CSE 433 Embedded Systems Project 1 Report

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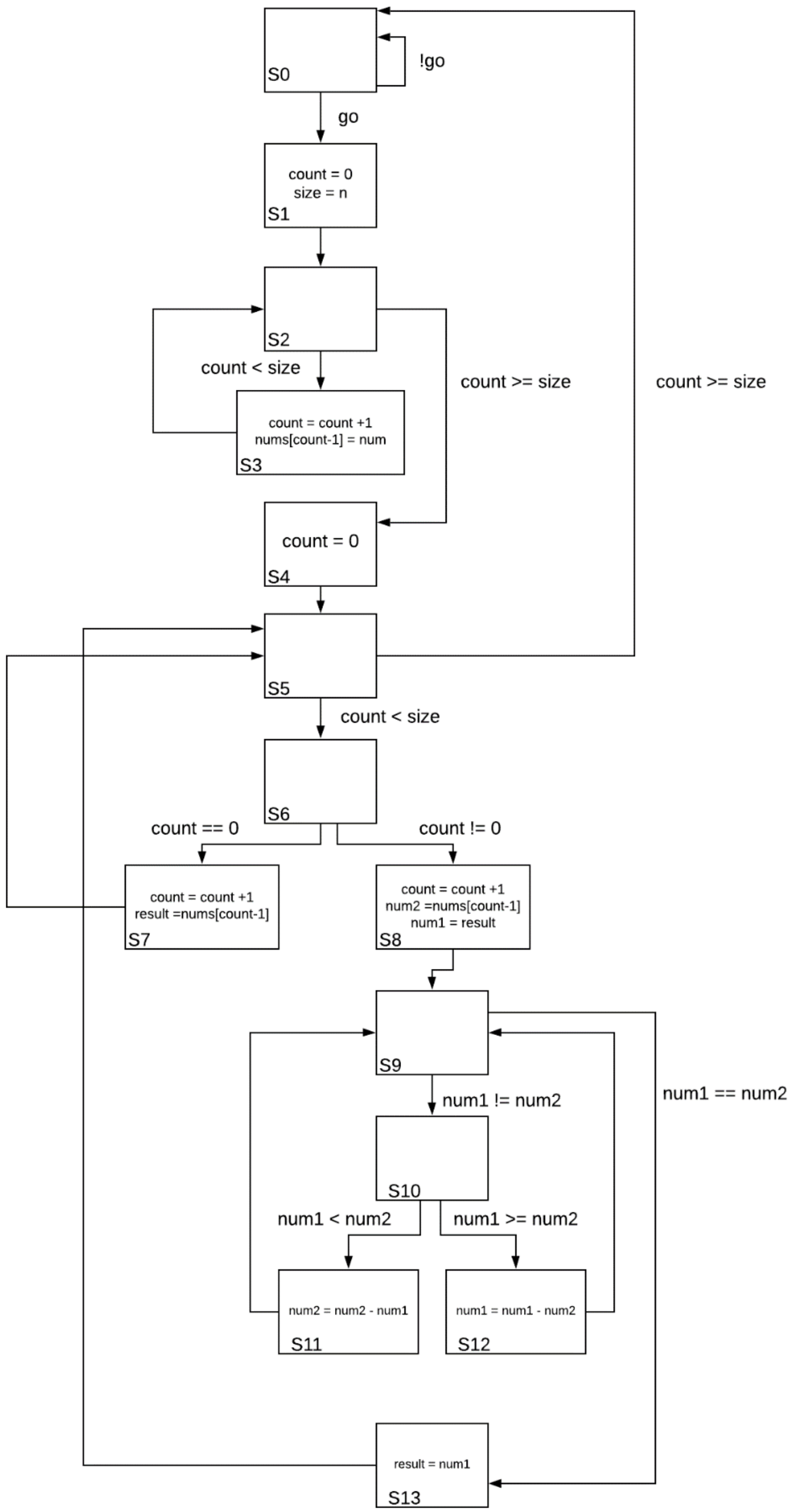
Assumptions and Notes

- When giving the go signal 1 the n input (which is the size input) has to be given.
- After all the numbers are entered the go input has to be 0.
- The first number must be entered at the 5th clock cycle, the second must be entered at the 7th clock cycle, the third is 9th and so on. Shortly, the first number must be entered right before the 5th clock cycle and between every 2 clock cycles the new numbers must be entered.
- As it can be observed the code and the implementation has minor differences. Due to the use of RAM in the logisim, loading a number to the RAM takes 2 clock cycles. That is why the "a" signal is implemented as count <=size so that the numbers can be loaded correctly before moving on to the next state.
- All the designs of this calculations are implemented in the logisim project with modules. This project includes a control unit a datapath and a state calculating (S0,S1..) module. The main circuit is the circuit which implements the gcd circuit.

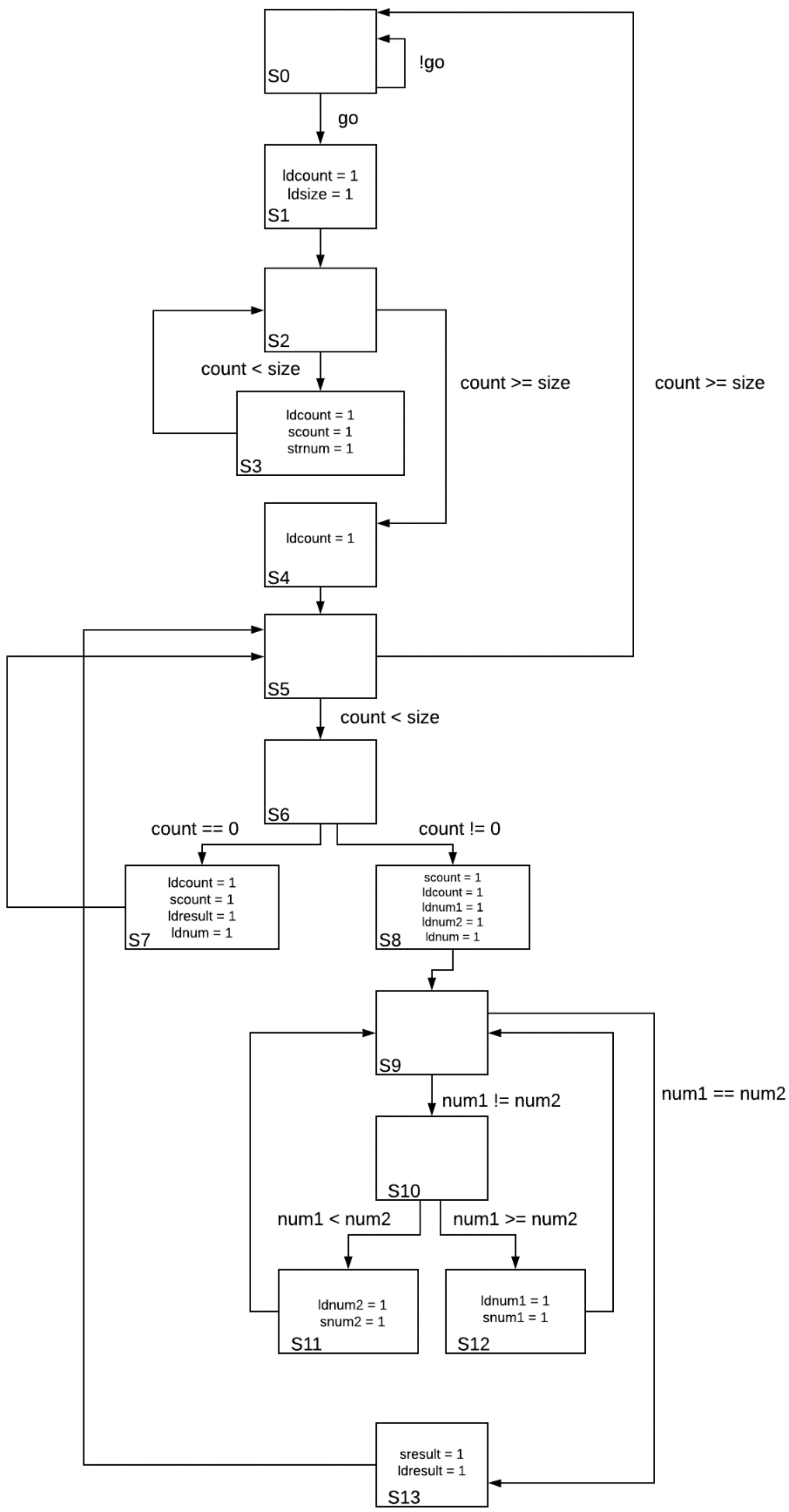
1) C code

```c
#include <stdio.h>
#include <stdlib.h>
int main(){
    int num_1, num_2, result, size, go;
    int num_arr[256];
    int count = 0;
    go = 1;
    while(!go);

    printf("Enter size :");
    scanf("%d" , &size);
    while(count < size){
        printf("Enter number %d :" , count+1);
        scanf("%d", &num_arr[count]);
        count++;

    }
    count = 0;
    go = 0;
    while(count < size){
        if(count == 0){
            count++;
            result = num_arr[count-1];
        }
        else{
            count++;
            num_2 = num_arr[count-1];
            num_1 = result;
            while(num_1 != num_2){
                if(num_1 < num_2){
                    num_2 = num_2 - num_1;
                }
                else{
                    num_1 = num_1 - num_2;
                }
            }
            result = num_1;
        }
    }
    printf("Result is: %d" , result);
}
```

2) State Diagram



3) Diagram for the signals which will be controlled by control unit



Conditions are coded from a to h which are:

a: count < size

b: count >= size

c: count == 0

d: count != 0

e: num1 != num2

f: num1 == num2

g: num1 < num2

h: num1 >= num2

With this diagram we can generate the signals which are:

snum1 = S12

ldnum1 = S8 + S12

snum2 = S11

ldnum2 = S8 + S11

scount = S3 + S7 + S8

ldcount = S1 + S3 + S4 + S7 + S8

ldsize = S1

sresult = S13

ldresult = S7 + S13

ldnum = S7 + S8

strnum = S3

4) State Transition Table and Boolean Expressions

Present State	go	a	b	c	d	e	f	g	h	Next State
S0 (0000)	**0**	x	x	x	x	x	x	x	x	S0 (0000)
S0 (0000)	**1**	x	x	x	x	x	x	x	x	S1 (0001)
S1 (0001)	x	x	x	x	x	x	x	x	x	S2 (0010)
S2 (0010)	x	**1**	**0**	x	x	x	x	x	x	S3 (0011)
S2 (0010)	x	**0**	**1**	x	x	x	x	x	x	S4 (0100)
S3 (0011)	x	x	x	x	x	x	x	x	x	S2 (0010)
S4 (0100)	x	x	x	x	x	x	x	x	x	S5 (0101)
S5 (0101)	x	**1**	**0**	x	x	x	x	x	x	S6 (0110)
S5 (0101)	x	**0**	**1**	x	x	x	x	x	x	S0 (0000)
S6 (0110)	x	x	x	**1**	**0**	x	x	x	x	S7 (0111)
S6 (0110)	x	x	x	**0**	**1**	x	x	x	x	S8 (1000)
S7 (0111)	x	x	x	x	x	x	x	x	x	S5 (0101)
S8 (1000)	x	x	x	x	x	x	x	x	x	S9 (1001)
S9 (1001)	x	x	x	x	x	**1**	**0**	x	x	S10 (1010)
S9 (1001)	x	x	x	x	x	**0**	**1**	x	x	S13 (1101)
S10 (1010)	x	x	x	x	x	x	x	**1**	**0**	S11 (1011)
S10 (1010)	x	x	x	x	x	x	x	**0**	**1**	S12 (1100)
S11 (1011)	x	x	x	x	x	x	x	x	x	S9 (1001)
S12 (1100)	x	x	x	x	x	x	x	x	x	S9 (1001)
S13 (1101)	x	x	x	x	x	x	x	x	x	S5 (0101)

With this table we can generate next state digits binary expressions which are:

$$N3 = S6\,.\,\bar{c}\,.\,d + S8 + S9.\,e.\,\bar{f} + S9.\,\bar{e}\,.\,f + S10.\,g.\,\bar{h} + S10.\,\bar{g}.\,h + S11 + S12$$

$$N2 = S2.\,\bar{a}.\,b + S4 + S5.\,a.\,\bar{b} + S6.\,c.\,\bar{d} + S7 + \ S9.\,\bar{e}\,.\,f + \ S10.\,\bar{g}.\,h + S13$$

$$N1 = S1 + S2.\,a.\,\bar{b} + S3 + S5.\,a.\,\bar{b} + S6.\,c.\,\bar{d} + S9.\,e.\,\bar{f} + \ S10.\,g.\,\bar{h}$$

$$N0 = S0.\,go + \ S2.\,a.\,\bar{b} + S4 + \ S6.\,c.\,\bar{d} + S7 + S8 + \ S9.\,\bar{e}\,.\,f + \ S10.\,g.\,\bar{h} + S11 + S12 + S13$$