MECHATRONICS SYSTEM INTEGRATION MCTA3202

DIGITAL LOGIC SYSTEM

EXPERIMENT 2

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Abstract

This experiment focuses on the interfacing and control of a 7-segment display using an Arduino Uno microcontroller. The main objective is to comprehend the basic principles of digital logic systems by designing and implementing a simple numeric display circuit. The process involves attaching an Arduino to a common cathode 7-segment display, with each segment being controlled by digital pins. Additionally, push button inputs are incorporated to increment and reset the displayed numbers. This experiment illustrates how to programmatically activate specific segments to display numbers from 0 to 9. It highlight the practical uses of logic gates in displays systems and emphasizes the importance of current-limiting resistors for circuit protection. The findings confirm the effectiveness of microcontroller-based digital logic control and provide insight into extending the design for more applications, for such multiplexed displays. Overall, the experiment helps mechatronics students to understand electronic circuit interface and the application of digital logic systems by providing them with a vital learning exercises.

Table of Contents

1.0 Introduction

This experiment aims to illustrate the fundamentals of digital logic systems through the interface of an Arduino Uno with a &-segment display. The objectives is to reset the count and increase te numbers from 0 to 9 by controlling the display using a push button. Students will obtain practical experience with basic logic gates, electronic circuit interface, and microcontroller-based display control through this experiment.

The foundation of embedded electronics and modern computing is digital logic systems. A 7-segment display is a basic output component frequently utilized in digital systems to represent numeric data. It displays numbers by turning on and off seven LED segments in particular combinations. By employing an Arduino Uno, these segments can be programmatically controlled according to digital logic principle. This experiment integrates basic electronic concepts including digital input/output control, pull-up resistors, and current-limiting resistors.

The hypothesis states that, with the circuit correctly connected and the program successfully uploaded to the Arduino, the 7-segment display will display digits 0 to 9 sequentially each time the increment button is pressed and the reset button will return the display to 0. Successful operation of these functions will demonstrate the proper implementation of digital logic operations and circuit interfacing principles.

2.0 Materials and Equipments

Materials and components that were used in the experiment :

2.1 Electronic Components

- Arduino Uno Mega Microcontroller
- Common Cathode 7 Segment Display
- 220 Ohm resistors (7x)
- Jumper Wires
- Breadboard
- Push Button (2x)

2.2 Equipments

- Arduino IDE Software
- USB Cable

3.0 Experimental Setup

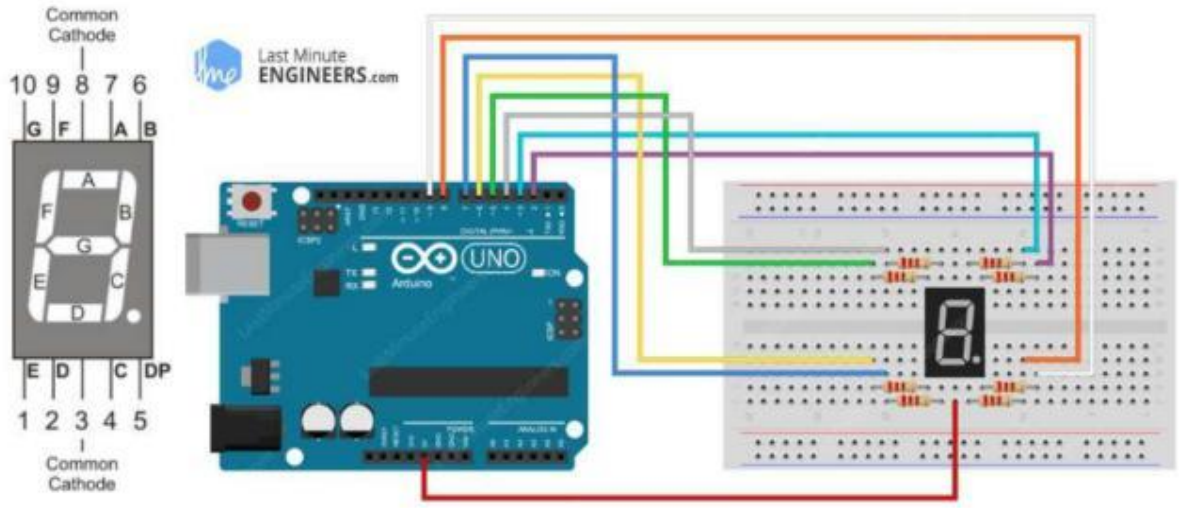
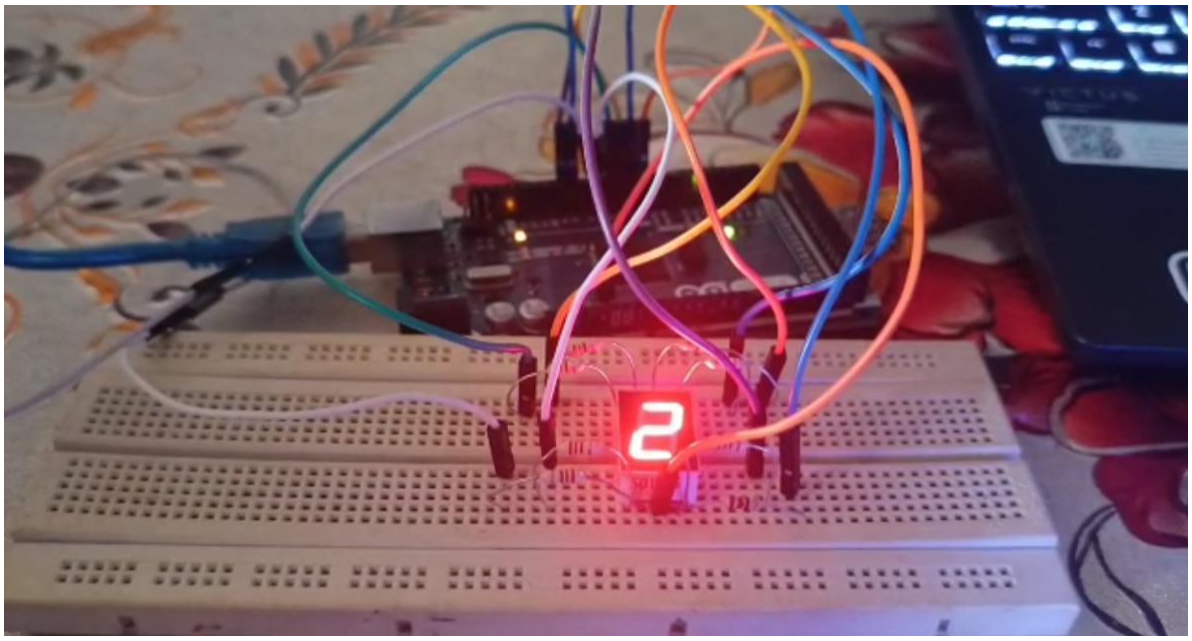


FIgure 3.1 Schematic Diagram 7 Segment Display Circuit Setup



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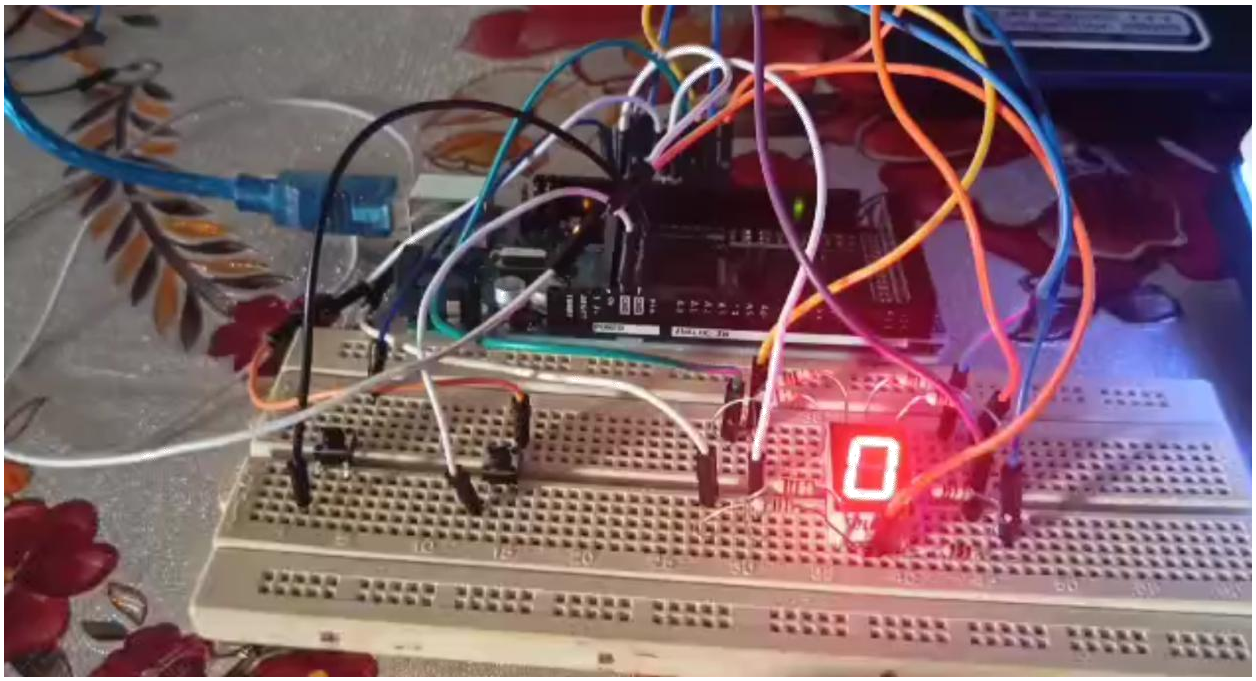

FIgure 3.1.1 Schematic Diagram 7 Segment Display Circuit Setup with Push Button

3.1 Circuit Setup

1. Common Cathode 7 Segment Display were connected to pins:
   A=D2
   B=D3
   C=D4
   D=D5
   E=D6
   F=D7
   G=D8
2. Common Cathode PIN of the display was connected to GND Pin on the Arduino Mega
3. 220 Ohm Resistors were used to connect every segment pins to digital pins on Arduino Mega

4.0 Methodology

4.1 Implementation and Testing

1. The circuit was built based on the schematic diagram.
2. The code of 7 Segment Display was uploaded to Arduino Uno Mega using Arduino IDE
3. There are 2 sets of codes which were code for increment to display 0 to 9 automatically and the other one was increment to manually increase the number 0 to 9 using push button.
4. The automatic increment display was automatically cycled showing numbers 0 to 9 sequentially.
5. The manual increment required one push button to show the next number and another push button used as a hard reset button where it immediately shows 0 after being pressed.

4.2 Control Algorithm

Arduino Uno Mega was programmed using Arduino IDE to upload the code and control the 7 segment display. The program displayed numbers from 0 to 9, showing appropriate segments using digital output signals.

The control algorithm follows:

1. Initialize pins (D2-D8) connected to each segment of the display as OUTPUT.
2. Define segment activation as LOW (common cathode) and the patterns for digits 0 to 0.
3. Loop the display continuously.
4. Use a delay function to control the timing and speed of the display.

Push Button Circuit

3. Press the Push button to manually increase the value and show the next number.
4. Push another push button to hard reset the count and display.

5.0 Result

The experiment successfully verified the operation of a 7-segment display interfaced with an Arduino Uno. The display sequentially presented digits from 0 to 9 in response to each press of the increment button, Each numeral was accurately represented through the correct activation of corresponding LED segments, confirming proper implementation of digital logic control. The reset button functioned as expected, returning the display to 0 when triggered.

The system exhibited immediate response times with no noticeable delays or flickering during operation. The 220-ohm resistors, in conjunction with the stable power output from Arduino provided efficient current regulation, preventing overheating or excessive power consumption. The circuit operated steadily throughout the experiment with no errors recorded.

Additional observations confirmed that after displaying the digit 9, the system returned to 0, demonstrating the correct execution of the rollover behavior programmed into the Arduino. This behavior indicated the accuracy of the implemented logic and the reliability of the push buttons inputs in controlling the counting sequence.

Overall, the results validated the intended functionality of the system, illustarting a successful application of microcontroller-based logic for display control.

6.0 Discussion

The experimental result confirmed that the 7-segment display correctly presented numerical values from 0 to 9 in response to user input. The counting function operated as intended, with accurate segment activation for each digit. The increment button advanced the count, while the reset button returned the output to zero, confirming both correct circuity and successful program execution.

A potential source of error was observed during the experiment. It is possible that some components exhibited faulty performance due to age or wear. This issues could be avoided in future implementations by replacing aging components with new ones to ensure reliable operation.

In summary, the experiment successfully illustrated the core concepts of digital logic and microcontroller-based interfacing with minor improvements could be made. These results emphasize the importance of precise circuit construction, efficient programming, and error-handling methods in embedded system application.

7.0 Conclusion

This experiment effectively demonstrated the interfacing of a 7-segment dislay with an Arduino Uno. By proper circuit assembly and implementation of the control program, the display showed the correct numerical sequence, confirming accurate digital output operation. The inclusion of push buttons for incrementing and resetting the count further illustrated the system's responsiveness. All in all, the experiment reinforced key principle of digital logic and microcontroller interfacing, serving as valuable practical exercise. It also provide a strong foundation for future projects involving digital display systems. Potential enhancement might include code refinement, integration of multiple displays, or alternative display technologies such as 12c-based LCD modules to enhance functionality.

8.0 Recommendation

Several improvements are recommended to enhance system performance and development efficiency. First, programming effieciency can be increased by utilized the Serial Monitor fro effective debugging and error detection. It is also essential to verify the use of appropriate resistor values, such as 220-ohm for current limitation to prevent potential hardware damage.

It is advisable to replace unreliable hardware elements like jumper wires and ensure secure connections to maintain circuit stability. An 12C LCD module could be used as an alternative to the 7-segment display to improve display clarity and simplified wiring.

Future system enhancement may include implementing EEPROM storage for retaining data after power loss, integrating an OLED display for more versatile output option, or using Bluetooth modules to incorporate wireless control.

9.0 References

1. Mechatronics System Integration Lab Module - Google Drive
https://drive.google.com/drive/folders/1QecGGN96D76UL2gwBjevFwiEXv2UEniO

10.0 Acknowledgement

We would like to express my sincere gratitude to Dr. Wahju Sediono, Dr. Zulkifli Bin Zainal Abidin, my teaching assistant, and my peers for their invaluable guidance and support throughout the completion of this report. Their insights, feedback, and expertise greatly contributed to the depth and quality of this work. I truly appreciate their time, patience, and commitment to my academic growth.

11.0 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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