LAB REPORT 1: DIGITAL LOGIC SYSTEM

GROUP 5

MCTA 3203

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MECHATRONICS SYSTEM INTEGRATION

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INTRODUCTION

This lab project aims to explore the fundamental concepts of digital logic systems and their applications in modern electronics. The project focuses on key building blocks of digital systems such as basic logic gates, electronic circuit interfacing, and the design of a simple Arithmetic Logic Unit (ALU). Additionally, the project demonstrates how to interface a 7-segment display with an Arduino microcontroller to display a sequence of numbers. This report outlines the experiment's methodology, procedure, results, discussion, and conclusion. This experiment aimed to give participants hands-on experience with circuitry, Arduino programming, and component integration by examining the processes involved in hardware setup and software execution.

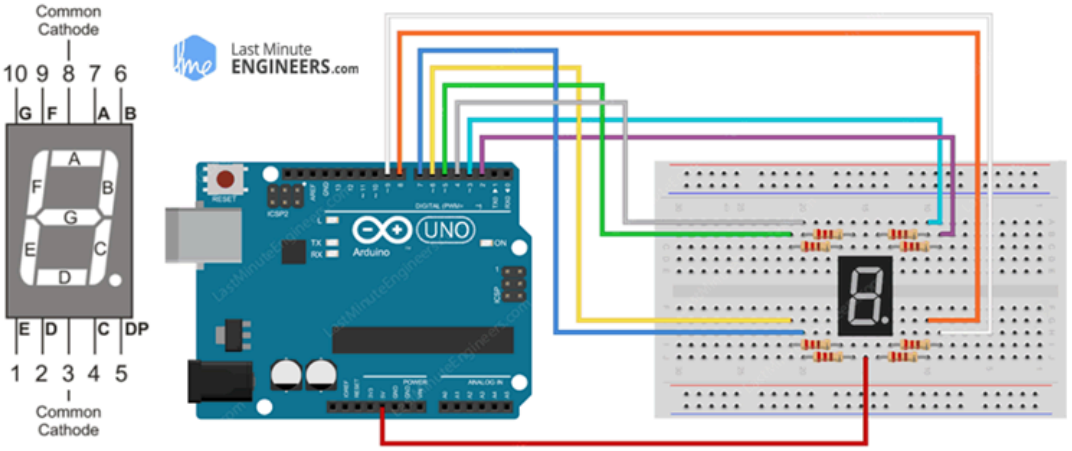
ABSTRACT

This lab report presents the design and implementation of a digital logic system using basic logic gates, electronic circuit interfacing techniques, and a simple Arithmetic Logic Unit (ALU). The project involves interfacing a 7-segment display with an Arduino microcontroller to display a sequence of numbers from 0 to 9 and can be controlled by pushbutton. Integrated Circuits (ICs) are employed to facilitate the interfacing of the components, while the Arduino microcontroller is programmed to control the timing and sequencing of the numbers displayed. Through this project, the fundamentals of digital systems, including binary logic, circuit design, and microcontroller programming, are reinforced, offering practical insights into their applications in modern electronics. The experiment concludes with a successful demonstration of manual counting and reset functionality, offering a foundation for expanding to more complex projects.

MATERIALS AND EQUIPMENT

- Arduino Uno Board
- Common Cathode 7-segment display
- Breadboard
- Jumper Wires
- Pushbutton

EXPERIMENTAL SETUP



1. Built the circuit according to the circuit setup instructions.
2. Upload the provided Arduino code to your Arduino Uno.
3. Open the Serial Monitor in the Arduino IDE.
4. Press the increment button to increase the count. The 7-segment display shows the numbers from 0 to 9 sequentially.
5. Press the reset button to reset the count to 0.

METHODOLOGY

1. Connect the common cathode 7-segment display to the Arduino Uno as follows:
    - Connect each of the 7 segments (a, b, c, d, e, f, g) of the display to separate digital pins on the Arduino (e.g., D0 to D6).
    - Connect the common cathode pin of the display to one of the GND (ground) pins on the Arduino.
    - Use 220-ohm resistors to connect each of the segment pins to the Arduino pins to limit the current.

2. Connect the pushbuttons to the Arduino:
    - Connect one leg of each pushbutton to a separate digital pin (e.g., D9 and D10) and connect the other leg of each pushbutton to GND.
    - Use 10K-ohm pull-up resistors for each pushbutton by connecting one end of each resistor to the digital pin and the other end to the 5V output of the Arduino.

3. Software Programming:

- Write a program in Arduino IDE to:

- Initialize the pins connected to the 7-segment display as output pins.
- Use a counter logic that increases the count displayed on the 7-segment display when a pushbutton is pressed.
- Include a reset function to reset the count to zero with the press of a reset button.
- Upload the Arduino sketch to the Arduino Uno.

4. Execute :
- Build the circuit as per the connection instructions mentioned in the setup.
- Open the Serial Monitor in the Arduino IDE to monitor the execution.
- Press the increment button to display the numbers from 0 to 9 on the 7-segment display.
- Use the reset button to reset the displayed count to zero.

RESULTS

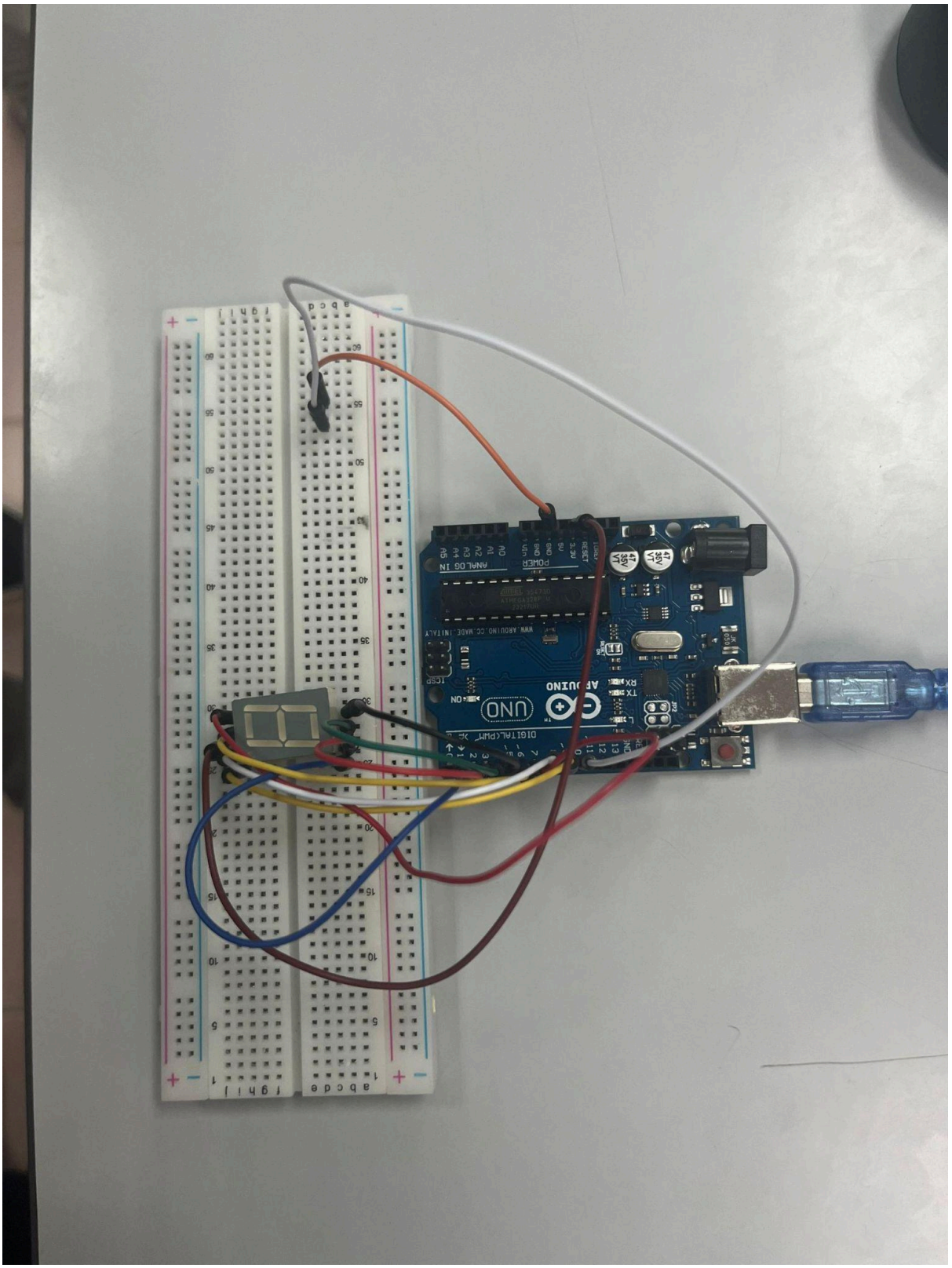


FIGURE 1: 7 SEGMENT DISPLAY WITHOUT BUTTON

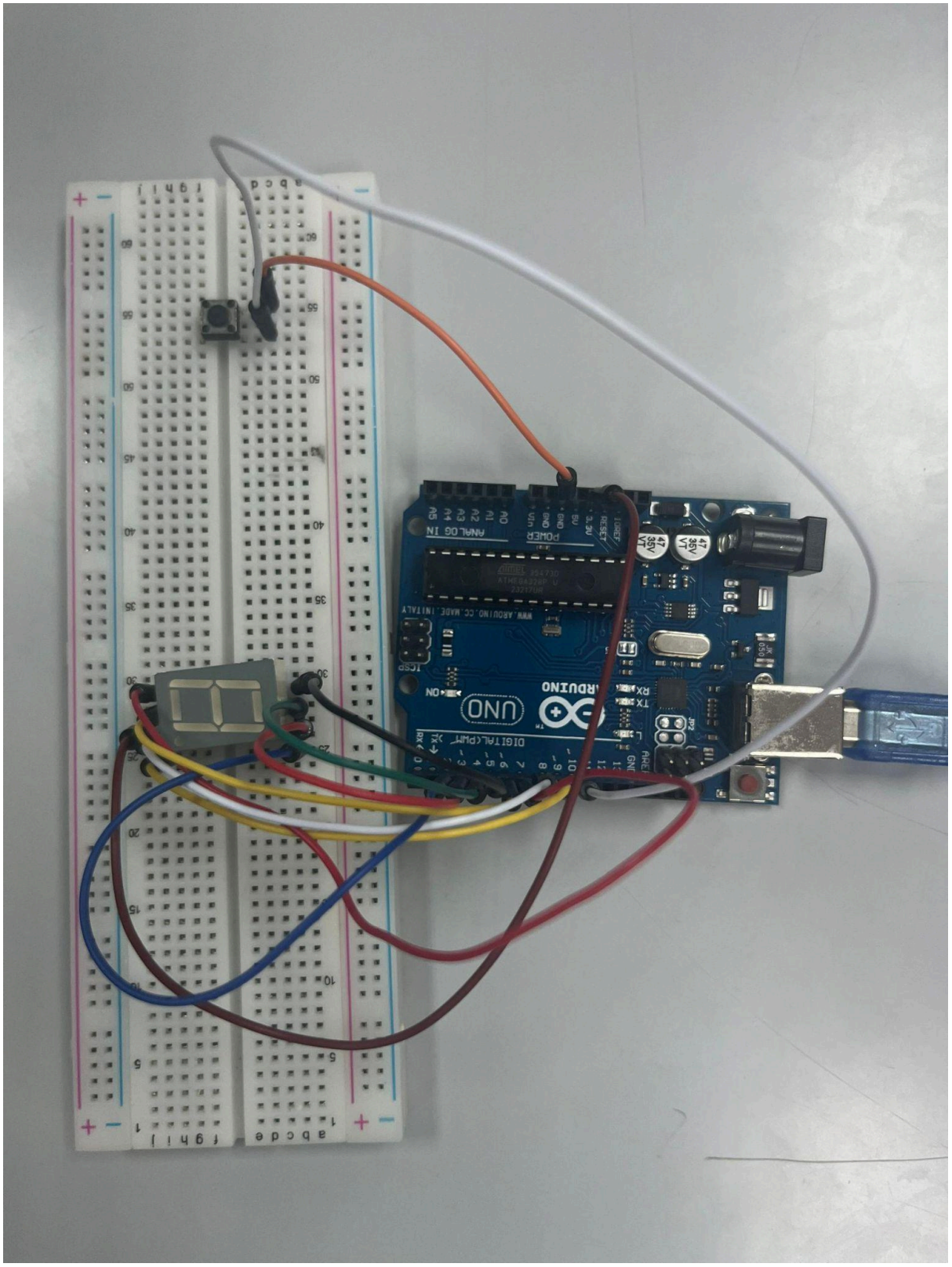


FIGURE 2: 7 SEGMENT DISPLAY WITH BUTTON

VIDEO LINK :

QUESTION

How to interface an I2C LCD with Arduino? Explain the coding principle behind it compared with 7 segments display and matrix LED.

Because an Arduino only requires two wires to control the display, connecting an I2C LCD to it is simple. You can use a custom library to show text quickly. A 7-segment display, on the other hand, requires more pins because each segment must be controlled separately, making setup more difficult. To operate rows and columns of lights, an LED matrix requires even more pins, and to display patterns or animations, the display must be refreshed continuously. While 7-segment displays work well for numbers, LED matrices are utilized for more intricate patterns, and the I2C LCD is often easier to use and more effective at displaying text.

Here is the code:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Set the LCD address to 0x27 for a 16 chars and 2-line display
LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {
  lcd.init();                  // Initialize the LCD
  lcd.backlight();             // Turn on the backlight
  lcd.setCursor(0, 0);         // Set cursor to the first row, first column
  lcd.print("Hello, World!");  // Print text to the LCD
}

void loop() {
  // Code to update the display can go here
}
```

Comparison

12C LCD:

- Two communication lines (SDA, SCL) and simpler wiring.
- High-level control through libraries, perfect for text display.
- Ideal for 16x2 or 20x4 character displays; not suitable for fast-paced animations.

7- segment Display

- Multiplexed control for more digits, or more wires per segment.
- rudimentary number display with only basic numerical output.
- calls for unique segment control patterns.

Matrix LED

- need a specialised driver IC or a row-and-column pin matrix.
- requires frequent updating (multiplexing), but it supports unique patterns and animations.
- Better suitable for animations or graphical displays than for plain text.

DISCUSSION

In this experiment, we successfully connected an Arduino to a 7-segment display to show numerical data. When controlled by the Arduino, the results showed that the LED screen could display the appropriate numbers, confirming wire connections and enabling meaningful coding.

Periodic flashes on the display can be cited as a drawback. Poor connections were the cause of this issue, and fixing all the loose connections helped resolve it. Additionally, certain timing changes were made to the Arduino code, which enhanced the microcontroller's display.

We can learn a lot from this experiment because it is used everywhere in our lives, like digital watches, calculators, clocks, and so on. Here, acquired abilities can be applied to increasingly difficult tasks, including utilizing various display interfaces or different kinds of sensors or actuators.

CONCLUSION

In conclusion, this experiment provided a foundational understanding of how to interface a 7-segment display with a microcontroller. Future enhancements could include more complex functionalities, such as displaying different characters or integrating a timer. Additionally, multiple displays can be connected to tackle more advanced projects.

This project also deepened our knowledge of key electronic components essential for functioning circuits. By working with Arduino, we gained valuable insight into how software communicates with hardware to create embedded systems, highlighting the critical role programming plays in these systems.

Overall, this experiment prepares us for more complex work in future projects, reinforcing essential concepts in microcontroller technology and sparking further interest in advanced electronic design

RECOMMENDATION

Several proposals would improve the experiment's reliability and effectiveness. First, double-check the connections before powering on the circuit, as incorrect wiring might result in poor functioning or damage. Next, the lab must provide a multimeter to examine voltage levels at various locations, which could reveal the source of problems in the power supply or improper resistor values. It is critical to ensure that the resistor values are accurate. Erroneous values will result in a dull display or damage.

Once the fundamental functionality is built, testing various scenarios can identify potential issues far earlier. Following these criteria results in a much more minimal, productive, and successful experimental experience, as well as significant learning opportunities.

ACKNOWLEDGEMENTS

A special thank you to Dr. Wahju Sediono and Dr. Zulkifli Bin Zainal Abidin, my teaching assistant, and peers, for their outstanding assistance and support in completing this report. Their advice, input, and expertise have had a significant impact on the quality and comprehension of this work. Their time, patience, and dedication to my academic progress are deeply appreciated.

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 acknowledgment, and that the original work contained herein has 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 that no further improvement on the reports is needed from any of the individual 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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