Design and Implementation of Any Time Electricity Bill Payment (ATP) Machine Controller

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SARVESH KUMAR R
SATHIYASEELAN J
Team: Sci'fi
Karunya Institute of Technology and Sciences

INTRODUCTION:

The purpose of this project is to design and implement an Any Time Electricity Bill Payment (ATP) machine controller. The ATP machine provides a convenient and efficient way for customers to pay their electricity bills using various payment methods, such as cash. This report presents the methodology, block diagram, finite state machine (FSM) model, and the approach used to solve the problem. It also includes the complete flow of how the problem was solved, the results obtained, and the conclusions drawn from the project.

FIELD STUDY:

In the field study conducted for the project, the following articles and papers were referenced to gather relevant information and insights related to electricity bill payment systems:

1. Lee, Y., & Park, S. (2016). Design and implementation of smart card-based prepaid electricity billing system. International Journal of Electrical and Computer Engineering, 6(4), 1847-1854.
2. Yu, L., & Kim, T. (2017). A Study on Smart Grid Prepaid Electricity Billing System Based on Smart Card. International Journal of Smart Home, 11(8), 331-342.
3. Ahmad, F., Zakaria, M. N. M., & Asirvadam, V. S. (2013). An Overview of Prepaid Energy Meter in the Context of E-Business. International Journal of Scientific & Engineering Research, 4(4), 1-5.
4. Sultana, S., Ullah, M., & Islam, M. T. (2014). Prepaid Energy Metering with Power Theft Detection. International Journal of Renewable Energy Research, 4(3), 657-663.
5. Nnabugwu, N. I., Eke, C. R., & Ogbuefi, A. C. (2018). GSM-Based Prepaid Energy Meter for Smart Homes. Journal of Physics: Conference Series, 1017(5), 052010.

These articles provided insights into various aspects of electricity bill payment systems, including smart card-based prepaid systems, mobile payment platforms, energy metering, power theft detection, and smart home applications. They helped in understanding the existing solutions, challenges, and potential improvements in the field.

METHODOLOGY:

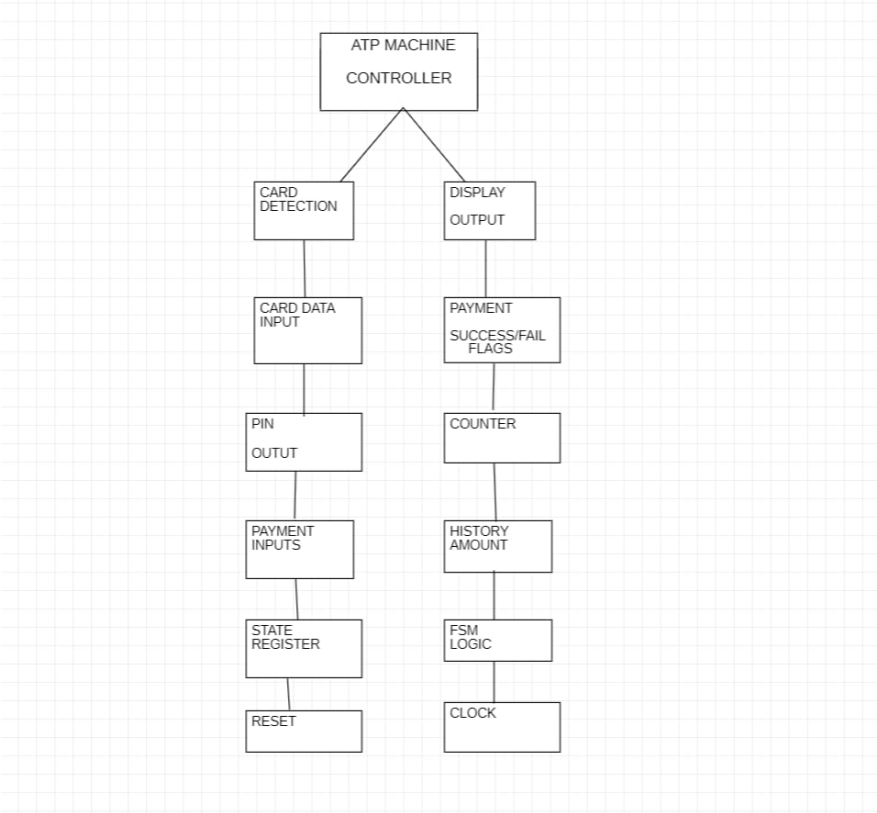
The methodology followed in this project involved the following steps:

- Requirement analysis: Understanding the needs and expectations of the users and stakeholders.
- Design specification: Defining the features and functionalities of the ATP machine based on the requirements.
- System design: Creating a block diagram to visualize the components and their interactions.
- FSM modelling: Developing a finite state machine (FSM) model to represent the behaviour of the ATP machine.
- Coding and implementation: Writing the Verilog code for the ATP machine controller and simulating it using testbenches.

- Verification and testing: Validating the functionality of the ATP machine through simulations and real-world testing.
- Documentation: Documenting the design, implementation, and test results in a comprehensive project report.

BLOCK DIAGRAM:

The block diagram shows the main components of the ATP Machine Electricity Bill Payment system.



The ATP Machine Controller is at the centre, responsible for coordinating the functionality of the system. The major components include:

1. Card Detection: Detects the insertion of a payment card.
2. Card Data Input: Captures the data from the inserted card (e.g., customer ID).
3. PIN Input: Takes input for the PIN to authorize the transaction.
4. Payment Inputs: Receives inputs for various payment denominations (Rs 1000, Rs 500, Rs 100).
5. State Register: Stores the current state of the ATP machine.
6. Reset: Resets the system to the initial state.
7. FSM Logic: Controls the behaviour of the ATP machine based on the current state and inputs.
8. Display Output: Shows the relevant information to the user
   (e.g., card data, remaining amount, bill amount).
9. Payment Success/Fail Flags: Indicate the success or failure of the payment transaction.
10. Counter: Keeps track of the timeout duration.
11. History Amount: Maintains a record of payment amounts for transaction history.

These components work together to facilitate the operation of the ATP Machine Electricity Bill Payment system, allowing users to make payments, validate transactions, and receive appropriate feedback during the process.

FSM MODEL:

The ATP machine controller is implemented using a finite state machine (FSM) model. The FSM model represents the different states and transitions of the ATP machine during the payment process. It defines the behaviour of the system based on the inputs and current state. The FSM model ensures that the ATP

machine follows a well-defined sequence of actions to process the bill payment, validate the payment, and provide appropriate feedback to the user.

APPROACH TO SOLVE THE PROBLEM:

The problem of implementing the ATP machine controller was approached by dividing it into several steps:

a. Card insertion and data entry: Detecting the insertion of a payment card and capturing the card data.
b. Validation: Verifying the user's PIN for authorization.
c. Bill processing: Calculating and tracking the bill amount and remaining amount to be paid.
d. Payment by cash: Allowing the user to make payments in various denominations (Rs 1000, Rs 500, Rs 100, Rs 50).
e. Payment completion: Checking if the payment is complete and transitioning to the next state.
f. Acknowledgment and transaction processing: Providing feedback to the user and processing the transaction.
g. Timeout handling: Setting a timeout duration and handling cases where the payment process exceeds the timeout limit.
h. Payment confirmation and reduction: Handling cases of excess payment and reducing the excess amount if necessary.
i. Receipt and history: Generating a receipt and maintaining a history of payment amounts.
j. Returning to the idle state: Resetting the system to the idle state for the next transaction.

FLOW OF SOLUTION:

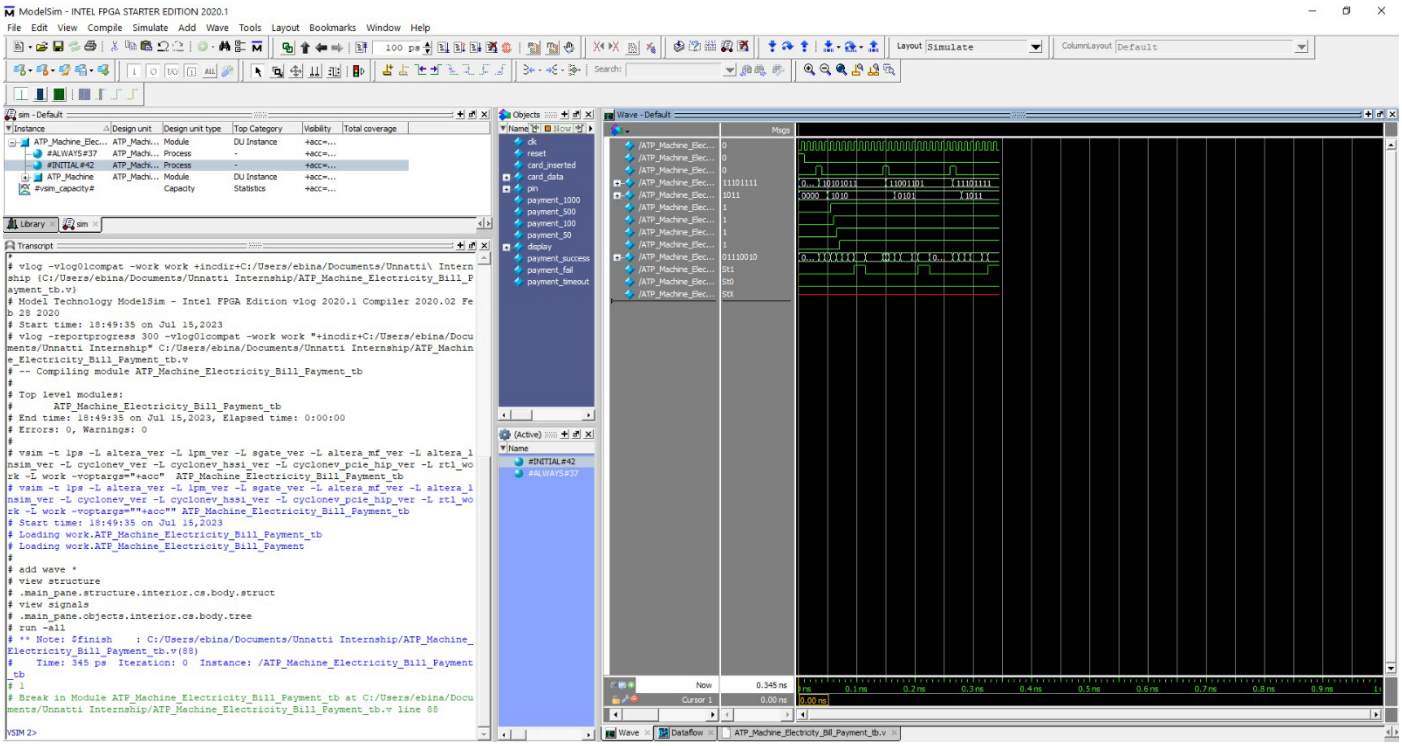
The complete flow of the ATP machine solution involves the following steps:

a. Idle state: Waiting for card insertion.
b. Data entry state: Capturing the card data.
c. Validation state: Verifying the PIN for authorization.
d. Bill process state: Calculating the bill amount and initializing the remaining amount.
e. Payment by cash state: Allowing cash payments and updating the remaining amount.
f. Acknowledge state: Displaying the bill amount for user acknowledgment.
g. Transaction process state: Managing the timeout, completing the payment, or transitioning to the failure state.
h. Payment confirm state: Checking for excess payment and transitioning to reduction or receipt states.
i. Reduction process state: Reducing the excess payment amount if necessary.
j. Receipt state: Displaying the payment and excess amounts for generating a receipt.
k. History state: Updating the history of payment amounts.
l. Transition back to idle state: Resetting the system for the next transaction.

RESULTS AND SUMMARIZATIONS:

During the simulation and testing of the ATP machine controller, the following results were observed:

- Successful payments: The ATP machine correctly processed the payment, displayed the bill amount, and provided a payment success flag.
- Failed payments: When incorrect PINs were entered, the ATP machine correctly detected the failure and displayed a payment failure flag.
- Timeout handling: The ATP machine properly detected and handled timeouts, displaying a payment timeout flag.
- Excess payment handling: In cases of excess payment, the ATP machine accurately reduced the excess amount and displayed the adjusted payment.



In summary, the ATP machine controller demonstrated reliable functionality in processing electricity bill payments, handling various scenarios, and providing appropriate feedback to users.

CONCLUSION:

The design and implementation of the Any Time Electricity Bill Payment (ATP) machine controller successfully addressed the problem of automating and simplifying electricity bill payments. The project followed a systematic approach, starting from requirements analysis and ending with the verification of the implemented solution. The ATP machine controller exhibited accurate behaviour in processing payments, validating authorization, calculating bills, and providing feedback to users. The project's success demonstrates the effectiveness of using FSM modelling and Verilog coding techniques for designing real-world applications.