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AUTOMATIC WASHING MACHINE CONTROL SYSTEM USING VERILOG

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Abstract : **As described by digital system the language Verilog HDL is widely used in the circuit design which has its own advantages to be able to used as software language which describes hardware features that makes it useful and has good efficiency, portability, etc. Its advantages not only reduce the hardware development cycle but also greatly reduce development costs. The below article describes the characteristics and application of Verilog HDL and takes the automatic washing machine control system as examples to illustrate the practicality of HDL. The result of simulation shows this method is feasible and effective.**

• INTRODUCTION

WITH RAPID DEVELOPMENT OF SCIENCE AND TECHNOLOGY, THE DESIGN OF ELECTRONIC SYSTEMS ALSO PRODUCE A DRASTIC CHANGE, A NEW CLASS OF DEVELOPMENT TOOLS RELATED TO ELECTRONIC SYSTEMS ARE SPREADING TOO QUICKLY. HARDWARE DESCRIPTION LANGUAGE (HDL) IS A METHOD TO DESCRIBE DIGITAL CIRCUIT. HDL DESCRIBES A CERTAIN FUNCTION OF DIGITAL CIRCUIT USUALLY HAS ONE OR MORE FILES COMPOSITION. WITH THE RAPID DEVELOPMENT OF ELECTRONIC SYSTEM DESIGN AUTOMATION (EDA) AND LARGE SCALE PROGRAMMABLE OF LOGIC DEVICE, HDL HAS HIERARCHICAL DESCRIPTION AND SIMULATION OF ANY ELECTRONIC COMPONENTS CHARACTERISTICS, SO THAT THE CIRCUIT DESIGNERS AND DEVELOPERS COULD DESCRIBE THE FEATURE OF THE CIRCUIT FREELY.

IT IS MOST COMMONLY USED IN THE DESIGN AND VERIFICATION OF DIGITAL CIRCUITS AT THE REGISTER-TRANSFER LEVEL OF ABSTRACTION. IT IS ALSO USED IN THE VERIFICATION OF ANALOG CIRCUITS AND MIXED-SIGNAL CIRCUITS, AS WELL AS IN THE DESIGN OF GENETIC CIRCUITS. IT INCLUDES THE HIERARCHICAL STRUCTURE, WHICH ALLOWS DESIGNERS TO DESCRIBE THE COMPLEXITY OF THE CONTROL. VERILOG HDL IS A LANGUAGE WHICH IS NOT ONLY EASY TO USE BUT ALSO HAS STRONG FUNCTION, ESPECIALLY THE VERILOG HDL INDUSTRIAL STANDARDIZATION, CONFORMS TO THE TREND OF MICROELECTRONICS TECHNOLOGY DEVELOPMENT. VERILOG HDL IS USED IN DIGITAL DESIGN MODELING FROM THE SWITCH LEVEL TO ABSTRACT ALGORITHM DESIGN LEVEL. THESE CONSTRUCTIONS CAN NOT ONLY BE USED TO DESIGN PATTERN ON HARDWARE INTER CURRENT BEHAVIOR, BUT ALSO ON HARDWARE DESIGN OF SCHEDULING PATTERN.

• THE DESIGN OF AUTOMATIC WASHING MACHINE

2.1 The principle of automatic washing machine

ALL AUTOMATIC WASHERS, REGARDLESS OF TYPE, MODEL, OR MAKE, HAVE ONLY FOUR BASIC FUNCTIONS OF OPERATION:
(1) FILL, (2) WASH (3) PUMP OUT, AND (4) EXTRACTION (SPIN).THE IMPORTANT PARTS OF THE WASHING MACHINE; THIS WILL ALSO HELP US UNDERSTAND THE WORKING OF THE WASHING MACHINE.

A) WATER INLET CONTROL VALVE: WHEN YOU LOAD THE CLOTHES IN WASHING MACHINE, THIS VALVE GETS OPENED AUTOMATICALLY AND IT CLOSES AUTOMATICALLY DEPENDING ON THE TOTAL QUANTITY OF THE WATER REQUIRED.

B) WATER PUMP: THE WATER PUMP CIRCULATES WATER THROUGH THE WASHING MACHINE. IT WORKS IN TWO DIRECTIONS, RE - CIRCULATING THE WATER DURING WASH CYCLE AND DRAINING THE WATER DURING THE SPIN CYCLE.

C) TUB: THERE ARE TWO TYPES OF TUBS IN THE WASHING MACHINE: INNER AND OUTER. THE CLOTHES ARE LOADED IN THE INNER TUB, WHERE THE CLOTHES ARE WASHED, RINSED AND DRIED. THE INNER TUB HAS SMALL HOLES FOR DRAINING THE WATER. THE EXTERNAL TUB COVERS THE INNER TUB AND SUPPORTS IT DURING VARIOUS CYCLES OF CLOTHES WASHING.

D) AGITATOR OR ROTATING DISC: THE AGITATOR IS LOCATED INSIDE THE TUB OF THE WASHING MACHINE. IT PERFORMS THE CLEANING OPERATION OF THE CLOTHES. DURING THE WASH CYCLE THE AGITATOR ROTATES CONTINUOUSLY AND PRODUCES STRONG ROTATING CURRENTS WITHIN THE WATER DUE TO WHICH THE CLOTHES ALSO ROTATE INSIDE THE TUB.

E) MOTOR OF THE WASHING MACHINE: THE MOTOR IS COUPLED TO THE AGITATOR AND PRODUCES IT ROTATOR MOTION.

F) TIMER: THE TIMER HELPS SETTING THE WASH TIME FOR THE CLOTHES MANUALLY.

G) DRAIN PIPE: THE DRAIN PIPE ENABLES REMOVING THE DIRTY WATER FROM THE WASHING THAT HAS BEEN USED FOR THE WASHING PURPOSE.

2.2 Washing Machine Controller specifications

THE WASHING MACHINE CONTROLLER HAS THE FOLLOWING FUNCTIONALITIES:

1. THE WASH MACHINE HAS THE FOLLOWING CONSECUTIVE STATES: IDLE, FILL, WASH, DRAIN, FILL, RINSE, DRAIN, SPIN.
2. THERE IS ONE CONTROL LINE TO THE WASHER WATER FEED. CHOICE OF HOT OR COLD-WATER WASH IS DONE MANUALLY BY THE USER FOR SIMPLICITY.
3. THERE ARE TWO DRUM ROTATION SPEEDS: LOW SPEED FOR WASH CYCLE AND HIGH SPEED FOR THE SPIN CYCLE. SPEED CONTROL IS ACCOMPLISHED THROUGH AN ELECTRICALLY CONTROLLED MECHANISM.
4. DURING THE WASH CYCLE, THE DRUM DIRECTION OF ROTATION IS CONTROLLED THROUGH THE AGITATOR MECHANISM. FIGURE1IS THE ICON FOR THE WASHING MACHINE CONTROLLER INDICATING MAIN INPUT AND OUTPUT LINES

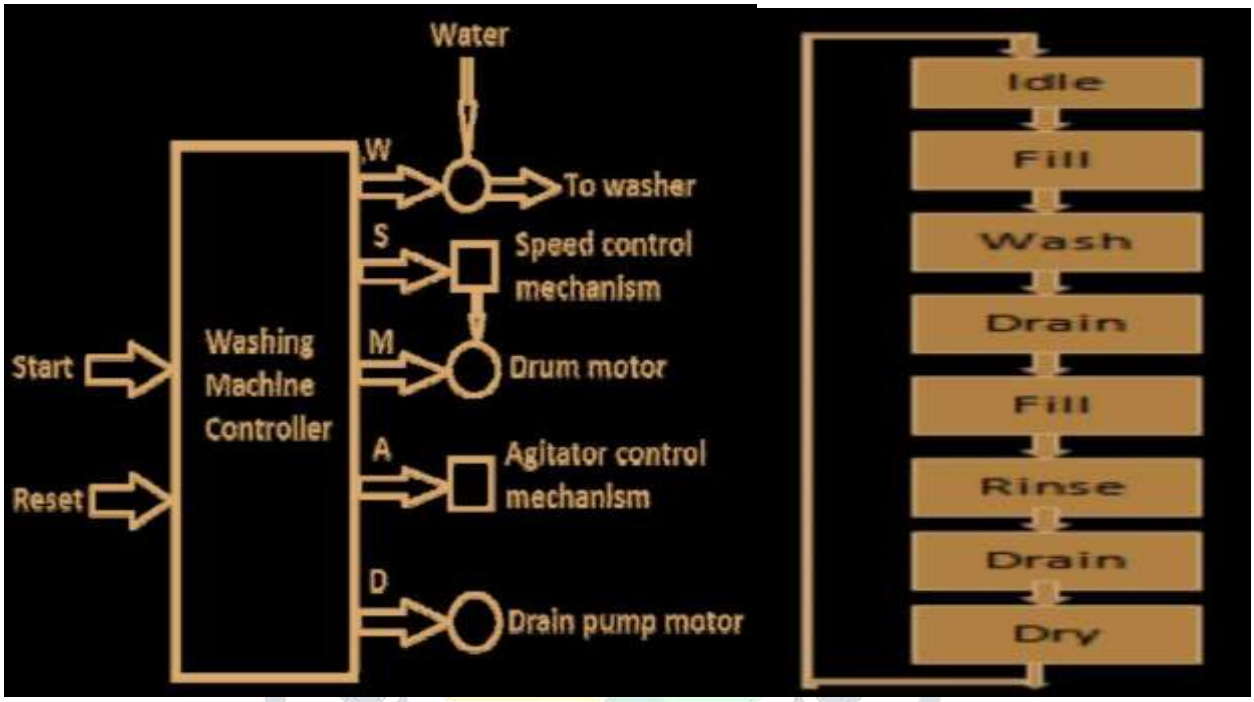

Figure A: block diagram of washing machine

Figure B: Different States of washing machine

- **WASH MACHINE CONTROLLER DETAIL FLOW CHART**

FIGURE B SHOWS THE MAIN COMPONENTS OF THE WASHING MACHINE CONTROLLER. THE CONTROLLER IS COMPOSED OF TWO BLOCKS: A FINITE - SATE MACHINE BLOCK AND A TIMER BLOCK. THE FSM BLOCK RECEIVES SOME SIGNALS FROM THE USER, FROM THE TIMER, AND FROM OTHER HARDWARE PARTS SUCH AS THE DOOR SENSOR. FSM BLOCK OUTPUT CONTROL THE TIMER BLOCK AND OTHER HARDWARE COMPONENTS OF THE WASHING MACHINE.

TABLE 1 IDENTIFIES THE FSM INPUT AND OUTPUT SIGNALS AND THEIR FUNCTIONALITY. THE TIMER BLOCK GENERATES THE CORRECT TIME PERIODS REQUIRED FOR EACH CYCLE AFTER IT HAS BEEN RESET. THE TIMER BLOCK IS COMPOSED OF AN UP - COUNTER AND COMBINATIONAL LOGIC TO GIVE THE CORRECT TIME SIGNALS ONCE CERTAIN COUNT VALUES HAVE BEEN ACHIEVED. OF COURSE THE TIMER VALUES WILL BE DETERMINED BY THE CLOCK FREQUENCY BEING USED IN THE SYSTEM. THIS, HOWEVER, IS BEYOND THE SCOPE OF THIS DISSERTATION.

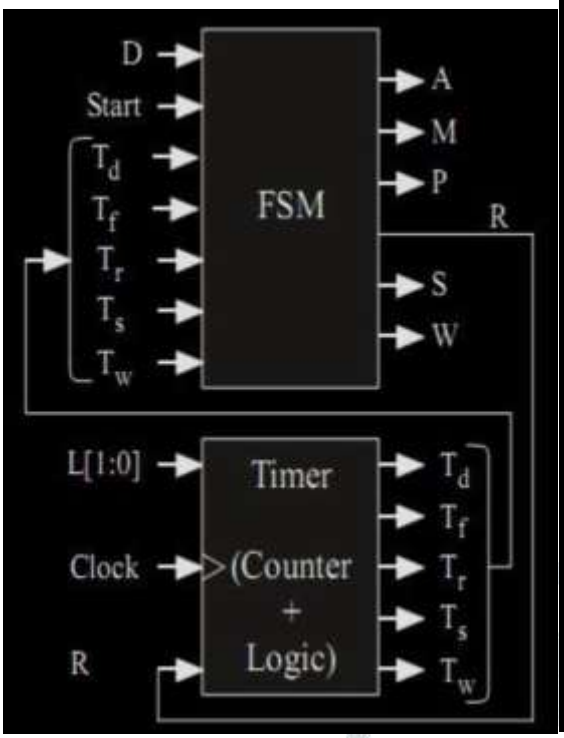

Figure C: The main components of the washing machine control system.

D	IN	Machine door (lid) is open
Start	IN	Start wash machine
T_d	IN	Drain time required to empty the machine tub
T_f	IN	Fill time required to fill the machine tub
T_r	IN	Rinse time
T_s	IN	Spin time
T_w	IN	Wash time
A	OUT	Activate the agitator mechanism
M	OUT	Enable motor
P	OUT	Activate the pump mechanism to drain the water
R	OUT	Timer reset
S	OUT	Activate motor speed control mechanism
W	OUT	Activate water source solenoid

Table 1: Alphabetical listing of input and output signals for the FSM. All signals are active high.

2. A RESULT

Simulation Results: Wave Forms

The below figure shows the that when reset signal comes, all of the signals are set to zeros; then if you put on start button the machine will enter water state. As long as you no longer press start button, washing machine will automatically execute the process according to the predetermined process. The simulation results are as shown in figure D

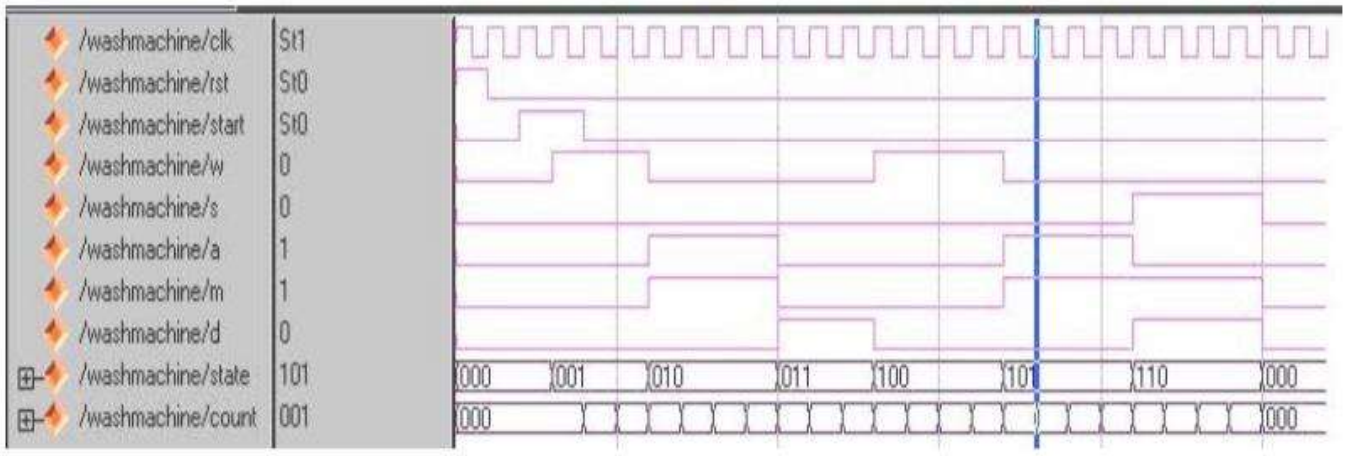

Figure D: Simulation of Automatic Washing machine controller.

3.1 ADVANTAGES

- o This makes washing machine a lot cheaper for all and affordable
- o It is a lightweight and compact option

3.2 DISADVANTAGE

o **Electricity Consumption –** Fully automatic washing machines have a range of features and smart control. Due to this, they usually acquire more electricity. The total consumption during the wash is slightly higher from the semi-automatic option.

4. CONCLUSION

We use this powerful language structure and concise code to describe the complex control logic. Through comprehend the corresponding hardware circuit and tools of Verilog HDL language to generate more than traditional logical design method which can adapt to the social development needs. We use hardware description language form digital system design which is not only flexible and convenient but also reduce the cost of development and the development cycle. This design method plays an increasingly important role in the future digital system design.

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