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**COMMAND CONTROL ROBOT ON FIELD  
PROGRAMMABLE GATE ARRAY**

**19ECE343 - FPGA BASED SYSTEM DESIGN**

**TERM WORK**

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## **ABSTRACT:**

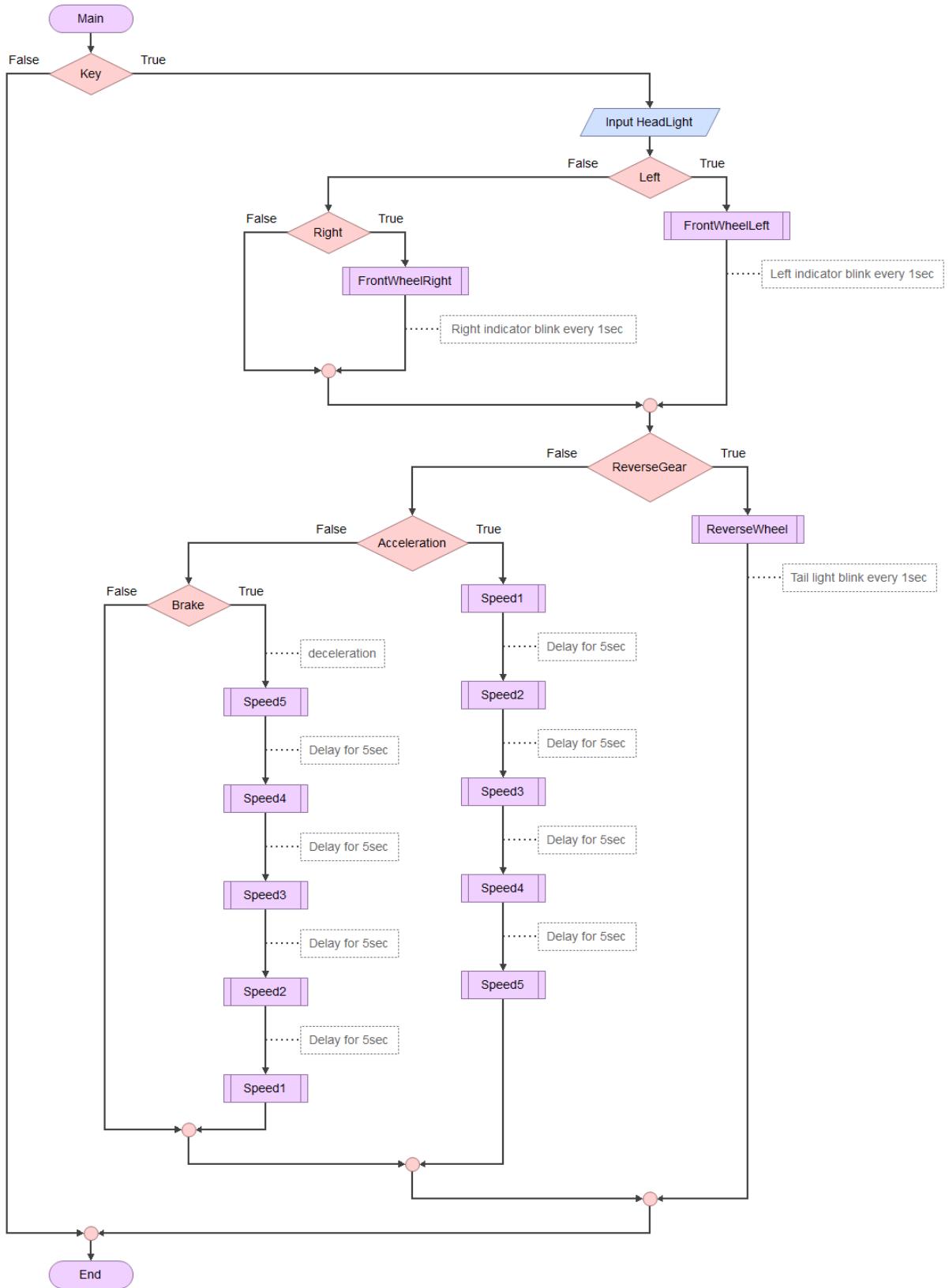
This term work is on a simple Car Control model using Basys 3 FPGA Board. The board helps to control the input using switches and debouncing buttons and displays the output on BCD display and LEDs. Initially, this design was implemented in Modelsim and then by using Vivado it is been implemented on the FPGA board.

## **INTRODUCTION:**

Our proposed model describes the different stages of car movements and is designed using FPGA Board. There are 5 stages of acceleration speed control, brake stage, and reverse stage. Further, the user can turn the car either left or right. The stages like brake, left, right and reverse can be indicated by the tail light, left indicator light, right indicator light, and reverse light respectively. The 5 stages of acceleration, brake, reverse, left and right turn are controlled by using debouncing buttons, where the output of the speed and brake is shown in the 7-segment BCD display and the light is indicated using the LEDs of Basys 3 FPGA board.

The Basys 3 is an entry-level FPGA development board designed exclusively for the Vivado Design featuring the Xilinx Artix-7-FPGA architecture. Basys 3 is the newest addition to the popular Basys line of FPGA development boards for beginners just to get ease with FPGA technology. The Basys 3 includes the standard features found on all Basys boards: complete ready-to-use hardware, an extensive collection of onboard I/O devices, all required FPGA support circuits, and a free version of development tools.

## BLOCK DIAGRAM:



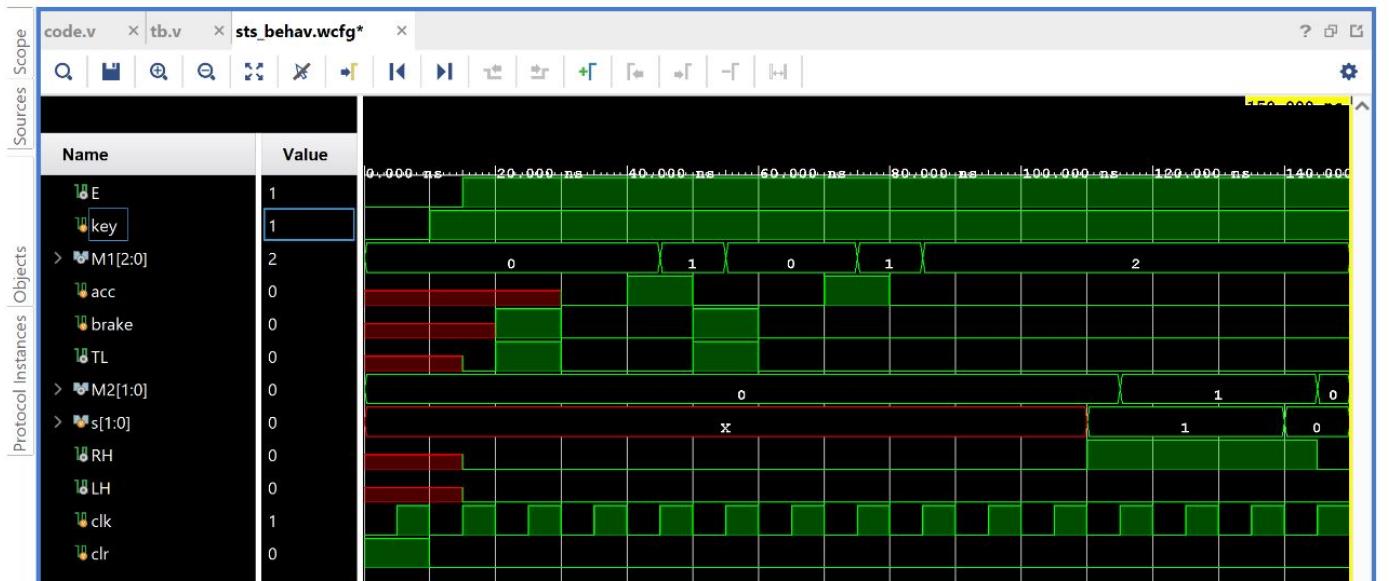
## CODE:

```
module Control_CC( output reg[1:0] M2,output reg E,TL,RH,LH,HL,AL, output reg [3:0] AN,output reg[6:0] LED,input key,brake,acc,r,l,clk,hl,gear);

parameter stop=3'd0,g1=3'd1,g2=3'd2,g3=3'd3,g4=3'd4,g5=3'd5,rg=3'd6;
parameter T=1'b1, F=1'b0;
parameter straight=2'd0, right=2'd1, left=2'd2;
reg sec,f,rst;
reg [2:0] M1;
reg [26:0] ct;
reg [6:0] count;

initial {f,count,M1}<={T,4'd0,3'd0};
always@(posedge clk) begin
    {ct,sec} <= (ct == 27'd50_000_000)?{27'd0,~sec}:{ct + 1'b1,sec};
    E <= key?1'b1:1'b0;
    AN<= key?(gear?(sec?4'b0000:4'b1111):4'b1110):4'b1111;
    TL <= (!gear)?((brake&&key)? 1'b1:1'b0):((sec&&gear&&key)?1'b1:1'b0);
    HL <= (hl&&key)? 1'b1:1'b0;
    AL <= (acc&&key)? 1'b1:1'b0;
end
always@(posedge clk) begin
    case({l,r,key,brake})
        {left,T,F}: if(M1<g4) {LH,RH,M2}<=sec?{left,left}:{straight,left};
        {right,T,F}:if(M1<g4) {LH,RH,M2}<=sec?{right,right}:{straight,right};
        default: {LH,RH,M2} <={straight,straight};
    endcase
end
always@(posedge sec) begin
    if(count<6'd3) M1<=stop;
    if(6'd10>count&&count>6'd5) M1<=g1;
    if(6'd15>count&&count>6'd10) M1<=g2;
    if(6'd20>count&&count>6'd15) M1<=g3;
    if(6'd25>count&&count>6'd20) M1<=g4;
    if(6'd30>count&&count>6'd25) M1<=g5;
    if(gear&&key) M1<=rg;
end
always @ (posedge sec) begin
    casex ({gear,key,brake,acc})
        {F,T,F,T}: count<=(M1<g5)?count+6'd3:count;
        {F,T,F,F}: count<=(M1>g1)?count-6'd1:count;
        {F,T,T,F}: count<=(M1>stop)?count-6'd3:count;
    endcase end
always @ (posedge clk) begin
    case(M1)
        stop: LED <= 7'b0000001; // "0"
        g1: LED <= 7'b1001111; // "1"
        g2: LED <= 7'b0010010; // "2"
        g3: LED <= 7'b0000110; // "3"
        g4: LED <= 7'b1001100; // "4"
        g5: LED <= 7'b0100100; // "5"
        rg: LED <= LED; // "6"
        default: LED <= 7'b0000001; // "0"
    endcase end
endmodule
```

## SIMULATION:



### **Test Bench:**

```

module sts;
wire [2:0] M1;
wire [1:0] M2;
wire E,TL,RH,LH;
reg key,brake,acc,clk,clr;
reg [1:0] s;

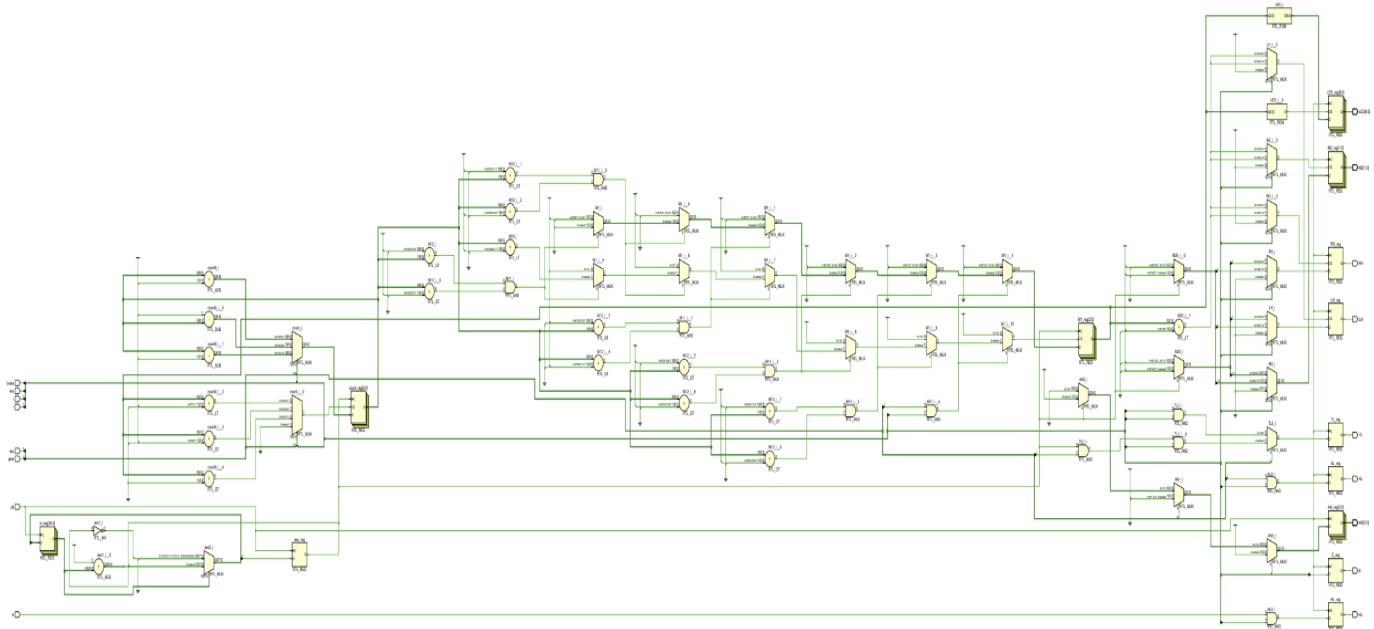
Control_Car c1(E,TL,RH,LH,M1,M2,key,brake,acc,clk,clr,s);
initial begin clk= `False;
forever #5 clk = ~clk; end

initial begin
clr = `True;
repeat (0.5) @ (negedge clk);
clr = `False; end

initial begin
key=0;
#10 key=1;
#10 brake=1;
#10 brake = 0; acc=0;
#10 acc=1;
#10 acc=0; brake=1;
#10 brake=0;acc=0;
#10 acc=1;
#10 acc=0;
#30 s=1;
#30 s=0;
end
endmodule

```

## RTL SYNTHESIS:



## PIN CONNECTIONS:

Inputs Switches:

clk	W5
key	R2
hl	T1

Debonucing Button :

acc	T18
l	W19
r	T17
brake	U18
gear	U17

Light Indicators:

E	L1
HL	P1
AL	N3
LH	U3
RH	V13
TL	P3
M2[0]	V3
M2[1]	W3

Seven-segment LED Display:

LED[6]	W7
LED[5]	W6
LED[4]	U8
LED[3]	V8
LED[2]	U5
LED[1]	V5
LED[0]	U7
AN[0]	U2
AN[1]	U4
AN[2]	V4
AN[3]	W4

## **RESULTS:**

Utilization		Post-Synthesis   Post-Implementation	
		Graph   Table	
Resource	Utilization	Available	Utilization %
LUT	37	20800	0.18
FF	52	41600	0.13
IO	27	106	25.47
BUFG	1	32	3.13

Fig: Utilization Report

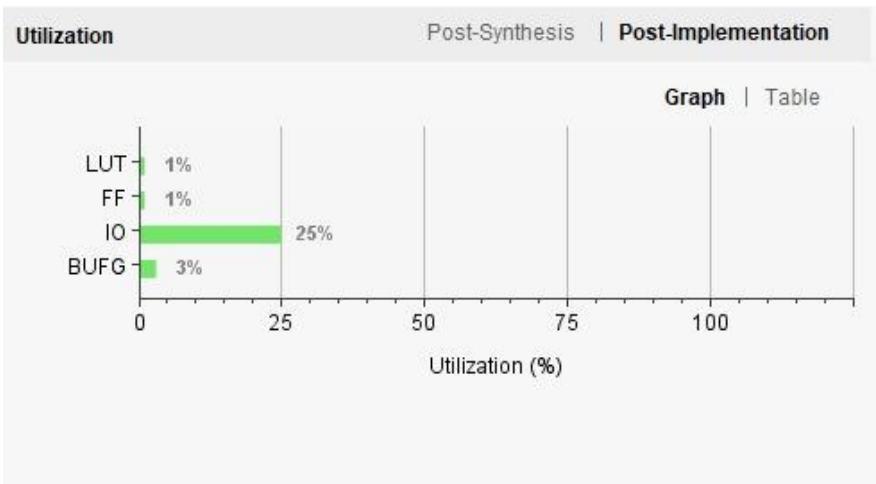


Fig: Utilization Graph

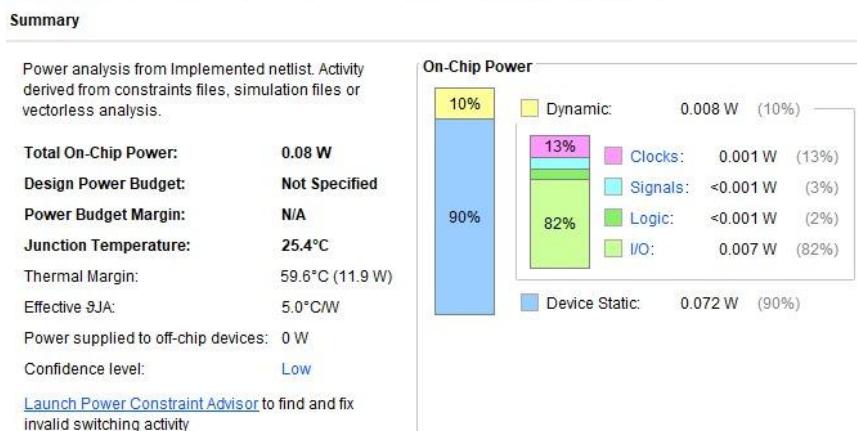


Fig: Implementation Power Report

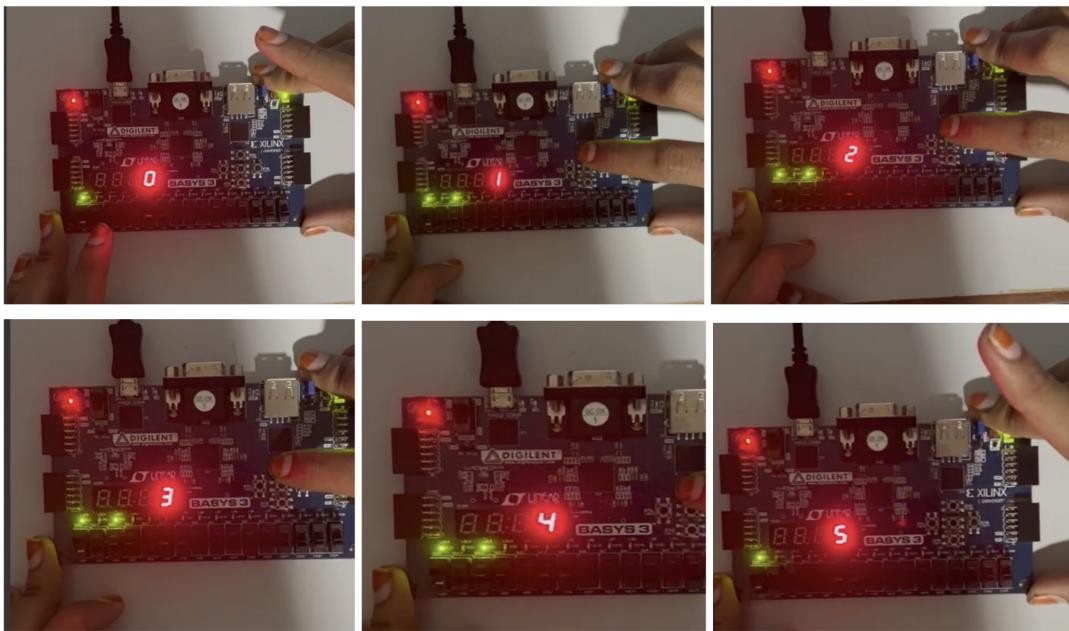


Fig: Speed levels

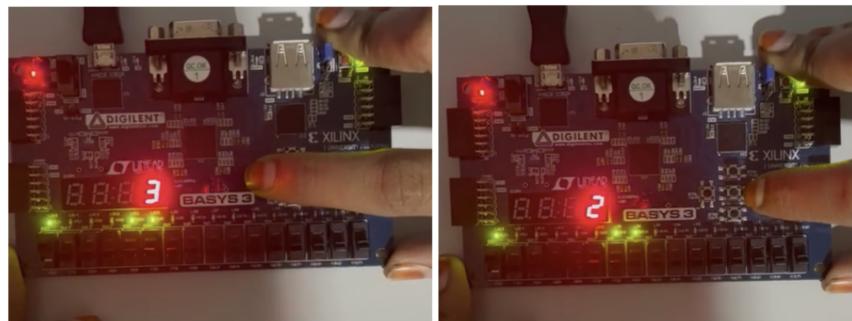


Fig: Left and Right Indicators

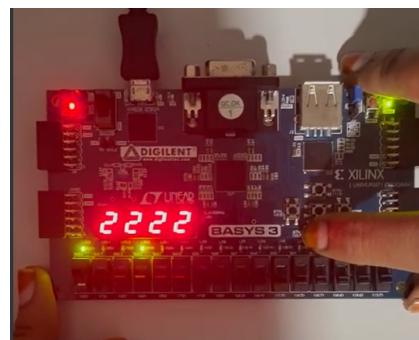


Fig: Reverse

Working VIDEO LINK:

[https://drive.google.com/file/d/1oRGV6CLLY5hv9Ai81t-KZeA9sLKwv6E4/view?usp=share\\_link](https://drive.google.com/file/d/1oRGV6CLLY5hv9Ai81t-KZeA9sLKwv6E4/view?usp=share_link)

**FUTURE SCOPE:** This can be further implemented by externally using USB to feed inputs, and also can be practically used by feeding the output signals to Driver motor and controlling it by a joystick through USB, or even more improved version can be used to send inputs through mobile application using Bluetooth connectivity.

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