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Design and Implementation of Verilog-Based Subway Ticketing System

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ABSTRACT

This work is a synthesis of practical investigation, theoretical analysis and literature reading. Using Verilog HDL language to research a subway automatic ticket selling system. In our country passengers get a ticket at the counter, it is a time-consuming process. Automatic ticketing system saves time. A programmed train ticketing machine that contains all goal tickets and simple to use for all travelers for 24 hours. The design of this subway ticketing system takes convenience, quickness and simplicity as the core, and takes saving time for passengers as the guide design. It completes the main process of buying subway tickets for passengers. Card reader is the heart of this system; passenger keeps their card on the sensing element of this system. The card reader reads minimum balance calculates the minimum fare and generate a message like balance is not sufficient for travel after fare reduction what the minimum balance. This automatic ticketing system will replace the existing paper ticket. Firstly, the development of subway ticketing system at home and abroad, and then studies the basic components of subway ticketing system. Through Xilinx ISE software to do schematic input mode, this project designs the subway automatic ticket selling system which composed of ticket selection module, coin calculation module, change processing module and display interface module. The paper also simulates the ticket selection module, coin calculation module, change processing module and display interface module on Xilinx ISE.

Keywords: Verilog HDL, Subway Ticketing System, Automatic Ticket Selling, Card Reader, Xilinx ISE, Simulation

1. INTRODUCTION

An automated ticketing system is an important component of help people to manage in bound customer support requests, providing assistance to customer service agents. China has three longest subway networks in the world, namely Shanghai subway network, Beijing subway network and Guangzhou subway network. By October 2020, cities including Shanghai, Nanjing, Suzhou, Wuxi, Changzhou, Xuzhou, Hangzhou, Wenzhou, etc. in the Yangtze River Delta have been opened or under construction more than 150 subway lines. At the same time, we can see that three subway lines in Beijing have realized unmanned automatic operation, and Shanghai subway has also made new

innovative practices in construction, operation, repair and maintenance.

This improves service quality and service efficiency. These facts all show the infinite vitality and importance of the subway in people's daily life. As a key equipment of urban rail transit, metro automatic ticketing system (AFC) naturally makes continuous progress with the development of rail transit. It is true that the progress of Metro automatic ticketing system will also react on the development of Metro field. AFC (Automatic Fare Collection) is a service system for customers to buy tickets, take buses and exit stations. It is an important yardstick to measure the level of urban rail transit. It is an automatic control system integrating computer network communication and automatic control technology. At the same time, we have noticed the rapid development of integrated circuit science and technology in recent years, especially in programmable logic gate circuits. Moreover, Verilog HDL language has inherent advantages, such as accurate timing, design independent of process, flexibility and easy to use. The design written in Verilog HDL language can also improve the design efficiency in the design process. Therefore, the basic language of designing the subway automatic ticketing system is Verilog HDL language.Initially a passenger should register.Then that person will be eligible to use our traveling system by using their user id. The user can recharge their account on their own by using their bank accounts.Otherwise, Payment methods are added to recharge from the counter at the metro station. When the person who travels, should activate their account. After ticket selection process money will be detached from the account and the remaining amount will be added to the user's account.

If there is no error and if there is no any illegal activity at his entrance, then he can enter to the train. All these activities will be recorded in to a database. If a passenger wants to see their travel details, that person can register to our web application using his/her user id. That user id will be provided when that person initially register to our travelling system.

2. LITERATURE REVIEW

With the new technology development of Internet & mobile payment [1] [2]and intelligent cities construction deep going, the cities network subway transportation system is occurring a great renovation. Directing at the passenger's transfer needs, the authors does investigation, summarizes its basic characteristic, researches and analyses the present tickets serviced system. Combining with actual running condition, aim to the condition between the passenger's transfer needs and practical services mismatching; it develops automatic tickets service system which based on Internet. Theoretical analysis shows that the new system could save passengers transfer time a lot, improve efficiency of the traveler. This research has significant theory and reality meaning.

In an attempt to improve efficiency, an increasing number of high-capacity railways are installing Automatic Fare Collection (AFC) systems [3] which ensure that every passenger has a valid ticket when they enter the railway and that they pay the correct fare for the journey taken. Meanwhile, AFC systems also automate the ticket accounting and selling processes as well as providing detailed information on system usage to cut down on ever increasing fraud by passengers and staff.

Beijing Metro network operation pattern [4] as been formed and has entered the stage of renovation and transformation. In order to meet the needs of renovation and flexible adjustment of business functions, Beijing Metro AFC system has begun to explore technical transformation, including software upgrading, hardware transformation, unifying AFC system standards, and improving business rules system, so as to make the AFC system of the whole network have the function of flexible implementation of business rules, eliminate dependence on manufacturers, and reduce the cost of system transformation.

Whereas the majority of evaluations of self-service kiosks [6] are based on interviews or observations and as such are burdened with personal bias, eye tracking was seen as a method for an objective analysis. To demonstrate the feasibility and usability of such an assessment technique, the task of purchasing a public transportation ticket from a modern ticket vending machine in Kraków, Poland was evaluated. The test participants relatively easily operated the machine with time taken to purchase a ticket ranging from 54 s for foreigners not familiar with the equipment to 29 s for local inhabitants. Even though the number of gazes recorded for the foreigners group was 2.4 times higher than for the local test participants, the fixation times

were almost equal. Faulty or delayed operation of the payment terminal [7] was a meaningful equipment issue encountered by eight test participants. The study demonstrated that the operation of the analyzed ticket vending machine should not cause much trouble to anyone. The use of an eye tracker, which was employed for such an assessment for the first time, permitted the identification of possible operational ambiguities that could hinder the user experience without the bias associated with other assessment techniques. The used method was found to be efficient and the results provided valuable information.

The study aims to compare different services, methods, and technologies used in auto train ticketing (ATT) as well as bus ticketing system and proposed a new system for local train and buses. It explains the advantages and disadvantages of these technologies, methods, and services. It proposes [8]-[14] the best methods for using these technologies, which make it possible to predict the best railway train ticketing system. Thus, we aim to reduce the human efforts, increase the sufficiency of ATTS, provides the benefits and efficiency to the passengers, with studying and comparing different train technologies regarding different features. Paper attempts to overcome the passenger efforts, increase efficiencies of the different railway to improve their auto ticket checking security and facilities to theirpassengers.

3.IMPLEMENTATION OF PROPOSED SYSTEM

This paper mainly designs an automatic ticketing system that can help passenger successfully buy tickets under simple operation. The ticketing system can recognize 5 yuan and 10 yuan notes. It is mainly composed of four modules: ticket selection module, coin calculation module, change processing module and interface display module.

As the name suggests, the function of the ticket selection module is to provide customers with ride route selection services. When the route is selected, passengers will put in coins. At this time, the output of the route selection module and the money input processing module will be transmitted to the calculation change module and the display module at the same time. The change calculation module is to calculate the amount of money invested by the passenger, calculate how much money the customer should get back, and output the results to the interface module, which will present the results to the passenger.

3.1 Ticket selection module

Module input: RD is the reset button, which can achieve the function of zero clearing after being pressed. CLK (Clock) is a clock signal and the cornerstone of sequential logic circuit. path_ 1、path_ 2. When one of the two is high-level effective, they are effective and will realize the function of line selection. 01 is the No. 1 busline, and 10 indicates that the route determined by the customer is the No. 2 busline. pri_ 3、pri_ 4 and pri_ 5 one of them is set to high level as the ticket price selection function. qua_ 1, qua_ 2 as the function of selecting the number of tickets to buy, qua_ 1 means to buy a ticket, qua_ 2 means to purchase 2 tickets.

Module output: PATH indicates the output of the selected line, which will be sent to the amount calculation and processing module and display function module as input. QUA is sent to the display module, and COST is the total amount to be paid, which will be input to the balance calculation and processing module for calculation. This will be used to calculate the amount that should be recovered. PRI is the selected fare, which will be sent to the amount calculation processing module and display module as input.

3.2 Coin calculation module

Module input: RD is the reset button. When it is operated by passengers, its function is to reset. CLK (Clock) is a clock signal and the cornerstone of sequential logic circuit. COIN_ 5 means the signal of input 5 yuan, and COIN_ 10 means to input 10 yuan.

Module output: COINH represents ten digits of the total amount of gold coins, COINL represents ten digits of the total amount of gold coins, and COIN represents the output of the total amount. This output is transferred to the amount calculation and processing module as an input to calculate the change.

3.3 Change processing module

Module input: RD is the reset button. When it is operated by passengers, its function is to reset and clear. CLK (Clock) is the clock signal, FINISH is the button pressed by the passenger after coin insertion, that is, the final confirmation button. When the customer presses, the signal will be set to high level, and the module function runs to determine whether the ticket should be sold to the customer. The change calculation function will also be carried out at the same time. PATH_ IN is

used to judge whether a ticket is issued. PRI_ IN is used to determine which ticket to sell. COST_ IN enters the total amount payable and COIN_ IN is the total amount of money invested.

Module output: REST indicates the amount that should be given to passengers, and inputs the result into the display module. Module A indicates that there are six kinds of tickets, and the lighting of six light-emitting diodes indicates the specific ticket issuance. ACT C is mainly used to control whether the diode in the circuit emits light or does not emit light. If the LED is on, it means that it needs to give change to the customer. If the LED is not on, it means that it does not need to perform change operation.

3.4 Display interface module

Display function module is composed of module 6 counter, 6-out-of-1 selector and decoder. The main function is to display the selected route, ticket price, number of tickets, amount invested and the amount of money that should be recovered.

- ✓ Modulo 6 counter: It is a counting design. When the clock rising, the counter will generate a 3-bit binary code, from 000 to 101, which is the total counting process of 0 to 5. When counting 101 plus 1, a carry signal will be generated, and all counts of the counter will be cleared. The nixie tube will be scanned, and the 6 data of the data selector will be selected and output in turn.
- ✓ 6-out-of-1 selector: the nixie tube scans the module 6 counter. The selector selects the data as the output according to the input sent by the module 6 counter. (3) Decoder: Seven Segment nixie tube indicates its function. It translates 4-bit binary number into 7-bit binary number to display the required number.

Advantages:

- ✓ No need to carry the card manually.
- ✓ Transaction takes at the beginning of the journey.
- ✓ Display the account balance every time after transaction.
- ✓ Encourages contactless transactions.
- ✓ Can recharge the account simply by using the user id.
- ✓ eliminates the need for manual ticketing and payment systems.
- ✓ making transportation transactions fastermore efficiently.
- ✓ more convenient for both passengers and transit operators.

4. RESULTS& DISCUSSION

Simulation results provide a comprehensive understanding of how the designed circuit behaves under different conditions. They are crucial for verifying the functionality, identifying and resolving issues, and ensuring that the circuit meets the desired specifications before physical implementation. The final simulation output, depicted in Figure 1, illustrates the implementation of the automatic subway ticketing module. This module comprises four sub-modules. The first module focuses on ticket selection, offering two paths labeled as path1 and path2. The second module is dedicated to coin selection, with inputs for coins of denominations 5 and 10. The third module is the change processing module, where change is issued based on the provided coins. Lastly, there is a display module presenting comprehensive information, and ultimately, the ticket is issued as the final outcome of the entire process.

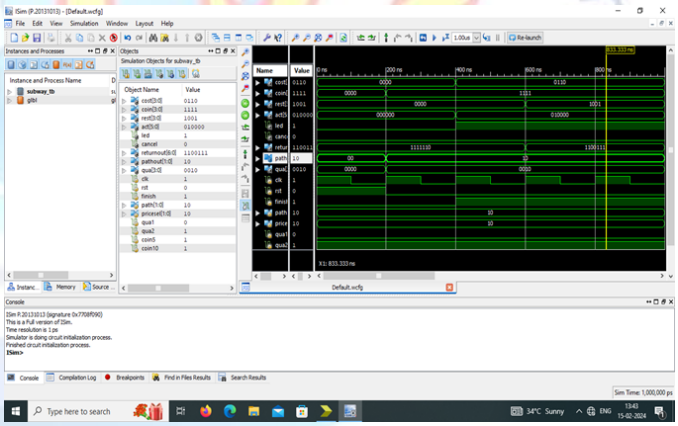

Figure 1: Simulation results of the proposed system

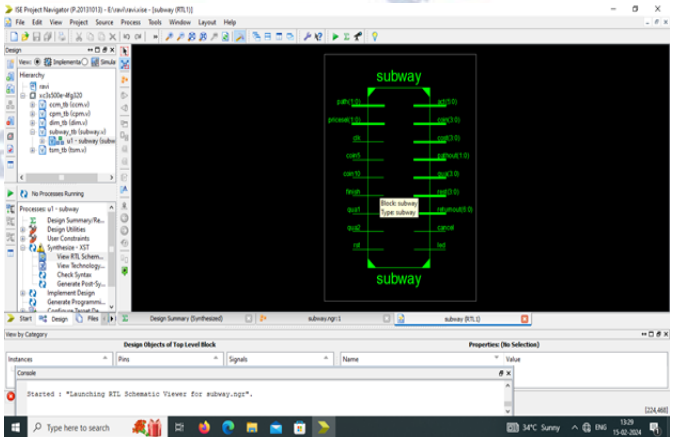

Figure 2: Block diagram of the proposed system

The block diagram offers a high-level representation of the entire system, illustrating the functional blocks and their interconnections. It serves as a visual guide for system architecture, aiding designers in conceptualizing and communicating the design structure and functionality. Figure 2 shows the block diagram of the parkingsystem.The architecture of the subway ticketing system is illustrated in the block diagram. The inputs of the system include path1, path2, clk, coin5, coin10, finish, qua1, qua2, rst, while the outputs consist of act, pathout, led, cancel, returnout, pathout, and cost.

RTL schematics depict the digital logic at a higher abstraction level, showing the flow of data between registers and logic elements. This representation is vital for understanding the data flow within the circuit, facilitating optimization, synthesis, and ensuring proper mapping of the design to hardware. Figure 3 shows the RTL schematic of the proposed parking system.

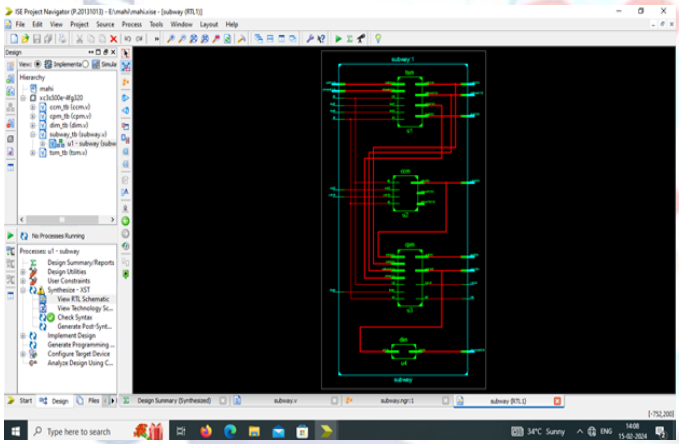

Figure 3: RTL Schematic of the proposed system

Delay estimation is essential for ensuring that the designed circuit meets timing requirements. It helps identify and address timing issues such as setup and hold time violations, ensuring that signals propagate through the circuit within the specified time constraints. Figure 4 presents the delay estimation of the proposed system.The timing summary of sub way ticketing system implementation shows that delay is 5.143ns. This timing report is only for synthesis estimate.

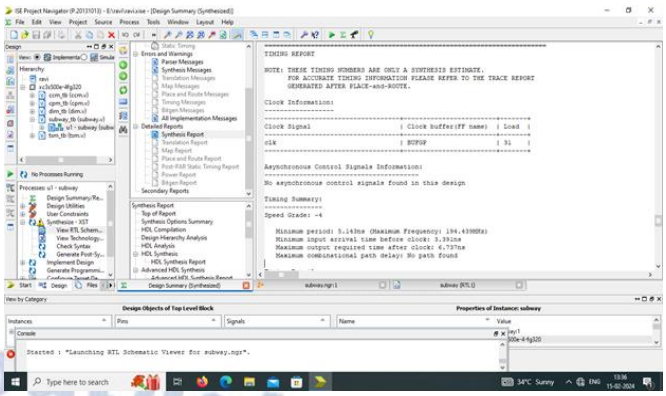

Figure 4: Delay estimation of the proposed system

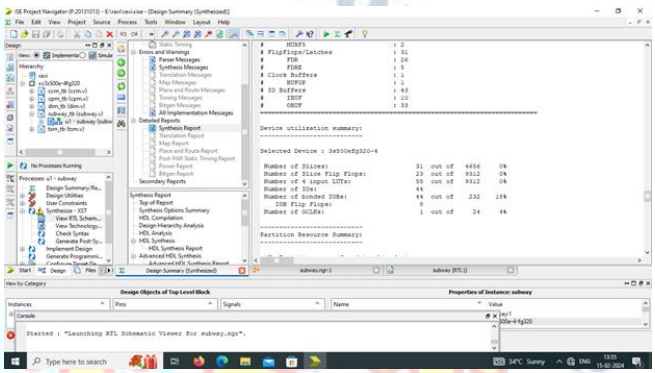

Figure 5: Device utilization summaryof the proposed parking system

Area estimation provides insights into the physical space occupied by the designed circuit on the semiconductor. It is crucial for optimizing the use of resources and determining the overall size of the chip. Efficient area utilization contributes to cost-effectiveness and manufacturability. Figure 5 presents the area estimation of the proposed system. The area report shows that it contains 4 look up tables.

5. CONCLUSIONS

This design is a subway automatic ticketing system. The system has the functions of line selection, line display, money collection, change and ticket issuing, and has the basic functions of a complete automatic ticket selling system. In the graduation comprehensive training, we can investigate the actual situation of the subway ticket vending machine, so we have a certain grasp and judgment on the actual situation of the design, and can design people who will not conduct online electronic transactions conveniently in combination with the actual situation, or people who cannot

conduct online transactions under unexpected circumstances such as no power on the mobile phone and limited network.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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