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Research Article

Design and Implementation of an Any Time Electricity Bill Payment System

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ABSTRACT

This work presents the design and implementation of an any time electricity bill payment (ATP), which is an unmanned system designed to collect payments from consumers by various modes such as cash, cheque, or demand draft (DD). The ATP operates 24/7 and provides a touch screen and multimedia-based interface to facilitate easy and convenient payment transactions. This paper discusses the objectives, simulation, output state diagram, area report, timing report, and algorithm for the Mealy Machine implementation of the ATP.

1 Introduction

The ATP is a payment collection system that aims to provide a user-friendly and efficient method for consumers to make payments. It accepts various forms of payment, including cash, cheque, DD, and pay order. The sys- tem is equipped with a barcode scanner, which enables automatic activation when the customer places the voucher or bill in the designated slot. The ATP captures data from the voucher/bill, displays relevant parameters on the monitor, and guides the customer through the payment process. This approach is supported by recent advancements in automated kiosk systems[1].

2 Objectives

The main objectives of this internship project are as follows:

- Design and develop an ATP system capable of collecting payments through multiple modes.
- Implement a touch screen and multimedia-based interface for user interaction.
- Capture data from the voucher/bill and display relevant parameters onthe monitor.
- Provide prompts and guidance to the customer during the paymentprocess.
- Implement a secure and efficient payment validation mechanism.
- Generate an acknowledgment for each payment made by the customer.

3 Existing Work

Existing systems for electricity bill payment primarily rely on manned counters or online payment gateways. Manned counters require consumers to physically visit payment centers during working hours, leading to inconvenience and long waiting times. Online payment systems, while accessible from anywhere, can be challenging for users who are not tech-savvy or lack access to reliable internet connections. These systems often do not provide support for payments via cash or cheques, limiting payment options for users. Additionally, there is a lack of integrated systems that offer 24/7 service with comprehensive payment mode acceptance and user-friendly interfaces [2].

4 Proposed Work

The proposed Any Time Payment (ATP) system aims to address the limitations of existing payment methods by introducing an unmanned, 24/7 payment kiosk that supports multiple payment modes including cash, cheque, and demand draft (DD). The ATP system is designed to be user-friendly, incorporating a touch screen and multimedia-based interface to guide users through the payment process. It includes a barcode scanner to automatically read and process vouchers or bills, thereby reducing manual input errors and speeding up the transaction process [3]. Additionally, the ATP system employs a secure payment validation mechanism and generates an acknowledgment receipt for each transaction. This comprehensive approach ensures greater accessibility, convenience, and efficiency for consumer's making electricity bill payments [4].

5 Model Block Diagram

The block diagram representation of any time electricity bill payment is shown in Figure 1.

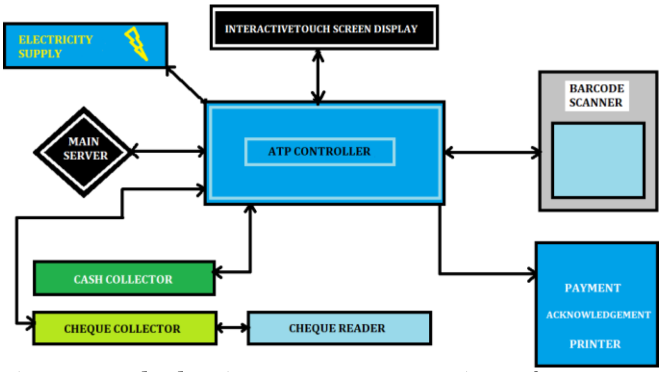

Figure 1: Block Diagram representation of ATP

6 Model State Diagram

This ATP is designed based on the Mealy Machine model as shown in Figure 2. The state diagram is a graphical representation of the different states and transitions within the ATP system. The Mealy model for this system contains 8 states, each representing a unique stage in the payment process. Transitions between states are triggered by user interactions and system events, ensuringa secure and orderly payment transaction [5].

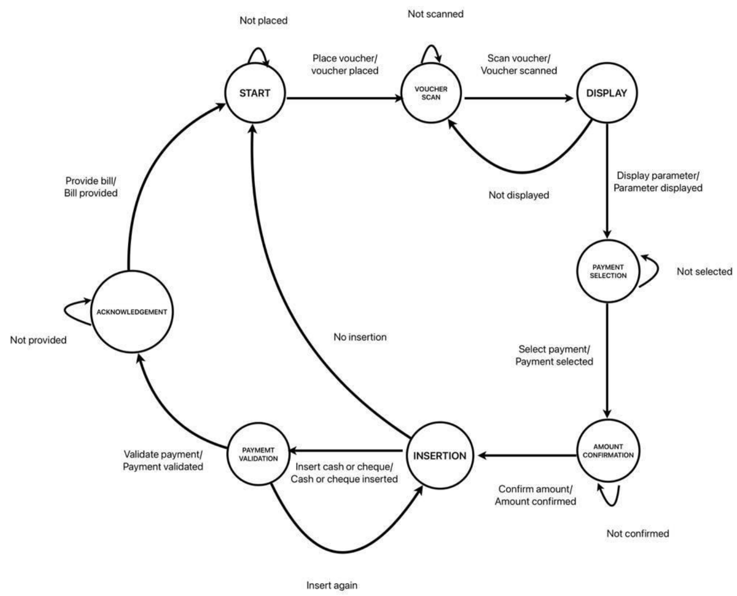

Figure 2: Mealy model representation of ATP

7 Model Flow Diagram

The flow chart representation of any time electricity bill payment is shown in Figure 3. This diagram outlines the sequential steps taken by the ATP system from the moment a user initiates a payment transaction to the final confirmation and acknowledgment of payment. The flow diagram helps in understanding the overall process and the interaction between different components of the system.

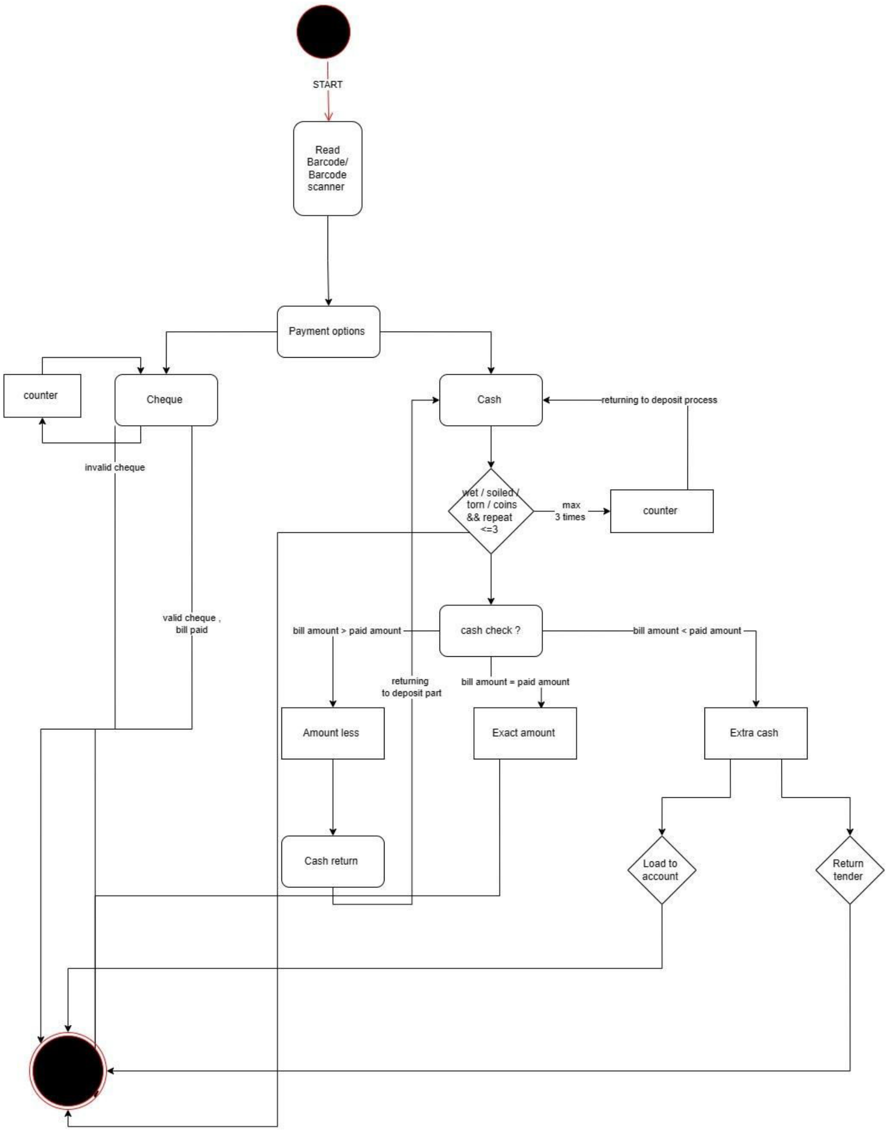

Figure 3: Flow diagram representation of ATP

8 Analysis and Elaboration

The analysis and elaboration process of a Verilog code refers to the initial stages of compiling and processing the code to prepare it for simulation or synthesis. It involves several steps that ensure the code is valid, well-formed and ready for further processing. This is shown in Figure 4.

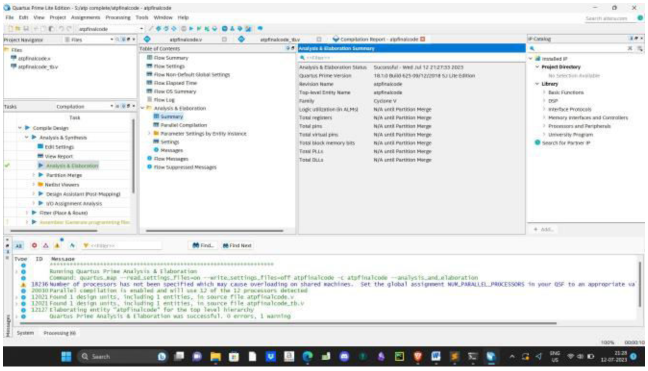

Figure 4: Output of Analysis and Elaboration

During analysis, the Verilog compiler scans the code and performs lexical and syntactic analysis. This step involves tokenizing the code, identifying keywords, operators, and identifiers, and checking for proper syntax and grammar. It detects any errors or inconsistencies in the code structure and reports them to the user. Once the code passes the analysis phase, the elaboration process begins. Elaboration involves expanding and connecting the modules defined in the code to create a hierarchical representation of the design. It resolves module instances, connects signals, and determines the interconnections between different modules. This step establishes the structure and hierarchy of the design, enabling further processing and simulation.

9 Simulation

When Verilog code is simulated, the inputs specified in the code are applied and the simulation engine processes the code to generate outputs based on the defined behavior and logic of the design. These outputs represent the behavior and functionality of the digital system being modeled [1].

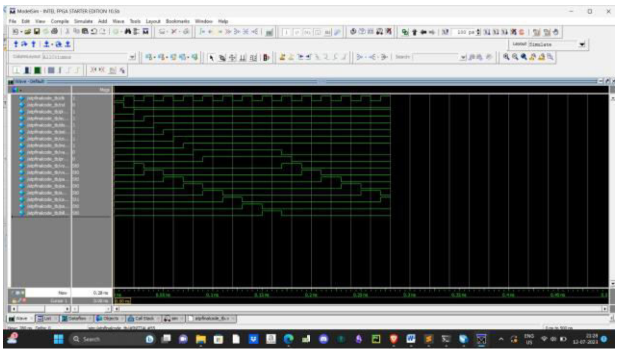

Figure 5: Simulation output

The simulation output includes values and waveforms for various signals and variables defined within the Verilog code. These outputs provide insights into the operation of the digital circuit, including the timing relationships between different signals, the propagation of data through the circuit, andthe overall functionality of the design.

10 RTL Viewer

This is the RTL viewer output diagram, after the analysis and elaboration process. An RTL (Register-Transfer Level) viewer is a tool used in digital design to visualize and analyze hardware description language (HDL) code, such as Verilog or VHDL, at the register-transfer level. It provides a graphicalrepresentation of the digital circuit, helping designers to debug their designs, verify functionality against specifications and optimize logic and timing. RTL viewers allow exploration of design hierarchy, tracing of signal paths, visualization of state machines, and sometimes include timing diagrams for comprehensive analysis. These tools are essential for ensuring the accuracy and efficiency of digital designs before synthesis and physical implementation stages. Popular RTL viewers like ModelSim, Questasim, and Verdi integrate seamlessly into HDL development environments, offering robust features for design validation and optimization.

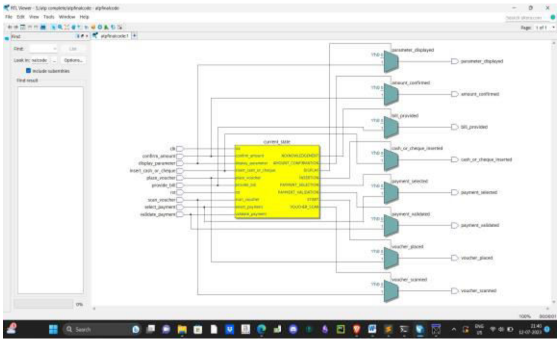

Figure 6: RTL view

11 State Machine Diagram

A state machine output diagram is a visual representation of the outputs generated by a Verilog code's state machine. The state machine output diagram illustrates the relationship between the current state of the machineand the corresponding output values. It helps to understand how the state machine responds to different inputs and generates specific outputs. The state machine diagram that I obtained after running the analysis and elaboration process represents my model in which it contains 8 states. The Figure7 shows the output of the state machine.

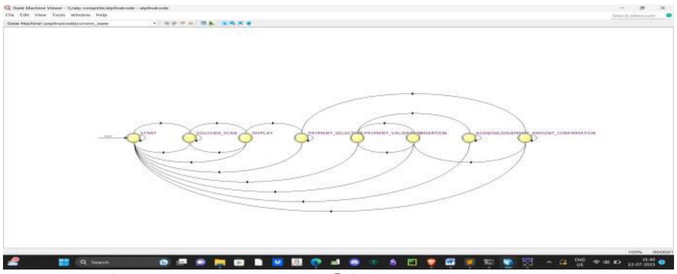

Figure 7: State machine output

12 Summary

This is the output of my design, which is a representation of 8 states in my design. During the internship, I worked on the design and implementation of an Any Time Electricity Bill Payment (ATP) system, addressing the limitations of existing payment methods. The ATP system is an un- manned, 24/7 payment kiosk supporting multiple payment modes, including cash, cheque, and demand draft (DD), and features a user-friendly touch- screen and multimedia-based interface. The system incorporates a barcode scanner for automated voucher/bill processing and employs a secure payment validation mechanism, ensuring efficiency and accuracy. The ATP generates acknowledgment receipts for each transaction, enhancing accessibility and convenience for consumers.

The design was based on the Mealy Machine model, consisting of 8 states representing different stages of the payment process. Throughout the intern- ship, I gained hands-on experience in digital design and Verilog programming, culminating in the successful development of a functional ATP system prototype. This experience has provided valuable insights into the intricacies of hardware design, state machine implementation, and the challengesof creating user-friendly interfaces for automated payment systems [6]. The knowledge and skills acquired during this internship have significantly contributed to my understanding of digital design principles and their practical applications in real-world projects [7].

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