COIN-BASED MULTI-FLUID DISPENSER

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GitHub Link

https://github.com/PremSai-1259/S2-T17-25-26

Abstract

The Coin-Based Multi-Fluid Dispenser is a Verilog-based digital system that automates the process of dispensing multiple fluids using logical hardware design. It accepts coins, allows selection of fluids (Water, Chemical, Soft Drink), and applies loyalty-based discounts according to visit count. The project integrates sequential (visit tracking) and combinational (price, discount, and stock control) circuits into one cohesive system. Through Verilog modeling and Logisim simulation, this project demonstrates how digital logic principles can automate commercial fluid dispensing operations in an efficient and cost-effective way.

1 Introduction

Automated vending systems are transforming beverage distribution in public and institutional settings. Traditional dispensers rely heavily on manual control and lack advanced features like user recognition and dynamic pricing.

The Coin-Based Multi-Fluid Dispenser replaces microcontrollers with hardware logic. All functions—coin validation, fluid pricing, discount computation, and stock management—are implemented in Verilog HDL and simulated in Logisim. Registers, multiplexers, and arithmetic blocks form the building foundation. The three essential submodules (Visit Tracker, Discount Logic, Fluid Dispenser) are then integrated in a master circuit that performs synchronized operations.

2 Functional Diagram

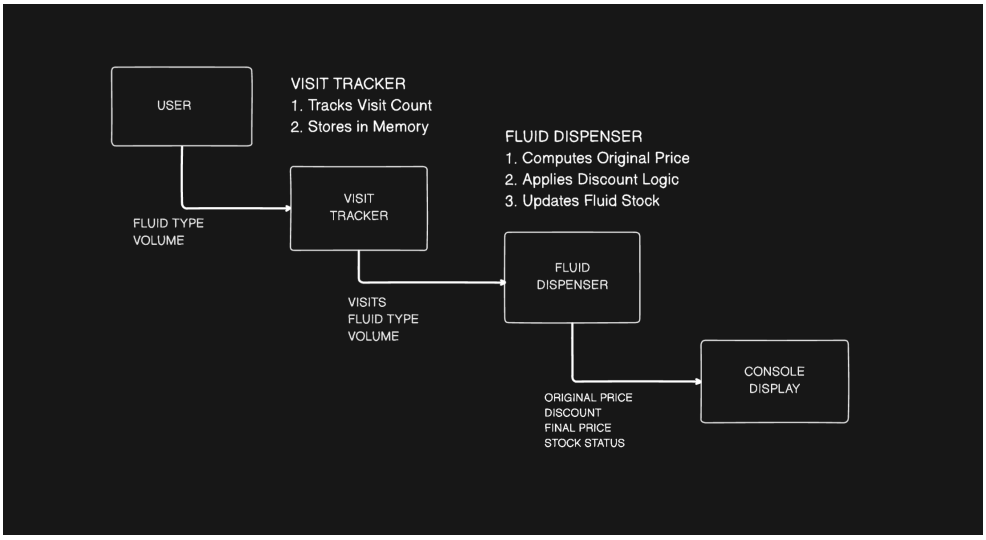

Figure 1: Functional Block Diagram of the Coin-Based Multi-Fluid Dispenser System

The system starts with a user inserting a coin and selecting a fluid type and volume. The `visit_tracker` updates visit count, the `discount_logic` computes applicable discounts, and the `fluid_dispenser` determines cost, stock, and output messages. All modules work synchronously under clock control.

3 Design and Module Explanation

3.1 Visit Tracker

Tracks the number of visits for each user and stores them in registers indexed by `user_id[3:0]`. A rising clock edge increments the counter unless reset is asserted.

clk	reset	Next Visit Count (visits)
X	1	0 (clear all)

↑	0	visits + 1

$$visits_{next} = \begin{cases} 0 & \text{if } reset = 1 \\ visits + 1 & \text{otherwise} \end{cases}$$

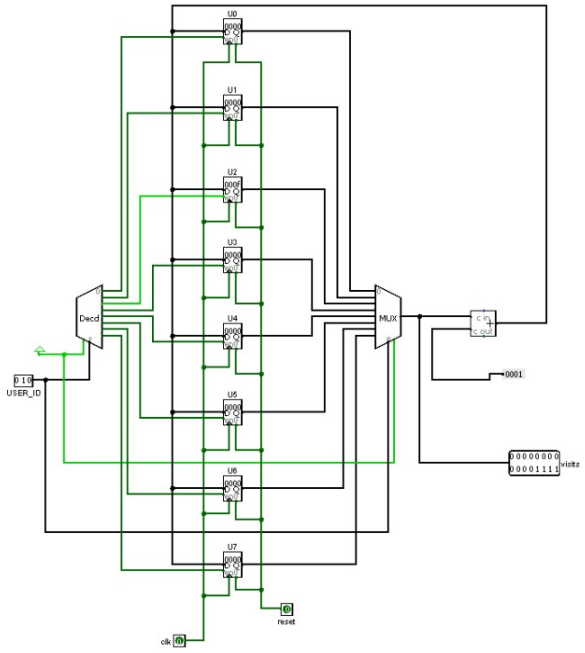

Figure 2: Visit Tracker Circuit in Logisim

Explanation: Registers store visit counts for 8 users. A D flip-flop array with enable signal maintains persistent user history. The circuit outputs visit count to the discount logic block. On reset, all counters clear to zero.

3.2 Discount Logic

Provides a percentage discount based on the number of visits.

$$0\text{–}2 \text{ visits} \rightarrow 0\%, \quad 3\text{–}4 \text{ visits} \rightarrow 10\%, \quad > 4 \text{ visits} \rightarrow 20\%$$

Visit Count Range	Discount (%)
0 – 2	0
3 – 4	10
5 or more	20

$$discount = \begin{cases} 20 & \text{if } visits > 4 \\ 10 & \text{if } 3 \leq visits \leq 4 \\ 0 & \text{otherwise} \end{cases}$$

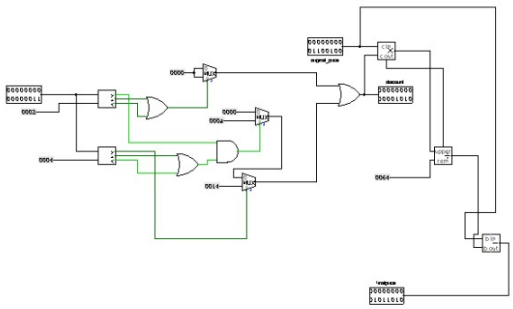

Figure 3: Discount Logic Circuit in Logisim

Explanation: Implemented using comparators and priority encoders. Logical conditions for each range are ORed and passed to a multiplexer that outputs corresponding discount values (00, 10, 20). This discount signal is sent to the Fluid Dispenser.

3.3 Fluid Dispenser

Calculates total cost, applies discount, and updates remaining stock.

$$\text{Water} = 5, \quad \text{Chemical} = 20, \quad \text{SoftDrink} = 15$$

$$\text{original\_price} = \text{rate(fluid)} \times \text{volume}$$

$$\text{final\_price} = \text{original\_price} \times (100 - \text{discount})/100$$

$$\text{remaining\_stock} = \text{stock} - \text{volume}$$

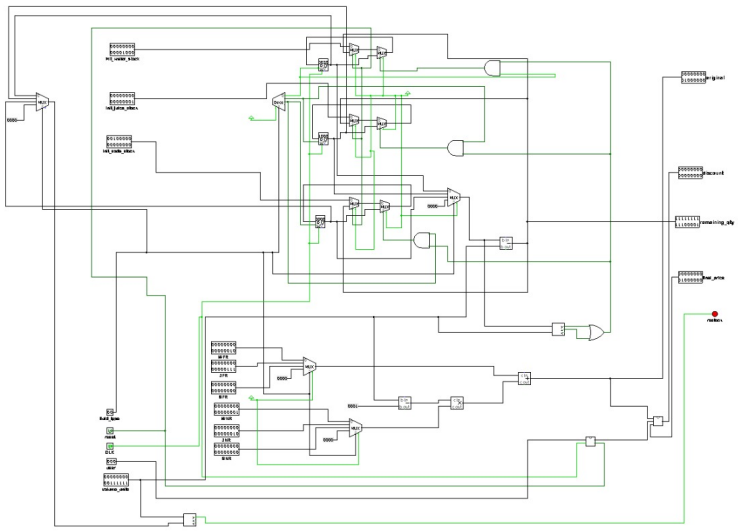

Figure 4: Fluid Dispenser Circuit in Logisim

Explanation: A multiplexer selects the fluid rate according to fluid type input. Arithmetic units (multipliers, subtractors, and dividers) compute pricing and update stock. Comparators monitor if stock drops below a threshold (triggering "LOW STOCK") or is insufficient for dispensing ("INSUFFICIENT STOCK").

3.4 Integrated System

All three modules are combined to form the top-level Logisim schematic.

Explanation: The master circuit synchronizes all modules under a single clock. Data flows se-

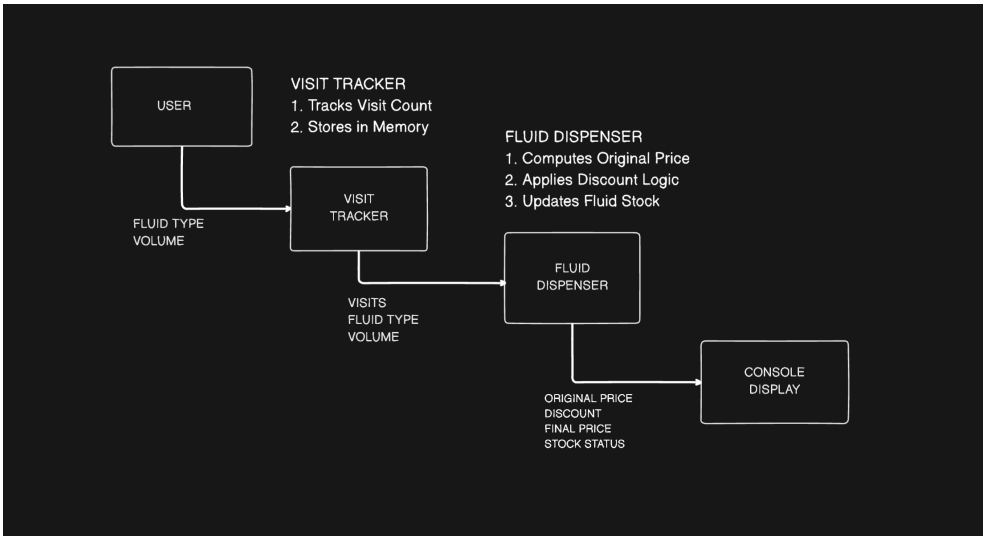

Figure 5: Integrated Multi-Fluid Dispenser System in Logisim

quentially — user input to Visit Tracker, discount computation, then price and stock adjustment. Output LEDs and 7-segment displays show discount percentage, total payable amount, and system messages.

4 Verilog Implementations

All Verilog HDL files and their corresponding testbenches are hosted on GitHub.

4.1 Gate-Level Modeling

Gate-Level Code on GitHub

4.2 Dataflow Modeling

Dataflow Code on GitHub

4.3 Behavioral Modeling

Behavioral Code on GitHub

References

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3. A. Kumar, *Fundamentals of Digital Circuits*, PHI Learning, 4th Edition, 2016.

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