Project Report

On

Automatic Washing Machine Control System

Submitted in the partial fulfilment of 5TH Semester project work of

Bachelor of Technology
in
Electronics & Communication Engineering

By

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OBJECTIVE :

- The main aim of the project is to design a automatic washing machine control system
- using Verilog on Cadence.
- The primary objective is to automate the various stages of the washing process, including filling and draining water, agitating the clothes, rinsing, and spinning. This automation reduces the manual effort required from the user and ensures consistent washing results.

SOFTWARE USED:

- Cadence
- Verilog: C like HDL is easier to comprehend and saves design time since the syntax is more concise that VHDL

INTRODUCTION

- The introduction of automatic washing machine control systems has revolutionized the way we approach laundry, streamlining the process and enhancing user convenience.
- offering a range of features that contribute to energy efficiency, water conservation, and overall washing performance
- Energy efficiency is another crucial aspect addressed by these control systems. With features such as load sensing, temperature control, and optimized motor operations, modern washing machines aim to minimize energy consumption without compromising on performance.

AUTOMATIC WASHING MACHINE

- An automatic washing machine control system is a sophisticated set of electronic and mechanical components designed to automate the process of washing clothes.
- Various sensors are employed to gather information about the washing process. Common sensors include load sensors to detect the amount of laundry, water level sensors to monitor water levels, temperature sensors, and imbalance sensors to ensure even distribution of the load.

WORKING PRINCIPLE:

- The washing cycle begins when the user selects the desired wash program and settings using the control panel or user interface. This input includes parameters such as wash cycle type, water temperature, spin speed, and any additional options.
- Load sensors detect the amount of laundry in the drum. This information is used by the control system to determine the appropriate water level for the wash cycle.
- Solenoid valves controlled by the system open to allow water into the washing machine.
- The washing machine has an automatic detergent dispenser, the control system releases the appropriate amount of detergent at the right time in the wash cycle.
- If the washing machine has a water heater, the control system manages the heating element to achieve the desired water temperature for the selected wash program.

STATE DIAGRAM

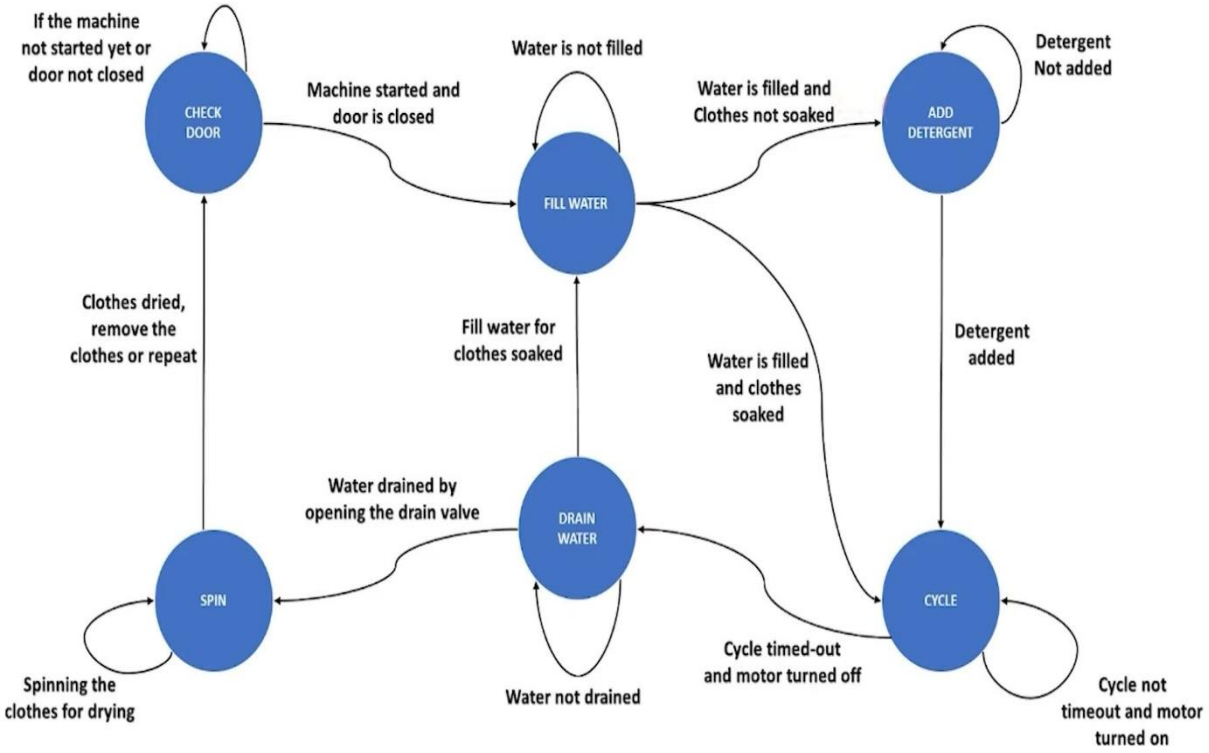


Fig. State diagram of Automatic Washing Machine Control System

CODE:

```
`timescale 10ns / 1ps

////////////////////////////////
////////////////////////////////
////////////////////////////////

module automatic_washing_machine(clk, reset, door_close, start, filled,
detergent_added, cycle_timeout, drained, spin_timeout, door_lock, motor_on,
fill_value_on, drain_value_on, done, soap_wash, water_wash);

input clk, reset, door_close, start, filled, detergent_added, cycle_timeout, drained,
spin_timeout;
output reg door_lock, motor_on, fill_value_on, drain_value_on, done, soap_wash,
water_wash;

//defining the states
parameter check_door = 3'b000;
parameter fill_water = 3'b001;
parameter add_detergent = 3'b010;
parameter cycle = 3'b011;
parameter drain_water = 3'b100;
parameter spin = 3'b101;

reg[2:0] current_state, next_state;

always@(current_state or start or door_close or filled or detergent_added or
drained or cycle_timeout or spin_timeout)
begin
case(current_state)
check_door:
if(start==1 && door_close==1)
begin
next_state = fill_water;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 0;
water_wash = 0;
done = 0;
end
else
begin
next_state = current_state;
motor_on = 0;
fill_value_on = 0;
```

```
drain_value_on = 0;
door_lock = 0;
soap_wash = 0;
water_wash = 0;
done = 0;
end

fill_water:
if (filled==1)
begin
if(soap_wash == 0)
begin
next_state = add_detergent;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 1;
water_wash = 0;
done = 0;
end
else
begin
next_state = cycle;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 1;
water_wash = 1;
done = 0;
end
end
else
begin
next_state = current_state;
motor_on = 0;
fill_value_on = 1;
drain_value_on = 0;
door_lock = 1;
done = 0;
end
add_detergent:
if(detergent_added==1)
begin
next_state = cycle;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
```

```
door_lock = 1;
soap_wash = 1;
done = 0;
end
else
begin
next_state = current_state;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 1;
water_wash = 0;
done = 0;
end
cycle:
if(cycle_timeout == 1)
begin
next_state = drain_water;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
//soap_wash = 1;
done = 0;
end
else
begin
next_state = current_state;
motor_on = 1;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
//soap_wash = 1;
done = 0;
end
drain_water:
if(drained==1)
begin
if(water_wash==0)
begin
next_state = fill_water;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 1;
//water_wash = 1;
done = 0;
```

```
end
else
begin
next_state = spin;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 1;
water_wash = 1;
done = 0;
end
end
else
begin
next_state = current_state;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 1;
door_lock = 1;
soap_wash = 1;
//water_wash = 1;
done = 0;
end
spin:
if(spin_timeout==1)
begin
next_state = door_close;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 0;
door_lock = 1;
soap_wash = 1;
water_wash = 1;
done = 1;
end
else
begin
next_state = current_state;
motor_on = 0;
fill_value_on = 0;
drain_value_on = 1;
door_lock = 1;
soap_wash = 1;
water_wash = 1;
done = 0;
end
default:
next_state = check_door;
```

```
endcase
end

always@(posedge clk or negedge reset)
begin
if(reset)
begin
current_state<=3'b000;
end
else
begin
current_state<=next_state;
end
end

endmodule

module new_test();
reg clk, reset, door_close, start, filled, detergent_added, cycle_timeout, drained, spin_timeout;
wire door_lock, motor_on, fill_value_on, drain_value_on, done, soap_wash, water_wash;


automatic_washing_machine machine1(clk, reset, door_close, start, filled, detergent_added, cycle_timeout, drained, spin_timeout, door_lock, motor_on, fill_value_on, drain_value_on, done, soap_wash, water_wash);




initial

begin
clk = 0;
reset = 1;
start = 0;
door_close = 0;
filled = 0;
drained = 0;
detergent_added = 0;
cycle_timeout = 0;
spin_timeout = 0;

#5 reset=0;
#5 start=1;door_close=1;
#10 filled=1;
#10 detergent_added=1;
```

```
//filled=0;
#10 cycle_timeout=1;
//detergent_added=0;
#10 drained=1;
//cycle_timeout=0;
#10 spin_timeout=1;
//drained=0;

/*

#0 reset = 0;
#2 start = 1;
#4 door_close = 1;
#3 filled = 1;
#3 detergent_added = 1;
#2 cycle_timeout = 1;
#2 drained = 1;
#3 spin_timeout = 1;
*/
end

always
begin
#5 clk = ~clk;
end

initial
begin
$monitor("Time=%d, Clock=%b, Reset=%b, start=%b, door_close=%b, filled=%b, detergent_added=%b, cycle_timeout=%b, drained=%b, spin_timeout=%b, door_lock=%b, motor_on=%b, fill_valve_on=%b, drain_valve_on=%b, soap_wash=%b, water_wash=%b, done=%b",$time, clk, reset, start, door_close, filled, detergent_added, cycle_timeout, drained, spin_timeout, door_lock, motor_on, fill_value_on, drain_value_on, soap_wash, water_wash, done);
end
endmodule
```

Test Bench :-

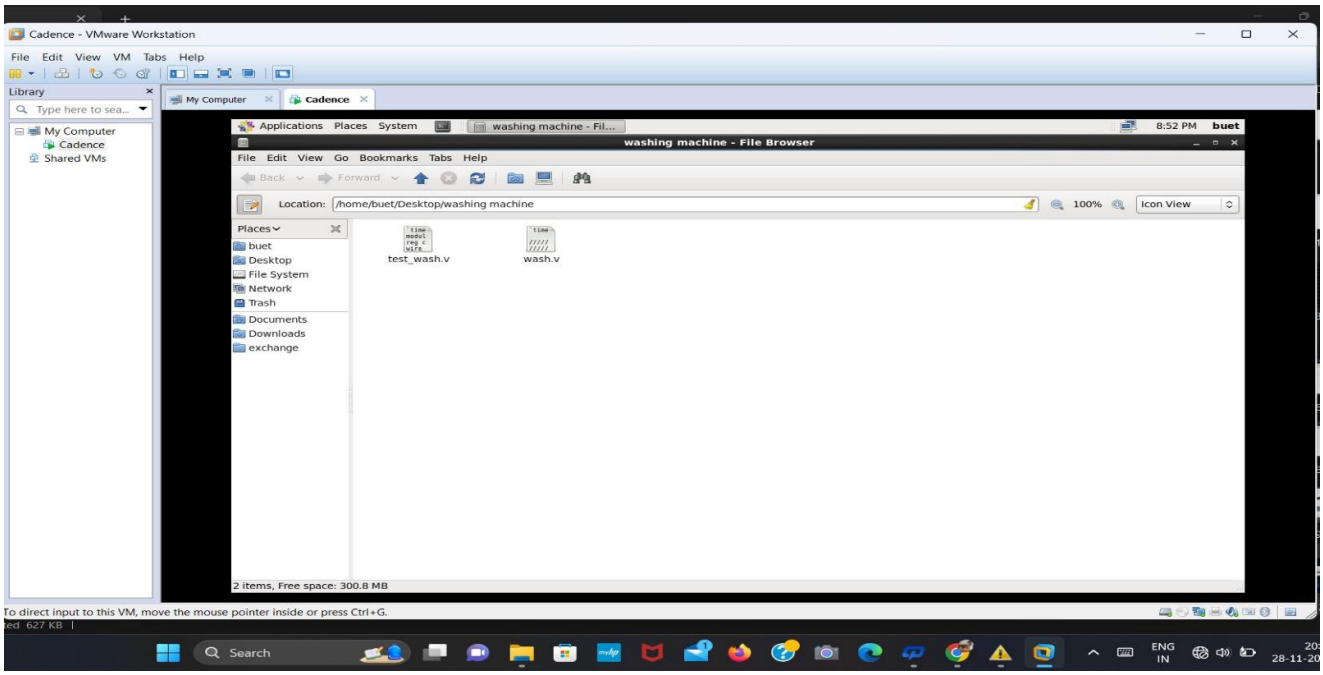
```
`timescale 10ns / 1ps
module new_test();
reg clk, reset, door_close, start, filled, detergent_added, cycle_timeout, drained, spin_timeout;
wire door_lock, motor_on, fill_value_on, drain_value_on, done, soap_wash, water_wash;
```

```
automatic_washing_machine machine1(clk, reset, door_close, start, filled, detergent_added, cycle_timeout, drained, spin_timeout, door_lock, motor_on, fill_value_on, drain_value_on, done, soap_wash, water_wash);



initial

begin
clk = 0;
reset = 1;
start = 0;
door_close = 0;
filled = 0;
drained = 0;
detergent_added = 0;
cycle_timeout = 0;
spin_timeout = 0;

#5 reset=0;
#5 start=1;door_close=1;
#10 filled=1;
#10 detergent_added=1;
//filled=0;
#10 cycle_timeout=1;
//detergent_added=0;
#10 drained=1;
//cycle_timeout=0;
#10 spin_timeout=1;
//drained=0;

/*

#0 reset = 0;
#2 start = 1;
#4 door_close = 1;
#3 filled = 1;
#3 detergent_added = 1;
#2 cycle_timeout = 1;
#2 drained = 1;
#3 spin_timeout = 1;
*/
end

always
begin
#5 clk = ~clk;
end
```

```
initial
begin
$monitor("Time=%d, Clock=%b, Reset=%b, start=%b, door_close=%b, filled=%b, detergent_added=%b, cycle_timeout=%b, drained=%b, spin_timeout=%b, door_lock=%b, motor_on=%b, fill_valve_on=%b, drain_valve_on=%b, soap_wash=%b, water_wash=%b, done=%b",$time, clk, reset, start, door_close, filled, detergent_added, cycle_timeout, drained, spin_timeout, door_lock, motor_on, fill_value_on, drain_value_on, soap_wash, water_wash, done);
end
endmodule
```

Simulation Output:

- ➔ **Made file named “Washing machine in VMWare Cadence”**
- ➔ **Made test_wash.v(test bench), wash.v inside it .**
- ➔ **Opened Terminal and nclaunch ~new**
- ➔ **Compiled and run**



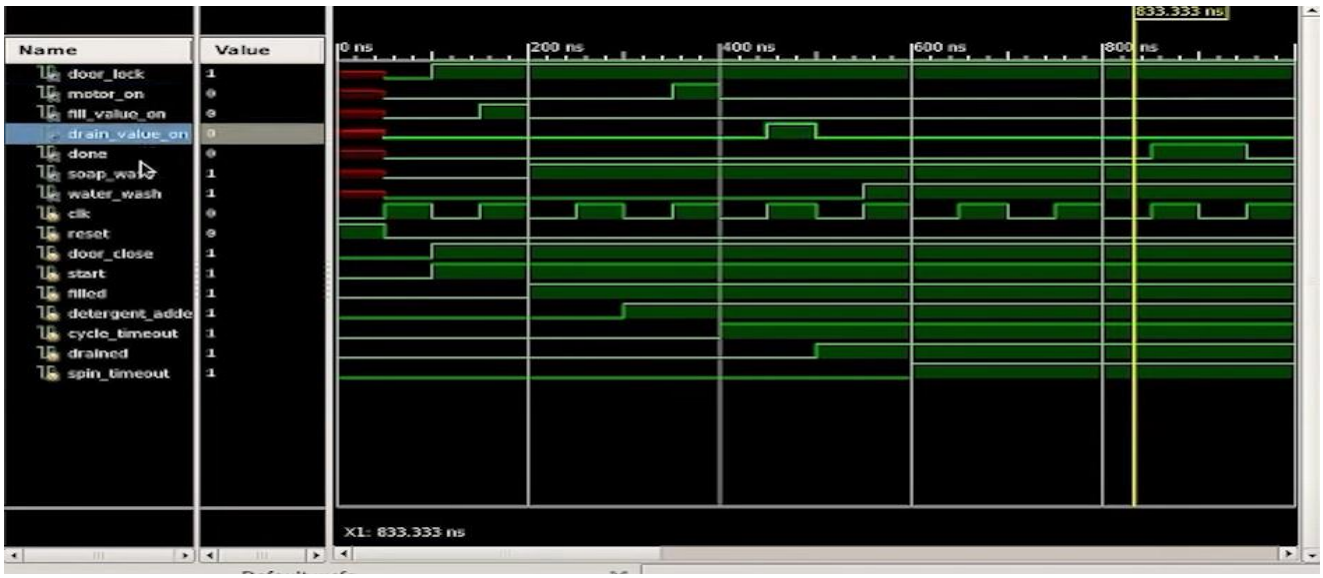


Fig: Output graphs

CONCLUSION:

In conclusion, the automatic washing machine control system represents a significant advancement in household technology, providing users with a convenient, efficient, and automated solution for laundry care. The integration of sophisticated components, including microcontrollers, sensors, and motor control units, has transformed the traditional manual washing process into a streamlined and user-friendly experience.

FUTURE SCOPE:

- Integration of systems that automatically dispense eco-friendly detergents in precise quantities based on factors like load size, fabric type, and soil level. This could contribute to reducing the environmental impact of laundry processes.
- Advancements in sensor technology for improved load sensing, water level detection, and fabric identification. Enhanced sensors could enable the washing machine to adapt to different types of fabrics and soil levels more accurately.

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- [1] Chen Xizhen, Chen Guangjian, Jia Jinling, Yu han, Zhou Tianpeng,"Design of Automatic Washing Machine Based on Verilog HDL" International Conference on Electronics and Optoelectronics, 29-31 July 2011, pp 38-40.
- [2] P. Usha, C H .Karuna, "An Efficient Implementation of Automatic Washing Machine Control System using Verilog", IJSET, volume 2, issue 7, Sep-Oct 2014, pp 1575-1578.
- [3] Thomas & Moorby, the Hardware Verilog Description Language [M], Beijing tsinghua university press, 2001. 23-36.