;10)</td>
<td></td>
</tr>
<tr>
<td>{</td>
<td></td>
</tr>
<tr>
<td>\texttt{var} = 5;</td>
<td></td>
</tr>
<tr>
<td>}</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMNW #10</td>
</tr>
<tr>
<td>R\texttt{BR} #5</td>
</tr>
<tr>
<td>ST\texttt{OR} \texttt{VAR}</td>
</tr>
<tr>
<td>L2: \texttt{JMP} \texttt{INSTRUCTION}</td>
</tr>
</tbody>
</table>
**IF-THEN-ELSE Flow Structure**

```
if (C)
    { A;
    }
else
    { B;
    }
```

**Example: IF-THEN-ELSE**

Assembly Code

```
if (A<10)
    { var = 5;
    }  
else
    { var = 0;
    }
```

**Example: IF-THEN-ELSE Decision**

```
; Get Temperature
ldaa AD_PORT
; IF Temperature > Allowed Maximum
cmpa #MAX_ALLOWED
    bls ELSE_PART
; branch lower or same (u.b.)

; THEN Turn the water valve off
ldaa VALVE_OFF
staa VALVE_PORT
bra END_IF

; ELSE Turn the water valve on
ELSE_PART:
ldaa VALVE_ON
staa VALVE_PORT
END_IF:
```

**DO-WHILE Flow Structure**

```
do
    { A;
    }
while (C);
```

**Example: DO-WHILE**

```
LDX table
CLRA
L1: ASR 1,X+  
INCA  
CMPA #LEN  
BLE L1
```

**Example: DO-WHILE Repetition**

```
:DO
:DO_BEGIN:
: Get data from the switches
ldaa SW_PORT
: Output the data to the LEDs
staa LEDS
:END_DO
:WHILE Any switch is set
    tst SW_PORT
    bne DO_BEGIN
:END_WHILE
```
WHILE Flow Structure

Example: WHILE

Example: WHILE-DO Repetition

Top-Down Design: An Example

Top-Down Design (1)

Top-Down Design (2)
Top-Down Design (3)

- Step 4: Use a simple flow chart to plan structure of program

Top-Down Design (4)

- Need a way to determine when we reach the end of the table
  - One way: Use a counter (say, register A) to keep track of how many elements we have processed

Top-Down Design (5)

- Step 5: Add code to implement blocks

Top-Down Design (6)

- Step 6: Write program

```
; Program to divide a table by two
; and store the result in memory
prog: cmp Byte Para
next: mov mem A
inc
mov mem B
jnz next
```

Top-Down Design (7)

- Step 7: Optimize program to make use of instructions set efficiencies

Summary of Top-Down Program Design

- Plan structures in memory
- Start with a large picture of program structure
- Work down to more detailed structure
- Translate structure into code
- Optimize for efficiency