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Project Digital Logic
Elevator Controller System

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Section: 02

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DEDICATION & KNOWLEDGE

We respectfully dedicate this Digital Logic Project to our lecturer, classmates, and family members for their continuous support, encouragement, and understanding throughout our academic journey. Their motivation and guidance played a significant role in the successful completion of this project.

We would like to express our scenes of gratitude to our lecturer, Dr Ahmad Fariz Bin Ali for this invaluable guidance and constant encouragement throughout the course of this project. We also acknowledge our classmates and our group members which are Puteri Anis Binti Mat Lazim, Qistina Batrisyia Binti Noor Mohd Azlan, Nur Zulaikha Binti Norhashim and Yong See En. for the cooperation and constructive discussions, and meaningful contributions, which greatly contributed and enhanced the quality of this work and enriched our learning experience.

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1.0 Background / Overview

Digital logic is a fundamental component of modern computing systems that enables the operation of devices ranging from smartphones to advanced computer systems. It is based on the use of binary numbers, namely 0 and 1, to represent and process information. Digital logic also involves the design of systems that perform specific functions using logical operations implemented through logic gates such as AND, OR, and NOT. These basic building blocks are essential in developing reliable and efficient digital control systems.

One practical and widely used application of digital logic is in the design of electronic control systems for automated facilities, such as elevator systems in hotel buildings. Elevators play a crucial role in providing efficient and safe vertical transportation for hotel visitors in multi-storey environments. A typical elevator operation involves a visitor selecting the desired floor, tagging a room access card for authorization, ensuring the elevator door is closed, and pressing the UP or DOWN button. The elevator then moves in the selected direction by counting up or down one level at a time until it reaches the destination floor.

Designing an electronic elevator controller requires accurate sequencing, direction control, and floor counting, all of which can be effectively implemented using digital logic principles. Therefore, this project focuses on the design and simulation of an electronic elevator controller using digital logic concepts to model the elevator's up and down movement based on user input. Through this project, the application of theoretical digital logic knowledge to a real-world-inspired control system is demonstrated, while enhancing understanding of synchronous counters, flip-flops, and state-based system design.

2.0 Problem Statement

Basic elevator systems designed using simple digital logic are often limited in functionality and scalability. Such systems usually support only a small number of floors and provide only basic up and down movement without sufficient consideration for security and safety requirements. This limitation makes the basic design unsuitable for practical applications in multi-storey buildings such as hotels.

In this project, the initial elevator controller design does not fully meet the operational needs of a hotel elevator system. The system must support multiple floors while maintaining reliable and synchronized operation. Additionally, the absence of security features such as visitor room card detection and user passcode verification may lead to unauthorized access. The lack of door open and close indication also increases the risk of unsafe elevator operation.

These limitations highlight the need to address issues related to system capacity, access control, and operational safety in the elevator controller design. Without proper enhancements, the elevator system cannot effectively represent a realistic and secure hotel elevator environment.

3.0 Suggested Solution

1. Expanding Floor Support

- Three bits synchronous counter was used to support the 8th Floor elevator as we needed a binary count from 000 to 111 .
- D Flip Flop expanded to JK Flip Flop because their ‘Toggle’ and ‘No Change’ states make designing counters more efficient . To determine what inputs are needed to move the lift from one state to another , excitation tables for JK Flip Flop were used ensuring smooth transition between states .

2. Security Features

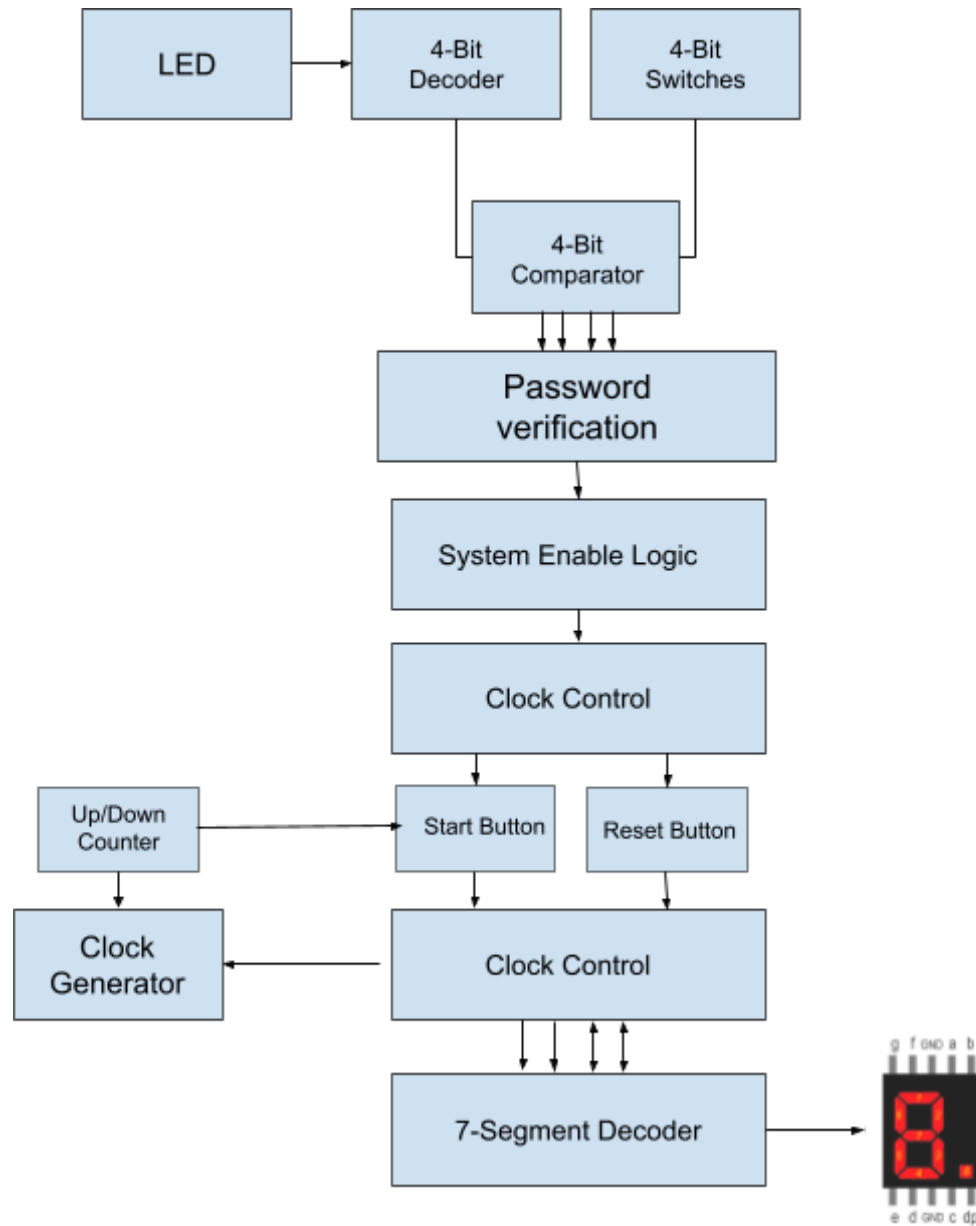
- **Password :**

To enhance security , a 4 bit password sequence detector was used. The system remains in a locked state by default , disabling the clock pulse to the floor selection based on JK Flip Flop. Circuit will trigger an 8 floor counter only when the user enters the correct password.

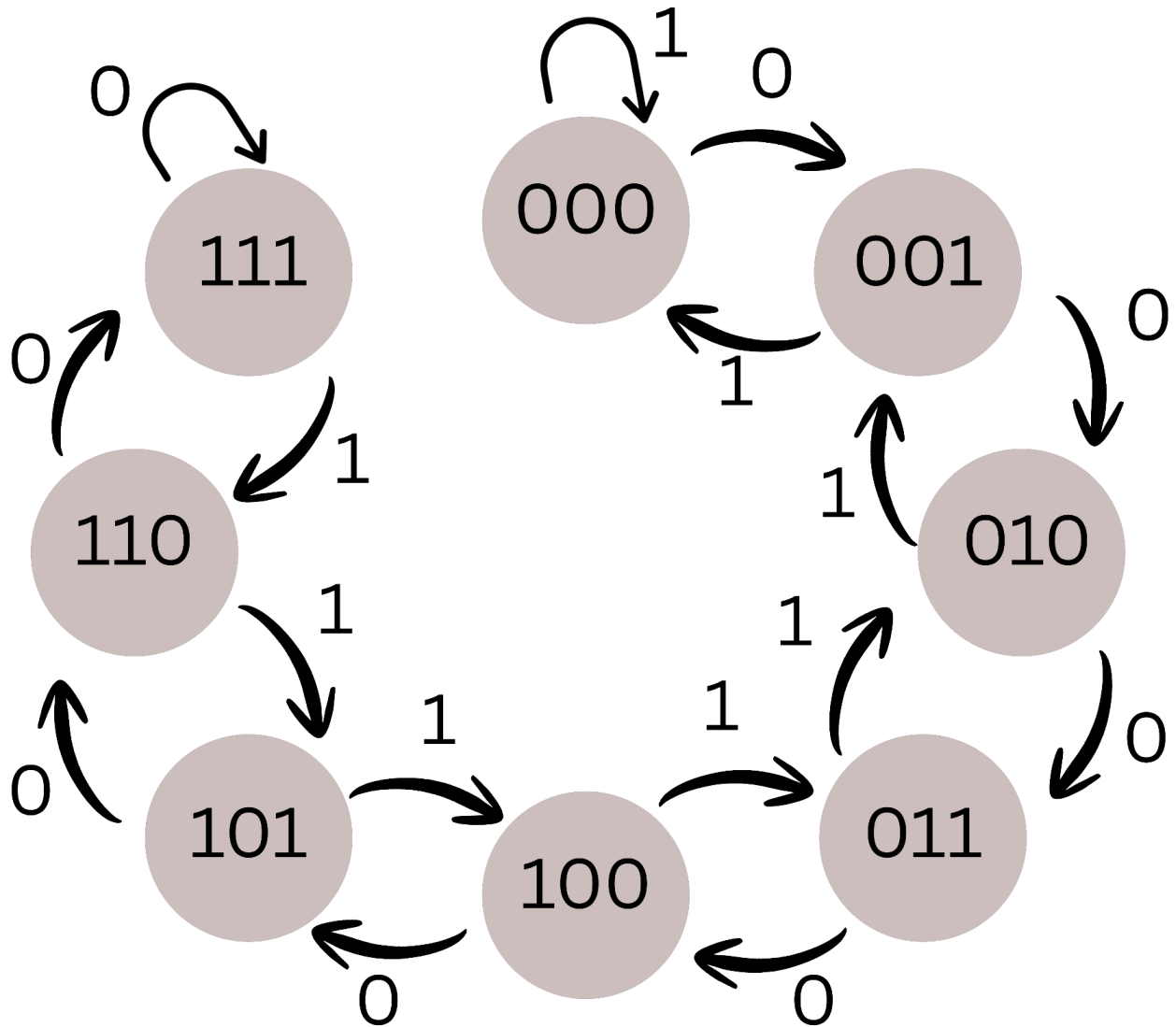
- **Integrated Input Controller :**

The security system integrates three primary inputs which is visitor card , specific password and power. The system uses a state diagram mainly to define elevator behaviour. It shows conditional logic where the system will stay in the locked mood until both visitor card is detected and password correctly entered. Once it satisfies both the conditions, the diagram allows transitions from 000 to 111 . If the door is open , the diagram will visualize a self loop meaning that it will hold present states. In transition tables, it is used to determine specific movement . K-Map is used to optimize the combinational logic required for JK Flip Flop inputs . By grouping the 1's and X , J and K inputs are only active when E=1. If E=0, the K-Map forces J=0 and K=0 , keeping the elevator to remain on the same floor.

3.1 Block Diagram



3.2 State Diagram



3.3 State and Flip-Flop Transition Table

							FF2	FF1		FF0		
Input, X	Present State			Next State			JK Transition Table					
	Q ₂	Q ₁	Q ₀	Q ₂₊	Q ₁₊	Q ₀₊	J ₂	K ₂	J ₁	K ₁	J ₀	K ₀
0	0	0	0	0	0	1	0	X	0	X	1	X
0	0	0	1	0	1	0	0	X	1	X	X	1
0	0	1	0	0	1	1	0	X	X	0	1	X
0	0	1	1	1	0	0	1	X	X	1	X	1
0	1	0	0	1	0	1	X	0	0	X	1	X
0	1	0	1	1	1	0	X	0	1	X	X	1
0	1	1	0	1	1	1	X	0	X	0	1	X
0	1	1	1	1	1	1	X	0	X	0	X	0
1	0	0	0	0	0	0	0	X	0	X	0	X
1	0	0	1	0	0	0	0	X	0	X	X	1
1	0	1	0	0	0	1	0	X	X	1	1	X
1	0	1	1	0	1	0	0	X	X	0	X	1
1	1	0	0	0	1	1	X	1	1	X	1	X
1	1	0	1	1	0	0	X	0	0	X	X	1
1	1	1	0	1	0	1	X	0	X	1	1	X
1	1	1	1	1	1	0	X	0	X	0	X	1

3.4 Karnaugh Map (K-Map)

J_2 and K_2 :

Q_1Q_0 XQ_2	00	01	11	10
00	0	0	1	0
01	X	X	X	X
11	X	X	X	X
10	0	0	0	0

$$J_2 = X' \cdot Q_1 \cdot Q_0$$

Q_1Q_0 XQ_2	00	01	11	10
00	X	X	X	X
01	0	0	0	0
11	1	0	0	0
10	X	X	X	X

$$K_2 = X \cdot Q_1' \cdot Q_2'$$

J_1 and K_1 :

Q_1Q_0 XQ_2	00	01	11	10
00	0	1	X	X
01	0	1	X	X
11	1	0	X	X
10	0	0	X	X

$$J_1 = X'Q_0 + XQ_2Q_0'$$

Q_1Q_0 XQ_2	00	01	11	10
00	X	X	1	0
01	X	X	0	0
11	X	X	0	1
10	X	X	0	1

$$K_1 = XQ_0' + X'Q_2'Q_0$$

J_0 and K_0 :

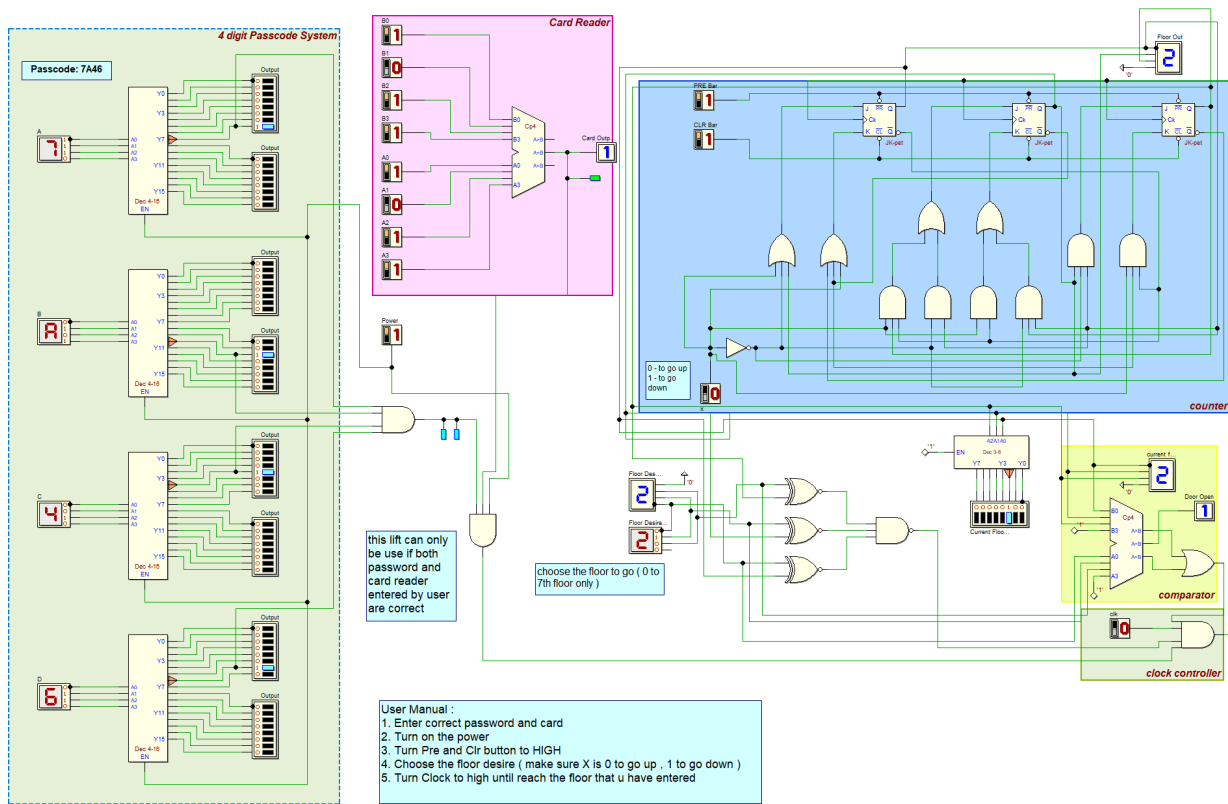
Q_1Q_0 XQ_2	00	01	11	10
00	1	X	X	1
01	1	X	X	1
11	1	X	X	1
10	0	X	X	1

Q_1Q_0 XQ_2	00	01	11	10
00	X	1	1	X
01	X	1	0	X
11	X	1	1	X
10	X	1	1	X

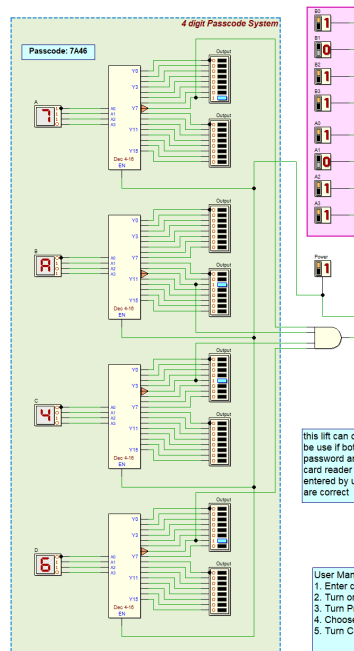
$$J_0 = X' + Q_1 + Q_2$$

$$K_0 = X + Q_1' + Q_2'$$

4.0 System Implementation

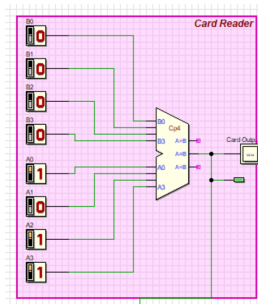


4.1 4-Digit Passcode System (Security Authorization)



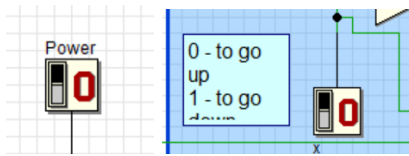
Four 16 line decoders is used and connected to a central AND gate. This is one of the security systems that have been implemented. Each decoder represents each digit of the password. The AND gate will only send a HIGH if the passcode '7A46' was entered by the user with the correct sequence.

4.2 Card Reader (Access Control)



This is the second security system that has been implemented. A magnitude comparator was used to compare binary code that has been set with user input switches. The comparator was connected to a 1-bit output and it will only show 1 if the binary code entered is the same as what has been set.

4.3 Power Switch and X-Button



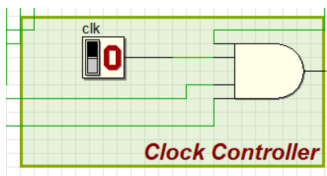
- **Power Switch**

Act as a main button for the lift circuit to function. The lift will only operate if the users power on the lift by turning the power button to 1.

- **X-Button**

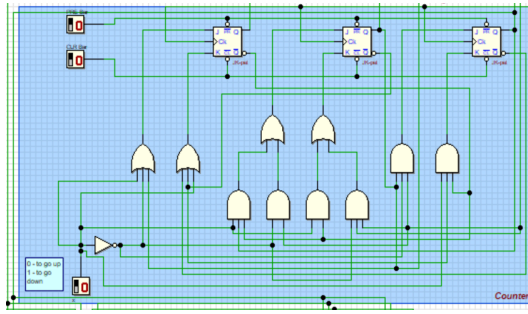
There is a button that has been prepared for the user to change the flow from going up to down and from going down to up . The user needs to turn the button to 0 if the lift wants to go up from a certain level to another level and 1 if the lift wants to go down from a certain level to another level.

4.4 Clock Controller



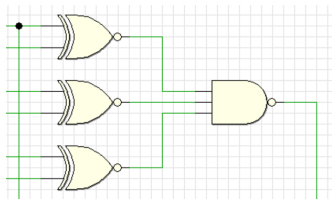
A clock controller was implemented using 4-input AND gate. The 4-input AND gate takes input from AND gates of passcode, card reader and power button, a signal from current floor and desire floor comparator and 3-bit comparator. The Clock Controller will only become operational if all the four inputs are in high state. The output of this 4-input AND gate is then linked to the clock inputs of JK Flip-Flops. This clock controller main function is to start and stop the lift when the floor that has been chosen by the user has arrived.

4.5 JK Flip-Flop



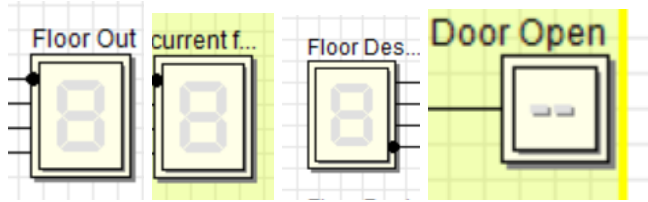
This JK Flip-Flop acts as a floor counter. 3 JK Flip-Flop configured as a synchronous 3-bit counter , which represents the positioning system. It stores the current floor in binary. The clock of JK Flip-Flop was controlled by a clock controller. The AND and OR gates determine the next state based on the current floor and the direction of the X-button.

4.6 3-bit Comparator



A NAND gate and three 2-input XNOR gates were used as a comparator to compare the choice of the floor that the user wants and the current floor. These XNOR gates constantly compare these 2 sources and if the 2 sources come with the two values that are identical , the XNOR gates produce output 1 , triggering the final AND gate to signal the destination has been reached.

4.7 Floor & Door Display



These are the features that are used to display the current floor to the users by using a 7-segment display. The door display is to show whether the door is open or closed . If the lift has not reached the floor that the user wants the door status indicator will show 0 which means the door is closed while if the floor has reached the floor that user wants the door status indicator will show 1 which means that the door is open.

5.0 Conclusion and reflection

Throughout this project, the opportunity was given to us to apply the implementation of our understanding towards the course topics as well as a chance to obtain a simulation of practical experience into system design and problem solving. By utilizing the combinational logic circuits, we have successfully developed a flexible working elevator system. This not only allowed us to showcase our understanding and level of expertise, but also allowed us to implement digital systems with great efficiency and performance, further elevating our practical experience in this aspect.

Our design has successfully shown significant strengths. The design implemented has been designed to adopt a simple yet flexible system to allow easier maintenance and take in new future updates without having to change the whole design ever again. Not only that, our design has also showcased better user interaction, allowing users to easily monitor the floor they are going to as the elevator moves toward the designated floor. Additionally, the design also showcased better security features such as identifying the correct passcode, visitor card as well as indication of the door open and close status. Ultimately, we have upgraded the old elevator system to our current system to better improve the operation of the elevator system, where it can hold a larger range of floors compared to the old system.

Though our system has its unique strength, it also has its own weaknesses. As of now, the elevator system can only go floor by floor one level at a time, slowing down its performance. By security measures, the elevator allows only one card to be scanned at a time, making it slightly risky and unsecured. Otherwise, our system may also face potential bugs and glitches which may affect the system's performance.

Although the system that has been designed shows to be a successful endeavor, the team believes that there is still room for improvement and greater creativity in our future works. Additionally, creating a more complex system with a more purposeful objective is eagerly anticipated by the team. To face the current flaws of the system, we propose to increase the security level of the system by implementing a better security system with data encryption and role-based access control as well as the ability to allow more than 1 card to be scanned.

Moreover, the system can be further enhanced by improving the user interface by doing user research and personalization. Furthermore, the system should also adopt better workflows and optimized resource management to prevent the system from crashing. All in all, this project has successfully deepened the knowledge obtained on this course.

6.0 References

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7.0 Appendices



Figure 7.1 : First Meeting Discussion



Figure 7.2 : Second Meeting Discussion

8.0 Task Distribution

No.	Name	Matrics No.	Tasks
1.	Puteri Anis Binti Mat Lazim	A25CS0339	<ul style="list-style-type: none">● Report Writing● Video Editing● Deeds Circuit Implementation● Video Content
2.	Qistina Batrisyia Binti Noor Mohd Azlan	A25CS0340	<ul style="list-style-type: none">● Report Writing● Video Content● Slide Preparation● Documentation
3.	Nur Zulaikha Binti Norhashim	A25CS0323	<ul style="list-style-type: none">● Report Writing● Video Content● Documentation● Slide Preparation
4.	Yong See En	A25CS0168	<ul style="list-style-type: none">● Report Writing● Deeds Circuit Implementation● Slide Preparation● Video Content