Performance Testing Report: Enchant Wings - Marvel Butterfly

1. Wing Motion Test

Objective: To evaluate the reliability, accuracy, and smoothness of the wing-flapping mechanism under various operating conditions.

Test Setup:

- Servo motor connected to butterfly wings through a hinge mechanism.
- Motion controlled via PWM signals from Arduino.
- Continuous operation cycle test performed.

Metrics Monitored:

- Flapping angle range: 0 to 90
- Flap rate: 20, 40, and 60 flaps per minute
- Mechanical wear and heating of motor

Results:

- Wings moved smoothly without jerking.
- Servo motor remained within safe temperature limits.
- No mechanical fatigue after 3 hours of continuous operation.

2. LED Lighting Test

Objective: To assess the intensity, color blending, and transition performance of LEDs.

Test Setup:

- RGB LEDs placed behind semi-transparent wings.
- Controlled via Arduino PWM outputs.
- Various patterns (rainbow, pulse, sparkle) tested.

Results:

- Brightness uniform and sufficient under indoor lighting.
- Smooth color transitions and consistent brightness.
- Synchronized successfully with wing motion and sensors.

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3. Sensor Responsiveness and Accuracy

Objective: To validate input responsiveness from sensors like sound or IR proximity.

Tests Conducted:

- Sound detection using clap or voice at 1m and 2m distances.
- IR proximity sensor reaction to hand movement at distances of 5, 10, and 30 cm.

Response Time Measured:

- Sound: 0.30.8 seconds
- Proximity: <0.5 seconds

Accuracy:

- 95% for sound sensor, 97% for IR sensor.
- False Triggers: Less than 2% in noisy environments.

4. Power Consumption Test

Objective: To measure battery efficiency and runtime under full load.

Power Source:

- 5V power bank and Li-ion battery (2000 mAh)

Components Active:

- Servo motor (average 150200 mA)
- 3 RGB LEDs (60 mA max)
- Arduino Nano + sensors (5080 mA)

Total Consumption: ~300350 mA

Battery Backup: ~6 hours of continuous usage with moderate LED and sensor activity.

5. Durability and Load Testing

Objective: To test system reliability over time and under physical stress.

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Tests Performed:

- 5-hour continuous run test (motor + LEDs + sensors)
- Wing hinge and arm subjected to light manual stress

Results:

- No component failure or performance drop.
- Servo motor showed stable torque and no drift.

6. System Integration Test

Objective: To ensure all subsystems work seamlessly.

Test Flow:

- Sensor detects trigger Arduino activates motor and LEDs

Observations:

- No lag or software conflicts.
- Sequential and parallel actions executed without delay.
- Smooth synchronization between visual and mechanical responses.

7. Environmental Performance (Optional)

Objective: To simulate indoor and mild outdoor conditions.

Conditions Simulated:

- Indoor: 2530C, moderate humidity
- Light outdoor: shade area, ambient noise

Performance:

- Stable under both conditions.
- Light breeze did not affect wing motion.
- Sensor detection slightly reduced under strong sunlight (IR interference).

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8. User Interaction Feedback

Users Tested:

- Children (ages 812), Teachers, General Audience

Feedback Collected:

- Highly engaging and beautiful LED effects
- Kids enjoyed triggering the butterfly using voice or clap
- Suggested adding sound/music for more immersive experience

Conclusion of Testing

The Enchant Wings: Marvel Butterfly prototype performed well across all tests. It successfully integrated mechanical motion, sensory feedback, and visual output in a synchronized, responsive, and energy-efficient manner. This confirms the design is suitable for real-world applications in education, therapy, and interactive art.