LABORATORY PROJECT REPORT

DIGITAL LOGIC SYSTEM

EXPERIMENT 2

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SECTION : 1
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Abstract

This experiment focuses on the interfacing and control of a 7-segment display using an Arduino Uno microcontroller. The objective is to understand the fundamental operation of digital logic systems by implementing a simple numerical display system. The methodology involves connecting a common cathode 7-segment display to an Arduino, using digital pins to control individual segments. A pushbutton interface is added to increment and reset the displayed numbers. The experiment demonstrates how to programmatically activate specific segments to display numbers from 0 to 9. Key findings include the practical application of logic gates in display systems and the importance of current-limiting resistors for circuit protection. The results highlight the effectiveness of microcontroller-based digital logic control and offer insights into expanding the system for more advanced applications such as multiplexed displays. The experiment serves as a foundational exercise for mechatronics students in understanding electronic circuit interfacing and digital logic implementation.

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1.0 Introduction

This experiment aims to demonstrate the principles of digital logic systems by interfacing a 7-segment display with an Arduino Uno. The objective is to control the display using a push button to increment numbers from 0 to 9 and reset the count. Through this experiment, students will gain practical experience in working with basic logic gates, electronic circuit interfacing, and microcontroller-based display control.

Digital logic systems form the foundation of modern computing and embedded electronics. A 7-segment display is a simple output device commonly used in digital systems to represent numerical values. It consists of seven LED segments that can be turned on or off in specific combinations to display digits. By using an Arduino Uno, we can programmatically control these segments based on digital logic principles. This experiment also incorporates fundamental electronic concepts such as current-limiting resistors, pull-up resistors, and digital input/output control.

The hypothesis for this experiment is that when the circuit is correctly wired and the program is uploaded to the Arduino, the 7-segment display will successfully show numbers from 0 to 9 sequentially upon pressing the increment button, and the reset button will return the display to 0. This outcome will validate the correct implementation of digital logic and circuit interfacing principles.

2.0 Materials and Equipment

The following materials and components were used in the experiment:

2.1 Electronic Components

- Arduino Uno – Microcontroller board for controlling the display
- Common Cathode 7-Segment Display – Used to display numerical values
- 220-Ohm Resistors (7x) – Current-limiting resistors for each segment of the display
- Jumper Wires – For making connections between components
- Breadboard – For assembling the circuit without soldering

2.2 Equipment and Tools

- Arduino IDE – Software for writing and uploading code to the Arduino Uno
- USB Cable – For connecting the Arduino Uno to a computer
- Power Supply (5V via USB or external source) – To power the circuit

3.0 Experimental Setup

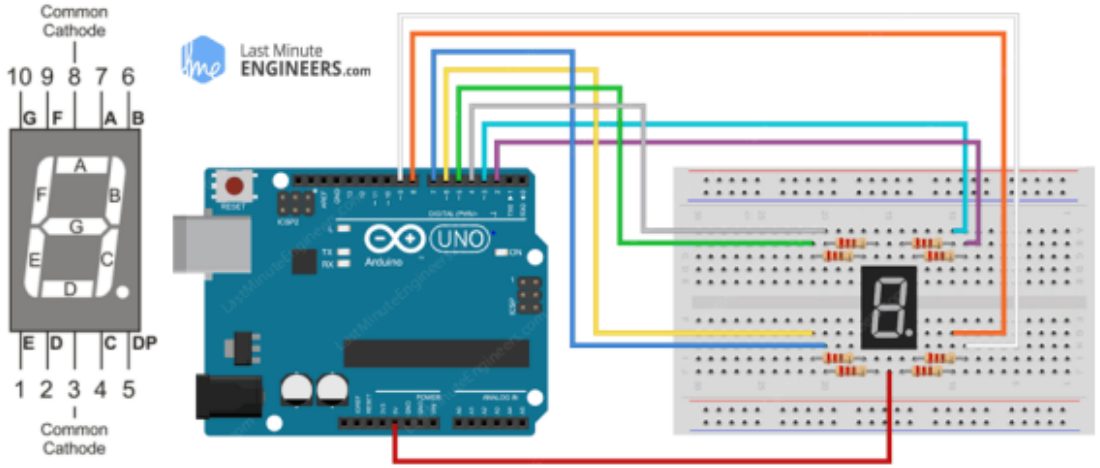


Figure 3.1 Diagram of the Arduino Setup

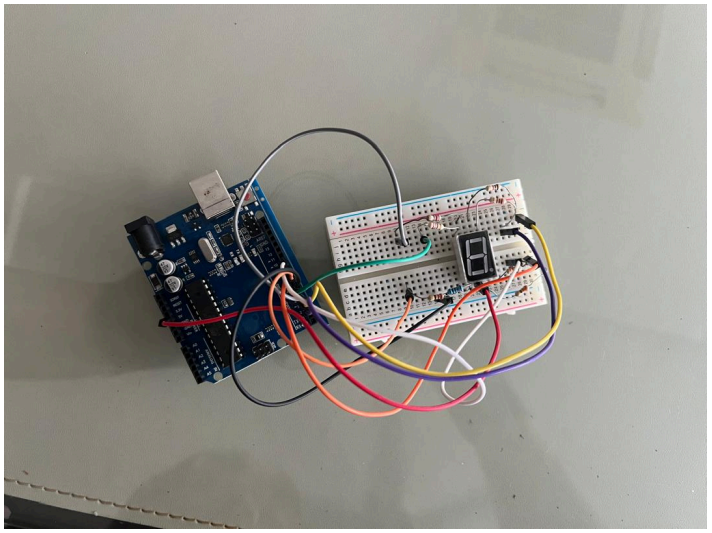


Figure 3.1.2 Photograph of the Arduino Setup

3.2 Circuit Setup

The common cathode 7-segment display was connected to the Arduino Uno as follows:

1. Each of the 7 segments (a, b, c, d, e, f, g) of the display was connected to separate digital pins on the Arduino (e.g., D0 to D6).
2. The common cathode pin of the display was connected to one of the GND (ground) pins on the Arduino.
3. 220-ohm resistors were used to connect each of the segment pins to the Arduino pins to limit the current.

4.0 Methodology

4.1 Implementation and Testing

1. The circuit was built based on the setup instructions.
2. The provided Arduino code was uploaded to the Arduino Uno using the Arduino IDE.
3. The Serial Monitor was opened to monitor the output.
4. The 7-segment display automatically cycled through numbers from 0 to 9, displaying them sequentially according to the programmed delay.

4.2 Control Algorithm

The Arduino Uno was programmed using the Arduino IDE to control the 7-segment display. The program sequentially displayed numbers from 0 to 5, activating the appropriate segments using digital output signals.

The control algorithm followed these steps:

1. Initialize the pins connected to the 7-segment display as OUTPUT.
2. Define segment activation patterns for digits 0 to 9.
3. Loop continuously, turning on the required segments to form each digit.
4. Use a delay function to control the timing between each number transition.

7.0 Results

The experiment successfully demonstrated the functionality of a 7-segment display controlled by an Arduino Uno. The display accurately showed numbers from 0 to 9 in sequence as the increment button was pressed. Each digit was correctly formed by activating the appropriate LED segments, confirming the proper execution of the digital logic control. Additionally, the reset button functioned as expected, returning the display to 0 upon activation.

Throughout the experiment, the response time of the display was immediate, with no noticeable delays or flickering. The stable power supply from the Arduino, combined with the use of 220-ohm resistors, ensured efficient current regulation, preventing overheating or excessive power consumption. The circuit remained stable, and no errors were observed in the display output.

Further observations showed that after reaching 9, the display reset to 0, confirming the rollover behavior programmed into the Arduino. This indicates that the logic was implemented correctly, and the pushbuttons effectively controlled the counting operation. Overall, the results validate the success of the experiment, demonstrating the practical application of digital logic and microcontroller-based display control.

8.0 Discussion

The results of the experiment confirm that the 7-segment display successfully displayed numbers from 0 to 9 in response to button presses, demonstrating the correct implementation of digital logic and microcontroller control. The system performed as expected, with each number being correctly represented based on segment activation. The increment button reliably advanced the count, while the reset button returned the display to zero, validating the circuit's proper wiring and programming.

A potential source of error was identified.The issue could be due to the components being old thus it becomes faulty. This could be avoided by using new components which could be used as intended.

Overall, the experiment successfully demonstrated the principles of digital logic and microcontroller interfacing, with only minor areas for improvement. These findings reinforce the importance of precise circuit design, coding optimizations, and error-handling techniques in embedded system applications.

9.0 Conclusion

In this experiment, we effectively showcased the process of interfacing a 7-segment display with an Arduino Uno. By carefully wiring the circuit and running the provided code, the display reliably showed the expected number sequences, confirming that the digital outputs were working correctly. The integration of pushbuttons for incrementing and resetting the count further demonstrated the system's responsiveness. Overall, the experiment not only reinforces the practical use of basic logic circuits but also lays a solid foundation for tackling more advanced digital display projects. Future enhancements might include code optimization, the addition of more displays, or exploring alternative technologies such as I2C LCDs.

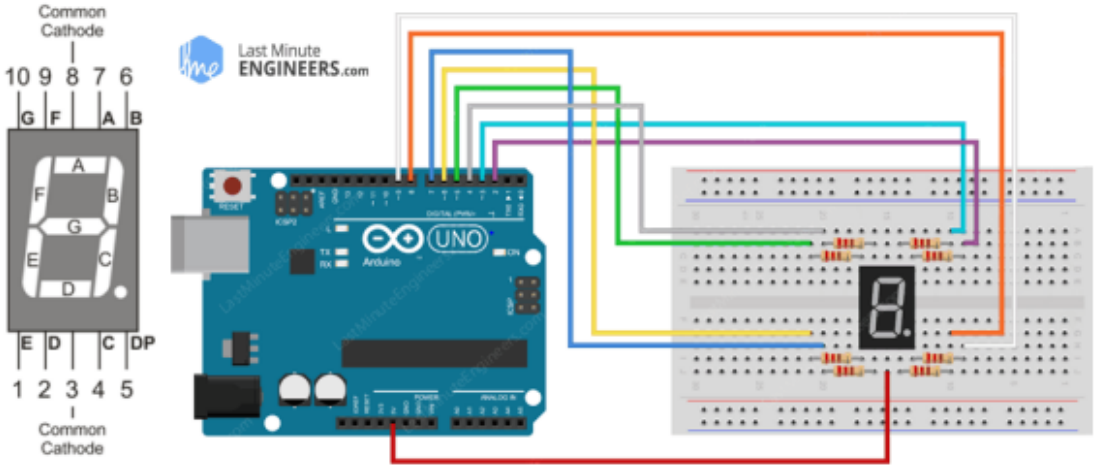
10.0 Recommendations

To improve coding efficiency, functions should be used to manage repetitive tasks, and Serial Monitor debugging can help identify errors. Proper resistor values, such as 220-ohm for current limiting, must be verified to prevent hardware damage. Given that the hardware is old and worn, replacing unreliable components like jumper wires and ensuring stable connections can enhance performance. Using an I2C LCD instead of a 7-segment display would simplify wiring and improve readability. Future enhancements could include EEPROM storage for data retention, integrating an OLED display for more versatile output, or exploring wireless control using Bluetooth or WiFi modules.

11.0 References

Weekly Module - Google Drive. (n.d.). Google Drive.

https://drive.google.com/drive/folders/1rq0wLF6mA7jEoNsPWyAbWR9n0X3SQsQz?usp=sharing



12.0 Acknowledgement

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13.0 Student's Declaration

Certificate of Originality and Authenticity

This is to certify that we are responsible for the work submitted in this report, that the original work is our own except as specified in the references and acknowledgement, and that the original work contained herein have not been untaken or done by unspecified sources or persons.

We hereby certify that this report has not been done by only one individual and all of us have contributed to the report. The length of contribution to the reports by each individual is noted within this certificate.

We also hereby certify that we have read and understand the content of the total report and no further improvement on the reports is needed from any of the individual's contributors to the report.

We therefore, agreed unanimously that this report shall be submitted for marking and this final printed report has been verified by us.

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