Digital Logic Design

EE1005

Project Report

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Whack a Mole

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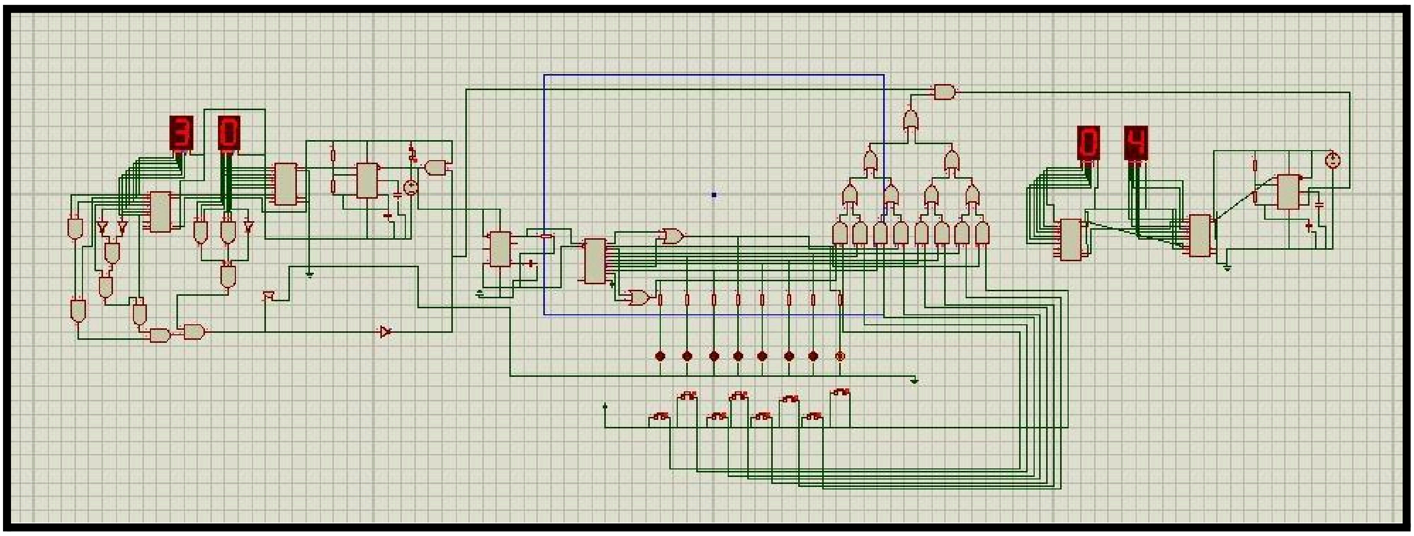
Whack-a-Mole Game Report



Components Used in Proteus

1. 555 Timer IC

2. 4017 Decade Counter

3. 4026 Decade Counter/7 Segment Drive

4. AND Gates

5. NOT Gates

6. OR Gates

7. Capacitors

8. Resistors

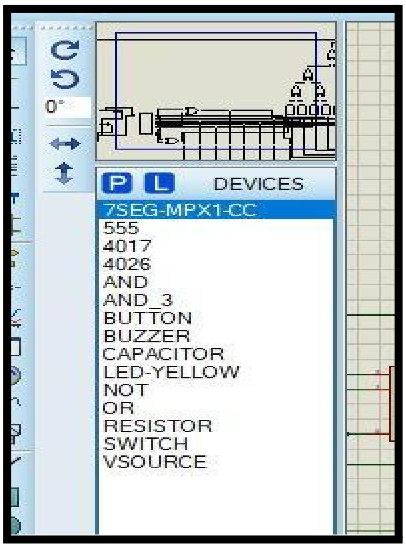
9. LEDs (Yellow)

10. 7-Segment Displays

11. Switches

12. Buzzer

13. Voltage Source (V-Source)



Introduction

The Whack-a-Mole game is an interactive game where the objective is to 'whack' or press a button corresponding to a randomly lit LED. The game includes a scoring system and a timer that ends the game after 30 seconds with a buzzer sound. This report details the implementation of the Whack-a-Mole game using Proteus simulation software, covering the design, components, and working principle.

Working Principle :

The Whack-a-Mole game involves generating a random sequence of LEDs lighting up, pressing corresponding buttons to increase the score, and displaying the score on a 7-segment display. The game also includes a timer that runs for 30 seconds, at which point a buzzer sounds to signal the end of the game.

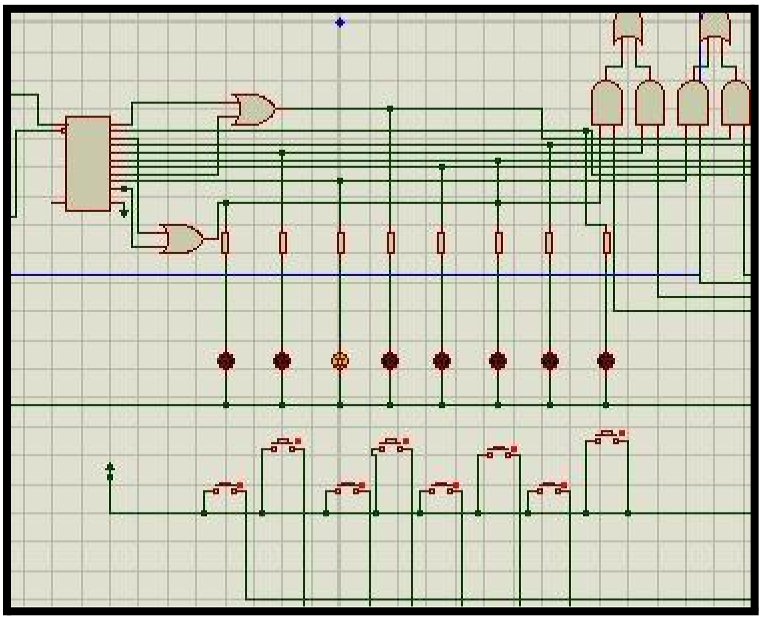
Detailed Explanation

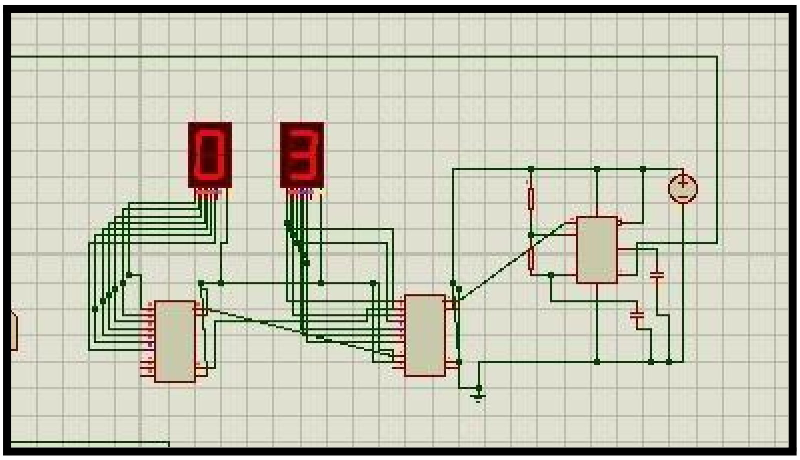
1. Random LED Generation:

- The 555 Timer IC is configured in a stable mode to produce a continuous clock pulse.
- This clock pulse is fed into the 4017 Decade Counter,

which has its outputs connected to multiple LEDs.

- As the 4017 Counter receives pulses, it sequentially turns on the LEDs in a random manner.





2. Button Press and Scoring:

- Each LED has a corresponding button. When a button is pressed while its LED is lit, an AND gate logic confirms the correct press.

- The confirmed press is then sent to the 4026

Decade Counter/7 Segment Driver.

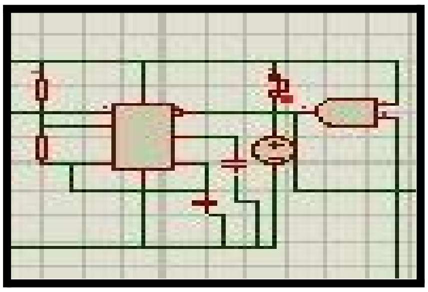
- The 4026 Counter increases the score and updates the 7-segment display.

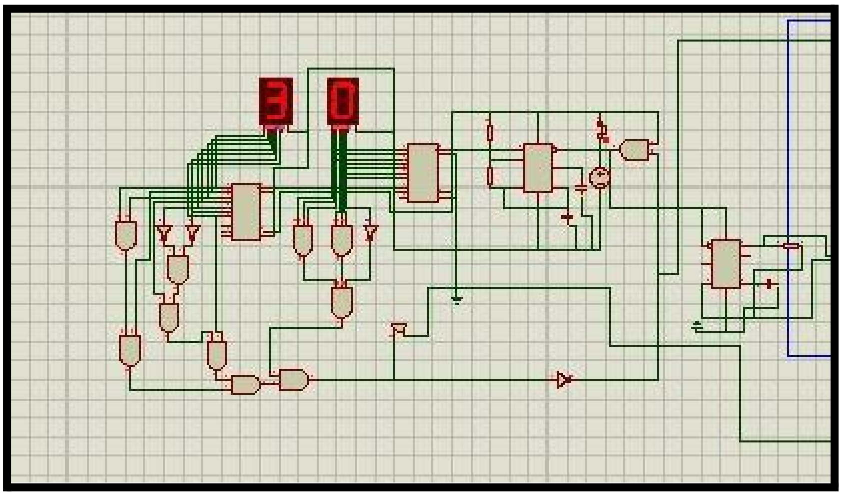
3. Timer and Buzzer:

- A second 555 Timer IC is used here to generate a precise 30-second interval.

- The timer starts as soon as the game begins.

- After 30 seconds, the timer output triggers a NOT gate that activates a buzzer, signalling the end of the game.





<u>Breadboard Implementation</u>

The implementation of the Whack-a-Mole game on a breadboard was a collaborative effort between team members

<u>1. Setting-up the Clock Pulse:</u>

- By Connecting the 555 Timer IC in a stable mode on the breadboard.

- We Used capacitors and resistors (with specific capacitance and resistance mentioned in proteus) to set the desired frequency for the clock pulse.

2. Counter and LED Connection:

- We Connected the 4017 Decade Counter with its outputs wired to the LEDs.
- We Ensured each LED had a current-limiting resistor to prevent damage.

3. Button and Scoring Mechanism:

- Connecting the buttons to the respective LEDs using AND gates to validate the correct button presses.
- Interfacing the output of the AND gates to the 4026 Decade Counter/7 Segment Driver.

4. Timer and Buzzer:

- Setting up a second 555 Timer IC in monostable mode for the 30-second interval.
- Connecting the output to a NOT gate and then to a buzzer.

5. Power Supply:

- Using a regulated power supply to ensure all components receive the appropriate voltage.

1. **Timer Setup:**
    - configured a 555 Timer IC in monostable mode to create a precise 30-second interval.
    - She carefully selected appropriate resistors and capacitors to ensure accurate timing.
2. **Counter and Display:**
    - Using a 4026 Decade Counter/7 Segment Driver, connected the outputs to a 7-segment display.
    - This setup was used to keep track of the player's score, updating the display with each correct button press.
    - ensured that the connections were stable and that the display correctly reflected the score increment.
3. **LED Connection:**
    - connected the outputs of the 4017 Decade Counter to the LEDs, ensuring each LED was properly limited by resistors to prevent damage.

- configured the 555 Timer IC in a stable mode to generate a continuous clock pulse, driving the 4017 Decade Counter to light up LEDs in a random sequence.

4. **Button Press Mechanism:**

   - implemented the push button mechanism by connecting each button to the respective LED through AND gates.
   - This setup allowed the system to verify correct button presses when an LED was lit, sending a signal to the counter to increment the score.

- **Interconnecting Breadboards:**
  - We carefully connected the outputs of the AND gates to the inputs of the 4026 Counter.
  - Power supply lines were shared across the breadboards to maintain a consistent voltage level for all components. The power supply and ground was given to the project from lab trainer board.

- **Synchronization and Testing:**
  - We tested the entire setup collaboratively, adjusting ensure the LEDs lit up randomly, buttons were correctly detected, scores were accurately displayed, and the buzzer sounded precisely at 30 seconds.

555 Timer IC

Truth table

Reset	Trigger	output
0	X	0
1	0	1
1	1	previous state

- **X**: Don’t care (can be either 0 or 1).
- The **Reset pin** has priority. If it's LOW, the output is forced LOW regardless of the trigger.
- The **Trigger pin** sets the output HIGH when it goes LOW.
- If neither reset nor trigger is active, the output remains in its last state.

k Map

R/T	0	1
0	0	0
1	1	Q

Q= R’T + Q(previous state)

<u>4026 DECADE COUNTER</u>

The 4026 is a Decade Counter IC that is commonly used to drive a 7-segment display. It can count from 0 to 9 and output the corresponding BCD (Binary Coded Decimal) signals, which are connected to the 7-segment display.

A 7-segment display has 7 segments labeled as a, b, c, d, e, f, g, where each segment can be controlled by setting the appropriate output pins.

Truth Table for 7-Segment Display (Driven by 4026):

Decimal (BCD Input)	a	b	c	d	e	f	g
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	1
3	1	1	1	1	0	0	1
4	0	1	1	0	0	1	1
5	1	0	1	1	0	1	1
6	1	0	1	1	1	1	1

7	1	1	1	0	0	0	0
8	1	1	1	1	1	1	1
9	1	1	1	1	0	1	1

K-map for 7-Segment Display:

Karnaugh maps (K-maps) for each of the seven segments a, b, c, d, e, f, g based on the above truth table:

1. Segment a:

AB \ CD	00	01	11	10
00	1	0	1	1
01	1	0	1	1
11	0	1	1	0
10	1	0	1	1

K-map for segment a:

- Boolean Expression: a = (B'C') + (A'C')

2. Segment b:

AB \ CD	00	01	11	10
00	1	1	0	0
01	1	0	0	1

11	0	1	1	1
10	1	1	1	0

K-map for segment b:

- Boolean Expression: b = A'B + AC + AB'

3. Segment c:

AB \ CD	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	1	1	1	0
10	0	1	1	1

K-map for segment c:

- Boolean Expression: c = A + B'C'

4. Segment d:

AB \ CD	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	0	0	1	1
10	1	1	1	0

K-map for segment d:

- Boolean Expression: d = (A'B') + (C')

5. Segment e:

AB \ CD	00	01	11	10
00	1	1	1	1
01	0	0	0	0
11	1	1	1	0
10	1	1	1	1

K-map for segment e:

- Boolean Expression: e = A'B + A'C'

6. Segment f:

AB \ CD	00	01	11	10
00	1	1	1	1
01	0	1	1	1
11	1	1	1	1
10	1	0	1	0

K-map for segment f:

- Boolean Expression: f = B' + A'C'

7. Segment g:

AB \ CD	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	1	1	1	0
10	1	1	0	1

K-map for segment g:

- Boolean Expression: g = A + B'

Summary of K-map results for the segments:

- a = (B'C') + (A'C')
- b = A'B + AC + AB'
- c = A + B'C'
- d = (A'B') + (C')
- e = A'B + A'C'
- f = B' + A'C'
- g = A + B'

4017 DECADE COUNTER

Truth table:

Truth Table for 4017 Decade Counter

Clock Pulse	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1	Q0
0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0	1	0
2	0	0	0	0	0	0	0	1	0	0
3	0	0	0	0	0	0	1	0	0	0
4	0	0	0	0	0	1	0	0	0	0
5	0	0	0	0	1	0	0	0	0	0
6	0	0	0	1	0	0	0	0	0	0
7	0	0	1	0	0	0	0	0	0	0
8	0	1	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0

Binary Clock Pulse Mapping:

The Binary Clock Pulse Mapping is a way of representing the sequence of clock pulses in binary format. In the case of a decade counter (such as the 4017), it counts from 0 to 9, and each pulse corresponds to a binary value that increments by 1 with each clock cycle.

In a 4-bit binary system, the clock pulse can be represented by a combination of four bits (A, B, C, D), where each bit can be either 0 or 1, representing the binary form of the decimal number.

Decimal Pulse	Binary (A, B, C, D)
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Explanation:

- **A, B, C, D** represent the binary equivalent of the decimal number.
- **A** is the most significant bit (MSB), and **D** is the least significant bit (LSB).
- The binary number increments with each clock pulse, so when the decimal counter reaches 9 (binary `1001`), the next pulse would wrap around back to 0 (`0000`).

The **Binary Clock Pulse Mapping** shows the binary representation of each decimal count. This is essential when setting up the K-map, where each combination of the bits (A, B, C, D) will be mapped to one of the outputs, such as Q0, Q1, Q2, etc., of the decade counter.

<u>k Map: (for Q0)</u>

AB\CD	00	01	11	10
00	1	0	0	0
01	0	0	0	0
11	0	0	0	0
10	0	0	0	1

Boolean expression:

- Q0 = A'B'C'D' + AB'C'D
- Q1 = A'B'C'D + AB'C'D'
- Q2 = A'B'C'D + AB'C'D'
- Q3 = A'B'C'D + AB'C'D'
- Q4 = A'B'C'D' + AB'C'D
- Q5 = A'B'C'D + AB'C'D'
- Q6 = A'B'C'D + AB'C'D'
- Q7 = A' B' C' D' + AB'C'D
- Q8 = A'B'C'D' + AB'C'D
- Q9 = A'B'C'D + AB'C'D'

Summary

The Whack-a-Mole game is an engaging interactive game that can be effectively implemented using Proteus software. The game utilizes key components such as 555 Timers, 4017 and 4026 Counters, logic gates, LEDs, switches, and a buzzer. The design involves generating random LED patterns, detecting correct button presses, keeping score, and implementing a timer. The game concludes with a buzzer sound after 30 seconds. Implementing this game on a breadboard involves careful placement and connection of components to mimic the circuit designed in Proteus. This exercise enhances understanding of digital logic, timing circuits, and practical circuit design.