IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 2, May 2023

Design and Implementation of Intelligent Car Washing System with Water Saving Technique

Bomma Aaradhana[1], M Bhagya Jyothi[2], Amrita Sajja[3], Kiran Kumar Mandrumaka[4]
ECE, Anurag University, Hyderabad, India

Abstract: *This paper discusses an FPGA-based intelligent car washing system. The system provides washing services that are rapid, convenient, and effective. A flow chart for controlling an automated car washing system with four working modes is given in this paper. The car washing system was built with the help of Xilinx Vivado in the software ISE Design Suite using the hardware description language Verilog HDL. In this project, a special feature for water conservation by biologically recycling the water is implemented.*

Keywords: FPGA, Intelligent car washing system, Verilog HDL

I. INTRODUCTION

Car washing is an important part of preventive maintenance. Keeping the exterior of a vehicle clean helps to avoid rust, oxidation, and fine scratches. A car wash, often known as an auto wash, is a facility for cleaning the outside and, in certain situations, the interior of motor vehicles. Car washes can be self-service (DIY), full-service (with staff washing the vehicle), or totally automated (possibly connected to a gas station). Car washing systems are frequently connected with gas stations. The usage of water and energy resources are the two most important environmental factors for automobile washing.

With the introduction of the private car into people's everyday lives, car washing, high water consumption, and other concerns have arisen, and automatic car cleaning has become a daily consumption of private car owners.

Automation of processes and technology continues to be at the leading edge of innovation. This is a set of approaches and technologies meant to construct systems that allow individuals to govern technical processes without their direct participation. One such method is automatic car washing, which has been increasingly popular among the general public in recent years. All car washing systems are classified as manual or automatic, contact or contactless.

Nowadays, technological advances in the car washing industry are classified into several categories, including new washing technologies (touch-free and hybrid washing technology), advanced water recycling systems (based on biological water treatment), water desalination and purification (via reverse osmosis), and other ecological and economic innovations (e.g. energy savings).

Depending on the program, car washing can typically contain different programs (washing, water, foaming, waxing, drying, and a variety of other procedures leading to better washing).

Field programmable gate array (FPGA) implementation utilizing the hardware description languages Verilog HDL or VHDL is a suitable option for realizing the car washing system. Because FPGA has the advantages of a rapid design cycle, high durability, and high integration, the hardware in this paper is implemented using FPGA. The interactions between the parts in these programmable devices are not uniquely determined throughout the manufacturing process. This entails being able to create many devices using a single FPGA, as well as readily changing their configuration and, as a result, the mode of action throughout the development process and even during operation. One of the primary benefits of employing FPGAs is that they can be reprogrammed fast, allowing for the introduction of new washing programs, resulting in higher quality and customer satisfaction.

This paper proposes the design of a car washing system based on a control flow chart through FPGA utilizing the Verilog HDL language in the Xilinx software ISE Design Suite. This sort of car washing system can work in four separate modes in different states: washing with water, spraying with foam, adding wax, and drying. The simulation results generated in Verilog Test Fixture for the various settings demonstrate the design system's functionality.

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 2, May 2023

II. CONTROL FLOW CHART

The car washing system has four different operating modes: "Standard mode", "Standard mode with Wax", "VIP mode" and "VIP mode with Wax". Every new set mode must be terminated before the next one may begin.

Individual modes will require the following states to be activated: "Foam," "Water," "Wax," "Dry," and "Finish". In the "Foaming" mode, the car wash system sprays foam through the nozzles situated around the entire vehicle, ensuring thorough coverage. All other conditions are paused in the "Washing" state, and clean water is provided to the nozzles. In the "Waxing" mode, wax is applied to the nozzles before spraying the car.

When the system is in the "Drying" mode, the blow valves are activated for a short amount of time until the car is dry. Figure 1 depicts a control flow chart of a car washing system with four working modes in various states. After the "Finishing" process for all modes is completed, a short timer is set to return the system to its initial condition.

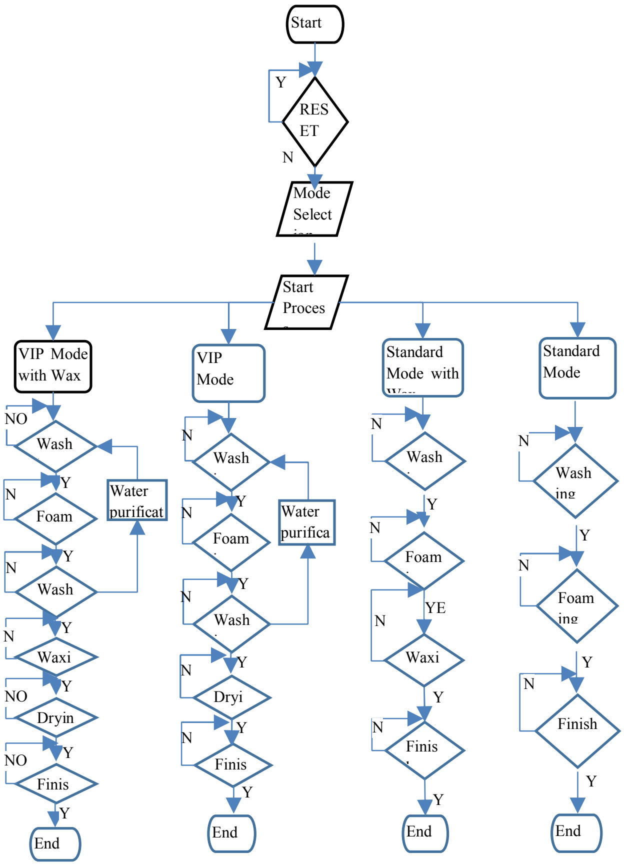

Fig. 1.A control flow chart of the car washing system.

III. IMPLEMENT DESIGN

The design program is synthesized and implemented in the Xilinx Vivado ISE Design Suite 2015.2 software using Verilog HDL based on the established control flow chart as shown in Figure 1. Zed Board Zynq Evaluation and Development Kit was chosen as the development kit in the design.

The following input signals are used: "clk" – global timer for all operations; "reset" – for resetting all operations; "standard mode," "standard mode with wax," "VIP mode" and "VIP mode with wax" – for selecting different washing modes. The following outputs are used: "wash", "foam", "water save", "wax", "dry", and "finish" – initiate the various operations of the car washing system. t1, t2, t3 - timings for various actions; y1, y2, y3 - for displaying various modes.

The register used is "c" for different cycles like wash_c, foam_c,water_save_c. Figure 2 illustrates the model of the car washing system in RTL Schematic after the design process.

.

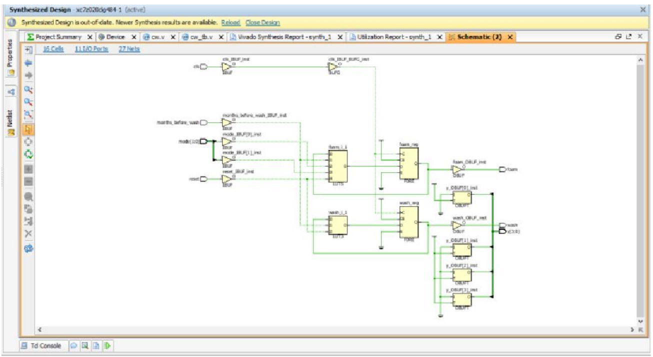

Fig. 2.Model of the car washing system.

Fuzzy Rules

In the fuzzy control of the intelligent car washing system, according to the prior data concluded by expert's experience, control of the various operations time lengths and their strength and can be divided into 12 kinds of rules, as shown in Table 1

	Standard Mode	**Standard Mode with Wax**	**VIP Mode**	**VIP Mode with wax**
Washing time	Medium	Shortest	Longest	Longest
Foaming time	Shortest	Medium	Longest	Shortest
Waxing time	-	Medium	-	Medium
Drying time	-	-	Medium	Medium

Table:1: Fuzzy Rules

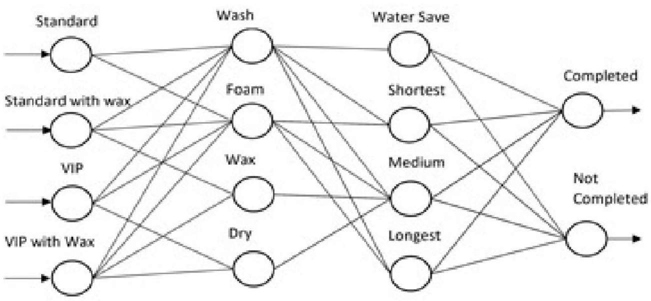

Fig. 3. Fuzzy neural network parameter optimization structure diagram

The neural network propagation forward at first, if the output does not reach the expected requirements, then reverse transmit the error signal to adjust the weights parameters W to make the error signal reached within the allowable range, so as to achieve the learning effect. After repeated training, the weights of the neural network and the parameters of the membership function are optimized.

IV. SIMULATION RESULTS

The following figures show simulation diagrams of the car washing system in various operation modes. The green states in the simulations shown correspond to the outputs. The program enters the designated mode and begins working based on the instructions. The times set in the separate modes are chosen as an example and can be adjusted as needed.

When working in the "VIP mode with Wax." It goes through the washing with water, foam spraying, washing with water again, wax application, drying, and finishing operations. The water from second wash process are purified further and reused.

Figure 4 presents the operation of the system in the "VIP mode," When the user selects this option, the procedure of washing with water, spraying with foam, washing with water again, drying and finishing is performed. The water from second wash process are purified further and reused.

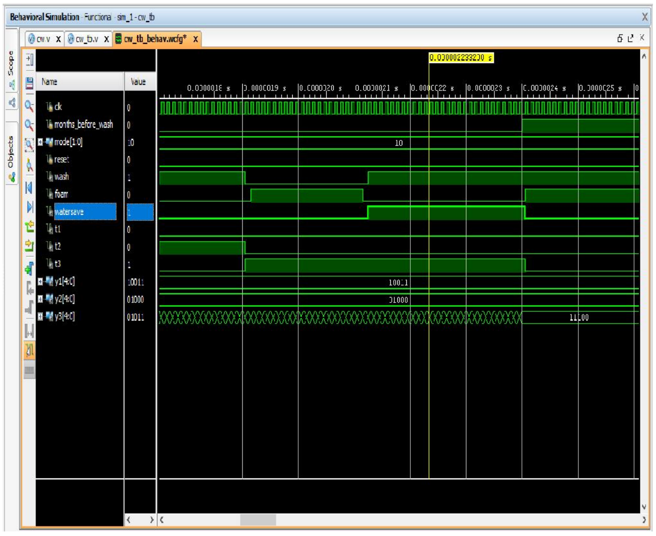

Fig. 4. VIP mode

Figure 5 demonstrates results when working in the "standard mode with Wax" the following steps are carried out: water cleaning, foam spraying, waxing and finishing. Figure 6 depicts the fourth mode of operation, "Standard mode." It covers the water-washing, foaming and finishing operations.

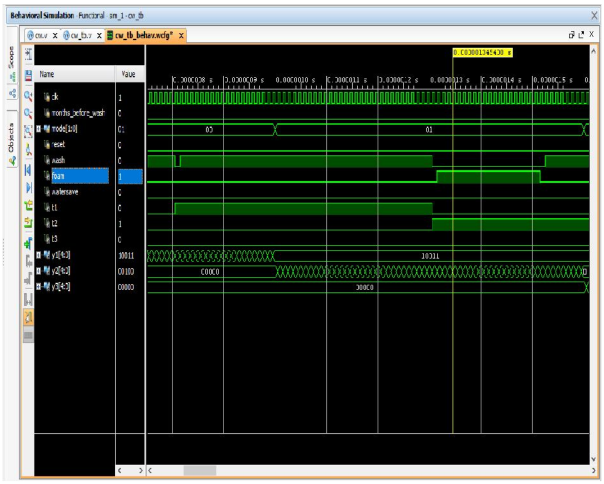

Fig. 5. Standard mode with wax

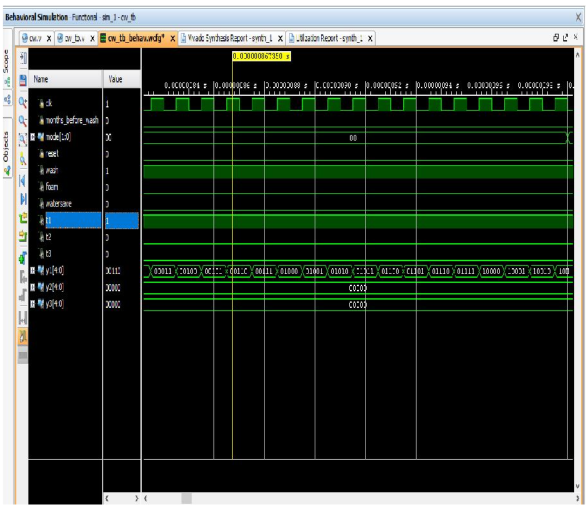

Fig. 6. Standard mode

Site Type	Used	Fixed	Available	Util%
Slice LUTs*	34	0	53200	0.06
LUT as Logic	34	0	53200	0.06
LUT as Memory	0	0	17400	0.00
Slice Registers	23	0	106400	0.02
Register as Flip Flop	23	0	106400	0.02

Table:2: Synthesis report

V. ADVANTAGES

The main advantages of the automated car washes are as follows :

- Less water consumption
- -Accelerates development of prototype
- Efficient UI designing
- No abrasive mechanical impact on the paint
- Rapid washing process
- High-quality cleaning of hard-to-reach places such as grille, wheels and others
- Saving time and money
- Better cleaning
- Easily operated system

VI. CONCLUSION

We can conclude that automation in any system provides better reliability, increase productivity and performance, this prototype ensures a reduction in water usage, manpower, and leads to fully automated washing of car in less time.

FPGAs (field programmable gate arrays) are frequently employed in today's environment. They represent a cutting-edge and promising approach to the design of numerous electromechanical items and systems.

Based on the suggested car washing system's flow chart, the control program was created in ISE Design Suite software using the Verilog HDL programming language. The established control allows for the selection of four modes based on the amount of money placed and the method of washing. The results of the simulation tests for the distinct operating modes of the car washing system demonstrate the design model's operability.

REFERENCES

[1]. G. Subramanian, K. Tharani, Raja, K. GowthamBabu and T.Devashena, "*Simulation of Automatic Car Washing Using PLC*", -International Journal for Scientific Research & Development, Vol. 3, No. 01, pp. 438-439, 2015.

[2]. K. Vidyasagar, R. Prasad and P. Nagasekhar, "*RFID-GSM Autonomous Car Washing System*", International Journal of Computer Applications, Vol. 121, No.2, pp. 30-33, 2015.

[3]. Y. Yu, L. Kurnianggoro and K.-H. Jo, "*Design of intelligent car washing system*", Conference: 2015 54th Annual Conference of the Society of Instrument and Control Engineers of Japan (SICE), 2015.

[4]. Z. Lalluwadia, N. Bhatia and J. Rana, "*Automatic car washing system using PLC*", International Journal of Innovative Research in Technology, Vol. 3, No.9, pp. 40-43, 2017.

[5]. M. Thwe, H. Min and N. New, "*Programmable Logic Controller based Automatic Car Washing System*", Iconic Research and Engineering Journals, Vol. 2, No.11, pp. 1-7, 2019.

[6]. H. Janik, A. Kupiec, "*Trends in modern car washing*", Polish Journal of Environmental Studies, Vol. 16, No. 6, pp. 927-931, 2007.

[7]. T. Pinjari, M. Hadpad, D. Sukale, D. Mulgoankar and P. Aswar,"*Automatic Car Washing System using Microcontroller*", International Research Journal of Engineering and Technology, Vol. 7, No.6, pp.2711-2714, 2020.

[8]. R. Singh, S. Nigam, S. Aggrawal, M. Neelgar, S. Kaura and Kailash Sharma, "*Design and implementation of automatic car washing system using PLC*", International Research Journal of Engineering and Technology, Vol. 5, No.5, pp. 4183-4185, 2018.

[9]. V. Taraate, Digital Logic Design using Verilog – Coding and RTL Synthesis, Springer India, 2016.

[10]. P. Chu, FPGA Prototyping by Verilog Examples, John Wiley & Sons, Inc, 2008.

[11]. S. Brown and Z. Vranesic, Fundamentals of Digital Logic with VHDL Design, The McGraw-Hill Companies, 2009.

[12]. B. Zeidman, Designing with FPGAs and CPLDs, 2002.

[13]. B. Patil, R. Henry and A. Patwardhan, "*Training methodology:Complex programmable logic device based system design & implementation*", 2nd International Conference on Education and New Learning Technologies, pp. 1995-1998, 2010.

[14]. S. Ramachandran, Digital VLSI Systems Design, Springer, 2007.