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EDGE DETECTION USING SOBEL OPERATOR

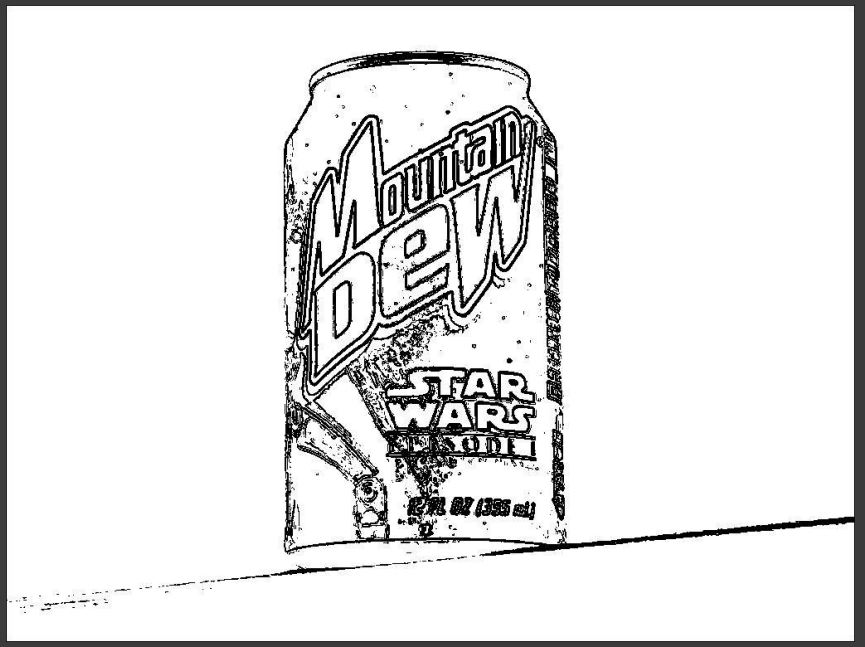
Uses

- Detecting discontinuities in depth
- Detecting changes in material properties
- Image processing software
- Finger prints detection

Example



Original



Edge detection

Approach

Sobel Operator

-1	0	+1
-2	0	+2
-1	0	+1

Gx

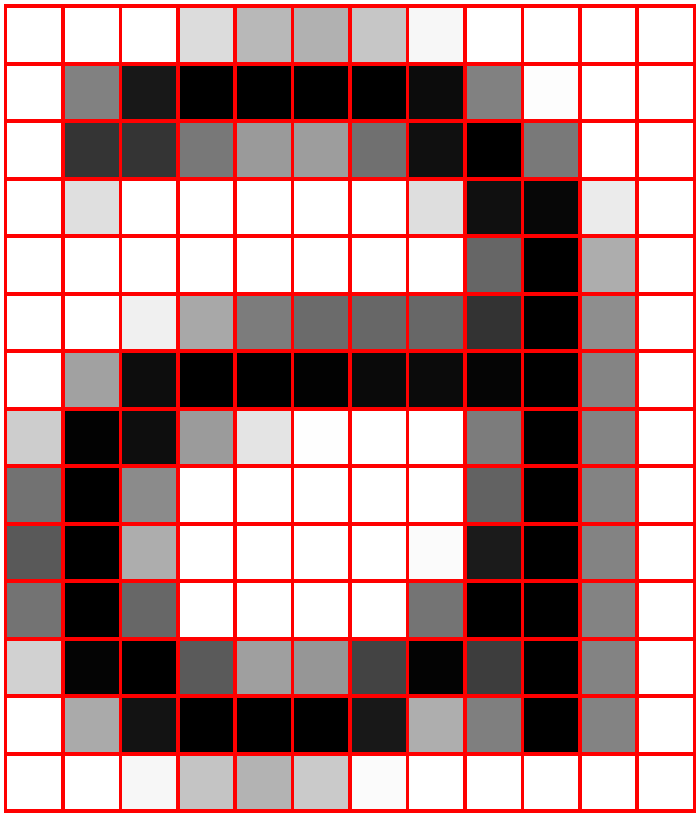
+1	+2	+1
0	0	0
-1	-2	-1

Gy

Sobel Convolution

Original Image

a



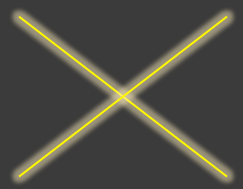
1.0	1.0	1.0	0.9	0.6	0.6	0.6	1.0	1.0	1.0	1.0	1.0
1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.0	1.0
1.0	0.2	0.2	0.5	0.6	0.6	0.5	0.0	0.0	0.5	1.0	1.0
1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.0	0.0	0.9	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.5	1.0
1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.4	0.0	0.5	1.0
1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0
0.9	0.0	0.0	0.6	1.0	1.0	1.0	1.0	0.5	0.0	0.5	1.0
0.5	0.0	0.6	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.5	1.0
0.5	0.0	0.7	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.5	1.0
0.6	0.0	0.6	1.0	1.0	1.0	1.0	0.5	0.0	0.0	0.5	1.0
0.9	0.1	0.0	0.6	0.7	0.7	0.5	0.0	0.5	0.0	0.5	1.0
1.0	0.7	0.1	0.0	0.0	0.0	0.1	0.9	0.8	0.0	0.5	1.0
1.0	1.0	1.0	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0

Image

255	255	255	230	153	153	255	255	255	255	0	255
255	128	0	0	0	0	0	0	128	255	255	255
255	51	51	153	128	128	153	0	0	255	255	255
255	230	255	255	255	255	255	230	0	0	230	255
255	255	255	255	255	255	255	255	128	0	128	255
255	255	255	128	128	128	128	128	102	0	128	255
255	102	0	0	0	0	0	0	0	0	129	255
230	0	0	153	255	255	255	255	128	0	128	255
129	0	153	255	255	255	255	255	255	0	129	255
179	0	179	255	255	255	255	255	0	0	129	255
153	0	153	255	255	255	0	129	0	0	129	255
230	26	0	153	179	179	129	0	129	0	129	255
26	179	26	0	0	0	26	230	204	0	129	255
255	255	255	204	204	230	255	255	255	255	255	255

Element wise Multiplication

255	255	255
255	128	0
255	51	51



-1	0	1
-2	0	2
-1	0	1

-255	0	255
-510	0	0
-255	0	51

Result

-(255+510+255)+(0+0+0)+(255+0+51)

= -714

Final Matrix - X

-714	-179	-25	-102	127	-26	103	765	254	0
-663	101	154	-50	50	-281	-433	535	867	255
-204	152	77	-25	25	-178	-790	-460	715	765
0	-102	-127	0	0	-25	-535	-868	256	1020
-255	-356	-254	0	0	0	-179	-511	181	1020
-740	-178	128	102	0	0	-153	-383	284	1020
-691	459	612	204	0	0	-254	-765	3	1020
-182	918	535	102	0	0	-382	-1020	-123	1020
24	1020	356	0	-255	-126	-510	-894	261	1020
-230	892	459	26	-560	-431	-255	-513	387	1020
-460	330	434	52	-329	-254	178	-359	54	1020
-230	-282	76	205	53	306	356	-73	-150	765

Final Matrix - Y

-612	-689	-383	-152	-177	-484	-867	-765	0	510
459	867	1020	1020	1020	995	587	-281	-663	-305
612	714	535	483	483	586	740	256	-509	-509
50	-102	-381	-508	-508	-483	-229	102	0	-204
-561	-918	-1020	-1020	-1020	-1020	-893	-511	-127	2
-790	-740	-78	406	508	508	407	179	26	0
-177	459	918	1020	1020	1020	1020	765	255	0
128	460	383	102	0	0	-128	-256	-127	2
24	0	0	0	-255	-636	-762	-636	-255	0
-76	-434	-459	-330	-354	-583	-507	3	129	0
104	-330	-866	-1020	-739	-102	432	509	204	0
738	790	382	152	253	558	762	762	762	507

Final Pixel Value

$$\mathbf{G} = \sqrt{\mathbf{G}_x^{\,2} + \mathbf{G}_y^{\,2}}$$

```
Process (clk,reset)
begin
        if reset = '1' then
        if clk'event and clk = '1' then
                L3: for m in 0 to 2 loop
                L4: for n in 0 to 2 loop
                        if i <= 12 then
                        if j <= 10 then
                        mat(m,n) <= A(i+m-1, j+n-1);

sobelx <=
(-1*conv_integer(mat(0,0)))+(-2*conv_integer(mat(1,0)))+(-1*conv_integer(mat(2,0))) +
(1*conv_integer(mat(0,2)))+(2*conv_integer(mat(1,2)))+(1*conv_integer(mat(2,2)));

sobely <=
(-1*conv_integer(mat(0,0)))+(-2*conv_integer(mat(0,1)))+(-1*conv_integer(mat(0,2))) +
(1*conv_integer(mat(2,0)))+(2*conv_integer(mat(2,1)))+(1*conv_integer(mat(2,2)));

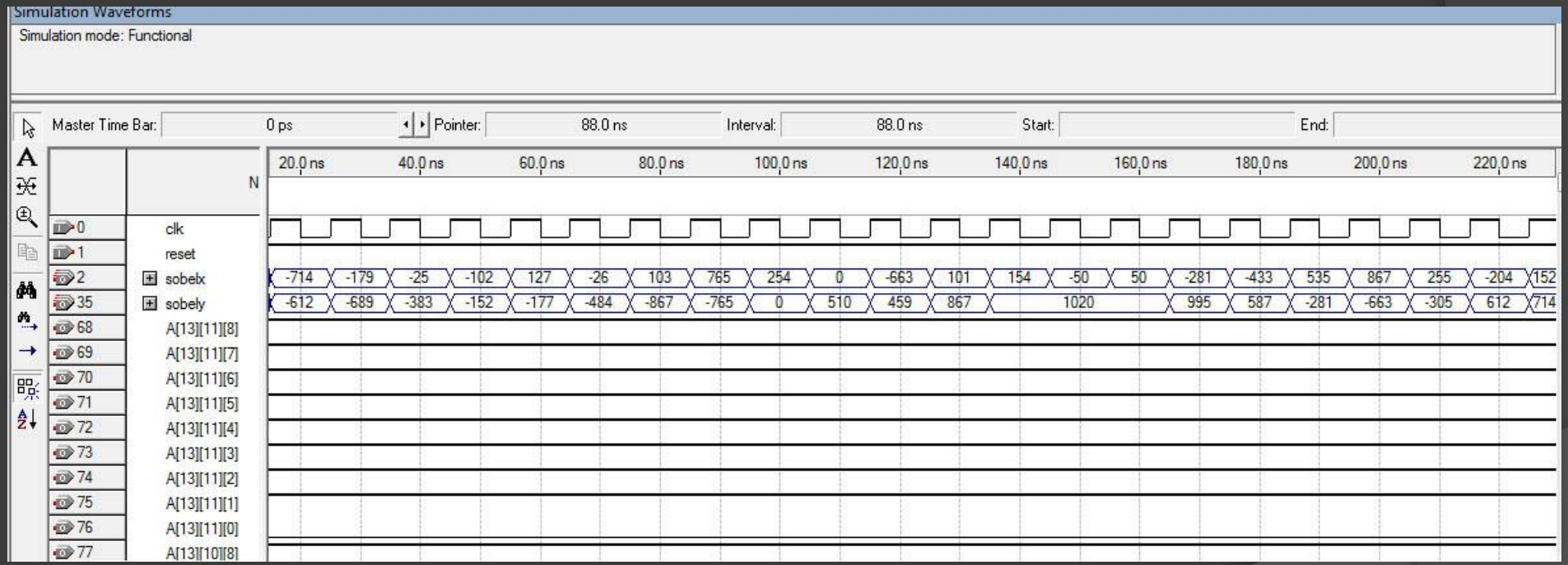
                        i <= i + 1;
                        end if;
                        if j = 10 then
                        i <= i +1;
                        j <= 1;
                        end if;
                        end if;
                end loop;
                end loop;
        end if;
        end if;
end process;
```

```
L1 : edge_detect PORT MAP (switch1, switch2,D,J);
        process(D,J)
        begin
                if D < 0 then
                        i1 <= (-1 * D);
                        LED_0 <= '1';
                        a1 <= i1/1000;
                        O4_1 <= a1;
                        b1 <= i1 - 1000*a1;
                        c1 <= b1/100;
                        O3_1 <= c1;
                        e1 <= b1 - 100*c1;
                        f1 <= e1/10;
                        O2_1 <= f1;
                        O1_1 <= e1 - 10*f1;
                else
                        LED_0 <= '0';
                        i1 <= D;
                        a1 <= i1/1000;
                        O4_1 <= a1;
                        b1 <= i1 - 1000*a1;
                        c1 <= b1/100;
                        O3_1 <= c1;
                        e1 <= b1 - 100*c1;
                        f1 <= e1/10;
                        O2_1 <= f1;
                        O1_1 <= e1 - 10*f1;
                end if;
```

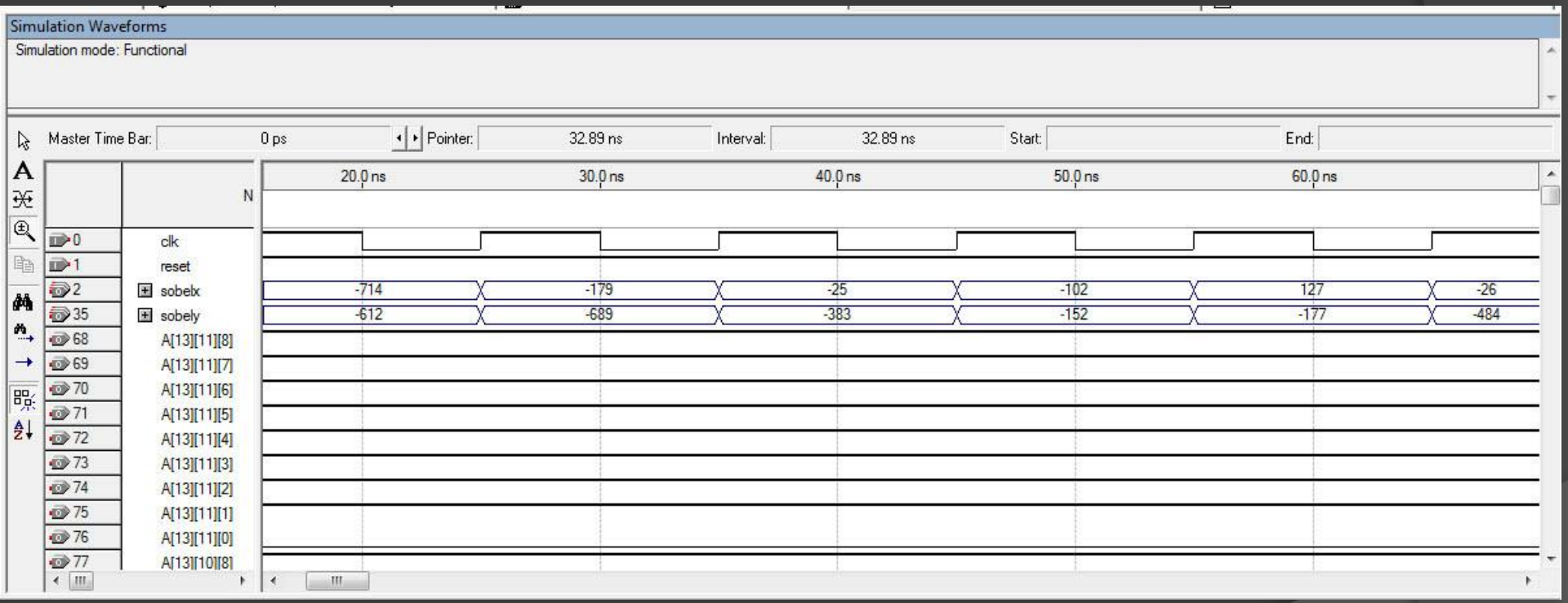
-------- For 7- Segment Display----------

```
CASE i1 IS
        WHEN "0000"=>B<="1000000";
        WHEN "0001"=>B<="1111001";
        WHEN "0010"=>B<="0100100";
        WHEN "0011"=>B<="0110000";
        WHEN "0100"=>B<="0011001";
        WHEN "0101"=>B<="0010010";
        WHEN "0110"=>B<="0000010";
        WHEN "0111"=>B<="1111000";
        WHEN "1000"=>B<="0000000";
        WHEN "1001"=>B<="0010000";
        WHEN OTHERS=>B<="0000000";
```

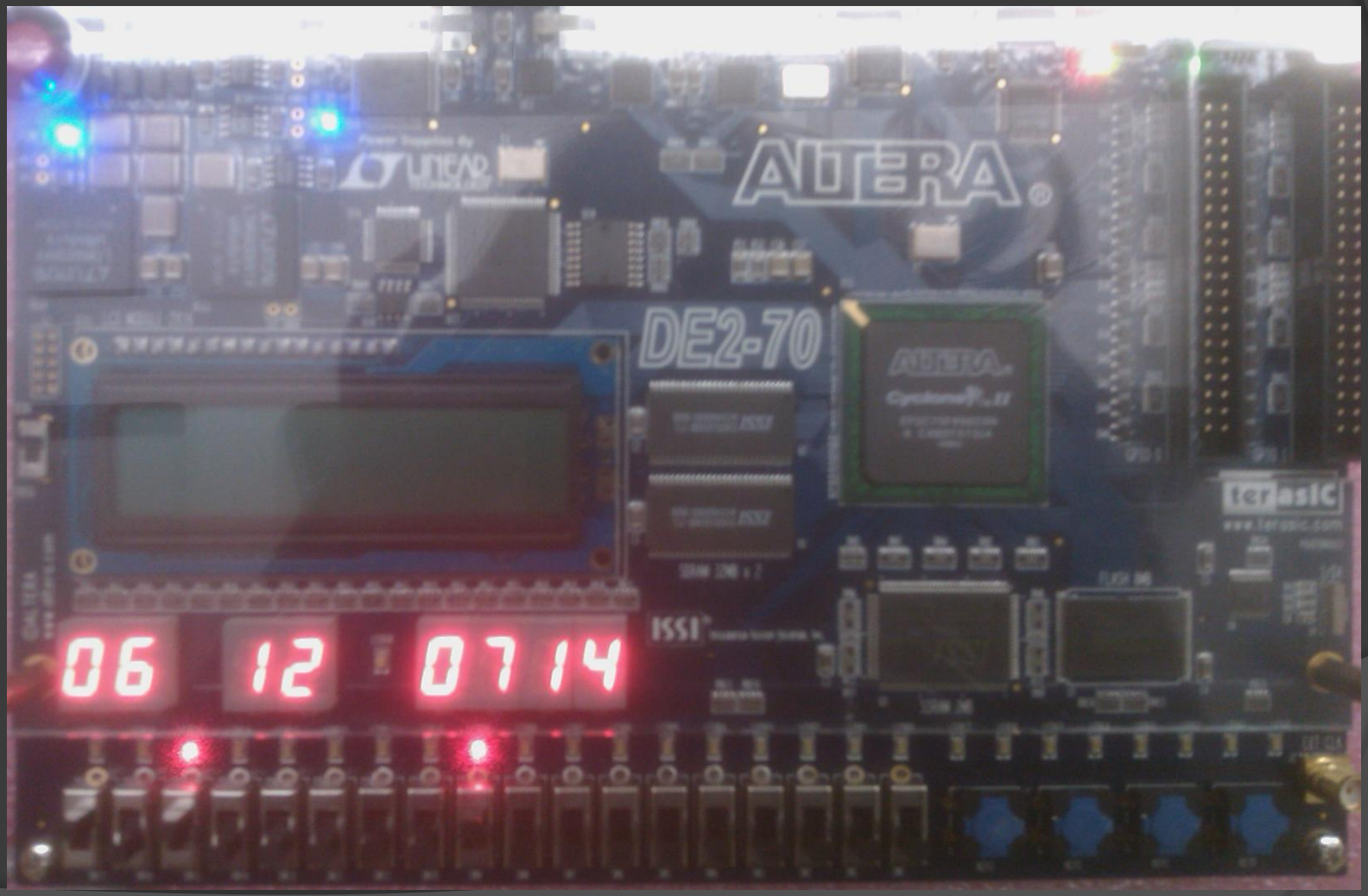
Simulation


Simulation Waveforms
Simulation mode: Functional
Master Time Bar: 0 ps
Pointer: 88.0 ns
Interval: 88.0 ns
Start:
End:
20.0 ns
40.0 ns
60.0 ns
80.0 ns
100.0 ns
120.0 ns
140.0 ns
160.0 ns
180.0 ns
200.0 ns
220.0 ns
N
0 clk
1 reset
2 sobelx -714 -179 -25 -102 127 -26 103 765 254 0 -663 101 154 -50 50 -281 -433 535 867 255 -204 152
35 sobely -612 -689 -383 -152 -177 -484 -867 -765 0 510 459 867 1020 995 587 -281 -663 -305 612 714
68 A[13][11][8]
69 A[13][11][7]
70 A[13][11][6]
71 A[13][11][5]
72 A[13][11][4]
73 A[13][11][3]
74 A[13][11][2]
75 A[13][11][1]
76 A[13][11][0]
77 A[13][10][8]

Simulation


Simulation Waveforms
Simulation mode: Functional
Master Time Bar: 0 ps
Pointer: 32.89 ns
Interval: 32.89 ns
Start:
End:
N
20.0 ns
30.0 ns
40.0 ns
50.0 ns
60.0 ns
0 clk
1 reset
2 sobelx -714 -179 -25 -102 127 -26
35 sobely -612 -689 -383 -152 -177 -484
68 A[13][11][8]
69 A[13][11][7]
70 A[13][11][6]
71 A[13][11][5]
72 A[13][11][4]
73 A[13][11][3]
74 A[13][11][2]
75 A[13][11][1]
76 A[13][11][0]
77 A[13][10][8]

Display using 7-segment



Future Implementation

- Project final image on a LCD screen
- Convolve Images in Real time.
- Implementing Color detection.

Questions?