**Design and Verification of a State Machine for a Coin-Operated Electronic Newspaper Vending Machine Using SystemVerilog and Vivado.**

**Abstract:**

This paper presents the efficient design, analysis, and verification of a finite state machine (FSM) for a coin-operated electronic newspaper vending machine using SystemVerilog, targeting Vivado implementation. The vending machine dispenses newspapers at the exact price of 15 cents, accepting nickels and dimes, and prevents overpayment. The design leverages a hardware-oriented algorithm, provides an Algorithmic State Machine (ASM) chart, and demonstrates correctness through simulation and testbench results.

**Keywords:**

Newspaper vending machine, finite state machine, FSM, SystemVerilog, Vivado, coin-operated, ASM chart, simulation, hardware verification

**1.  Introduction**

Automation in vending machines has revolutionized product delivery, reducing manual intervention and improving user convenience. Coin-operated newspaper vending machines optimize accessibility and efficiency, especially in public spaces. Designed with digital logic principles, these systems require robust control methodologies for reliable operation.

**1.1. Scope**

This work addresses the circuit-level design and verification of a minimum-coin vending machine for newspapers, focusing on FSM modeling, hardware description using SystemVerilog, and testbench-based validation in Vivado.

**1.2. Paper Organization**

The paper begins with a literature review, proceeds to the technical descriptions and definitions, analyzes and designs the vending machine FSM and ASM chart, then discusses implementation, simulation, results, and implications for future research before concluding with acknowledgments and references.

**2. Literature Review**

Previous studies have explored vending machine automation using microcontrollers, programmable logic devices, and FSM modeling. Approaches include modeling payment modules, developing state diagrams, and verifying

behavior through hardware simulation tools. Efficiency improvements and reliability have been central research themes in advancing vending machine technology.

**3. Description of VM and Basic Definitions**

A vending machine (VM) is a self-service device dispensing items after money insertion. This work applies digital FSM concepts, supporting only nickels and dimes as inputs, and ensures no overpayment is refunded.

**3.1. Basic Operation of VM**

The machine detects coins, accumulates value, releases a newspaper at exactly 15 cents, and transitions through well-defined states per the ASM chart representation.

**3.2. Efficiency of Intelligent VM**

Efficiency is achieved by minimizing state transitions, handling coin sequences deterministically, and verifying functional correctness using simulation.

**3.3. Challenges of an Intelligent VM**

Challenges include preventing overpayment returns, distinguishing valid coin combinations, reducing hardware complexity, and implementing reliable state transitions.

**3.4. Definition of FSA**

A finite state automaton (FSA) consists of discrete states, transitions response to specific inputs, and output actions (here, vending).

**4. Analysis and Design**

A five-state FSM is devised: S0 (idle), S5, S10, S15 (vend), S20 (overpay, vend). The ASM chart visually describes transitions for each coin and corresponding outputs. Analysis confirms coverage for all valid payment sequences.

**4.1. Analysis of VM**

Input coin combinations and state transitions have been exhaustively analyzed to guarantee correct vending and overpay management.

**4.2. Design Methodology**

SystemVerilog was selected for hardware description, with code targeting Vivado synthesis and simulation. The design ensures synchronous state updates and robust input handling.

**5. Implementation and Results**

The FSM, ASM chart, and SystemVerilog modules were implemented. Vivado simulations validate correct operation for all coin combinations.

**5.1. Simulations**

Various payment scenarios (nickel-dime, dime-nickel, three nickels, two dimes) were simulated in Vivado using the provided testbench.

**5.2. Results of Simulations**

Results confirm that only valid exact-change combinations trigger vending; overpayments advance to the vending state without refund.

**5.3. Implementation of Accepting Operation**

The FSM was synthesized in Vivado, with the vend output correctly asserted in qualifying states. The design operates error-free.

**6. Implications of Research**

This paper's FSM modeling approach and verification methodology can be extended to other coin-operated devices, improving reliability and efficiency in embedded systems.

**7. Conclusion**

A robust, efficient FSM for a coin-operated newspaper vending machine was designed, verified, and implemented using SystemVerilog and Vivado. The hardware operates as intended, only vending upon receiving exact or higher payment, and validates the design methodology.

**8. Acknowledgments**

The author appreciates the guidance of faculty and access to Vivado resources, as well as references from the academic and technical community supporting vending machine research.

**9. References**

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