IT&BUSINESS COLLEGE

Department: Computer science

Project title: Automated curtains

Group name: Team 4

Members:

Alimbekov Jail - 238715024

Boibosunov Chyngyz - 238715002

Koshaliev Alikhan - 238715010

Iugai Ilia - 238715028

Instructor: Nurbekov Mirlan

Group: SCA-23A

Table of contents

List of figures

List of tables

List of listing

Abstract

Such a small automated curtain system is developed in this project work as an example on basic principles of sensor-controlled systems and home automation. The functional model is developed on a small number of students using an Arduino microprocessor, including sensors, programming process mechanisms, and a small motor system mechanism in a manner to imitate exactly how a modern smart curtain system works. The possibility is developed in this device as it is possible using this device as it is possible using mobile application technology by Bluetooth connection, as it provides a means for remote controlling. Thus, this functional model is able to process information from both remote and local settings for automatic curtain controlling as well as using a mobile application. Finally, this V5 prototype has developed a functional device as a final solution for automated curtain systems.

Introduction & background

The use of automated curtain systems is steadily gaining popularity in the current society. This is because the comfort offered by the automated curtain systems is utilized in conserving time and maximizing the use of light, and even the efficiency of the sun.
To be more specific, the automation of curtains will be possible if these three components are involved: Sensors, Micro-controllers, and an Actuator. This can be understood by looking at the **Figure 1.** Structure of our curtains below:

Figure 1. *Structure of our curtains.*

Problem statement & objectives

1. Problem Statement

Smart home systems are becoming increasingly popular, and traditional systems like manual control of curtains are less convenient and efficient. The disadvantage of manual control of curtains is that a lot of human labor is required, and one thing that a curtain system is unable to monitor is changes in light conditions. For almost all applications, ranging from managing indoor lighting to effective use of energy in buildings or just providing a means for distant control, manual curtains lack what consumers today demand. For this reason, a need for a curtain system with small size and a means to illustrate basic concepts of touch control exists.

2. Objectives

1. Design an automated curtain system using an Arduino microcontroller.

2. Implementation of the mobile application interface, which enables the user to open or close the curtains from a far distance through the use of Bluetooth.

3. Construct a functional prototype incorporating proper integration of hardware and software along with positional control.

4. For carrying out testing with the intention of system evaluation.

System design (Hardware & software)

The selection of components is a consequence of the project's needs. A short description of all the components used in this project can be found in Table 1 below. Key Functional Requirements.

Component	**Purpose**	**Prototype use**	**Image reference**
Arduino Uno R3	Central microcontroller and Processing Unit	V0000 – V5	***Figure 2***
DC Motor 12V	Primary actuator for linear curtain movement	V0002 – V5	***Figure 3***
HC-05 Bluetooth Module	Wireless communication for mobile app control	V0001 – V5	***Figure 4***
L298N Motor Driver	High-Current Supply and Directional Control for DC Motor	V0002 – V5	***Figure 5***
IR Receiver & Controller	Secondary Input Method for Remote Operation	V0001 – V5	***Figure 6***
Servo Motor SG90	Initial testing of angular actuation (Low Torque)	V0000	***Figure 7***
BreadBoard	Solderless prototyping tool with a grid of holes and internal metal clips	V0000	***Figure 8***
Stepper Motor 28BYJ-48	Tested for precise control (Too Slow)	V0001	***Figure 9***
ULN2003 Motor Driver	Driver used specifically for the Stepper Motor	V0001	***Figure 10***
Power Supply (Battery/Adapter)	Provides stable power for the motor and electronics	V0002 – V5	***Figure 11***

Table 1. *Key Functional Requirements.*

As indicated in Table 1, the brain or Arduino Uno R3 is shown in Figure 2, and the mechanical power source is the High Torque DC Motor portrayed in Figure 3.

7.1. Hardware overview 0000

Wireless communication is handled by the module illustrated in Figure 4. HC-05 Bluetooth Module. In order to link the higher current demand of the motor to the lower power consumption of the Arduino, the Figure 5. L298N Motor Driver was employed. As a backup communication system, an infrared technology involving the Figure 6. IR Receiver was incorporated. Initial rotational position measurements were done by the Figure 7. SG90 Servo Motor.

Figure 2. *Arduino Uno R3 Microcontroller.*

Figure 3. *High Torque DC Motor.*

Figure 4. *HC-05 Bluetooth Communication Module.*

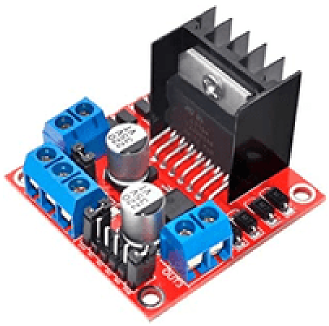

Figure 5. *L298N Motor Driver.*

Figure 6. *IR Receiver Module and IR Controller.*

Figure 7. *SG90 Servo Motor.*

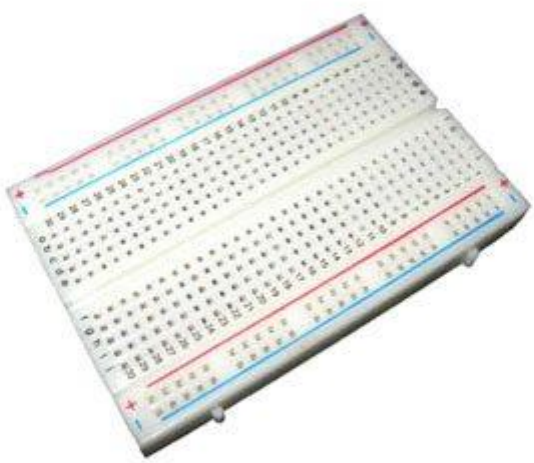

Figure 8. *Breadboard.*

7.2. Hardware overview 0001

Precise experiments were performed using the Figure 9. Stepper Motor and the Figure 10. ULN2003 Driver. These were replaced with the DC Motor for better speed, as described in limitations. For the L298N, constant power from the Figure 11. External Power Supply is achieved. Construction materials The hardware was as crucial as the electronics. All other materials other than the electronics are categorized in Table 2: List of Construction Materials and Their Purposes. The materials listed in Table 2 are those which made up the physical model housing the motor and the curtain track.

Figure 9. *Stepper Motor.*

Figure 10. *ULN2003 Motor Driver.*

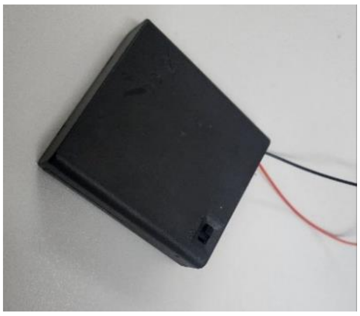

Figure 11. *External Power Supply.*

Construction materials

The physical construction was as important as the electronics. All non-electronic parts are categorized in ***Table 2. List of Construction Materials and Their Functions.***

Material	Purpose	Notes
Bambook Panel	Structural support, foundation.	Used for the main foundation due to its stability.
Foamed PVC Sheet	Window frame simulation, casing.	Lightweight and easy to cut for the visual mock-up.
Bambook Sticks	Light structural supports, small joints.	Used for reinforcement.
Wooden Skewer	Guides, temporary axis.	Used for connecting small parts and ensuring straight movement.
Electrical Tape	Securing wiring, minor fixes, **Friction Reduction**.	Used for bundling cables and as a smooth sliding surface.
Hot Glue	Permanent structural bonding.	Primary method for assembling the PVC and bambook elements.
Thread	Drive belt (cable/belt system).	Used as the high-friction, low-cost "belt" system to pull the curtain fabric.

Table 2. *List of Construction Materials and Their Functions*

The materials listed in ***Table 2*** formed the physical mock-up that holds the motor and the curtain track.

Prototype 0000 (Servo motor test)

•Aims and Objectives

The purpose and objective of Prototype 000 was to carry out the initial verification process of basic control signals and the evaluation of the angular movement capability offered by the actuator.

Description

The prototype was composed of an electronic circuit that was quite simple and included an SG90 servo motor and an Arduino Uno R3 microcontroller. The circuit was fitted with a push button that was used to turn the motor on and enable it to respond to the control signal. The design of the circuit did not involve a complex system in this level only to demonstrate the functionality of the motor.

• Results: The test outcomes verified that there was proper functioning of the servo motor for reaction to Arduino signals and angular movements required. The lack of torque in the SG90 servo motor verified that the motor was not suitable for linear motion of the curtain.

• Components Section: Arduino Uno R3 (Figure 2), Servo Motor SG90 (Figure 7), Breadboard (Figure 8)

• Visual Documentation: The control code is shown in Listing 1, while the setup of the prototype is shown in Figure 12 below.

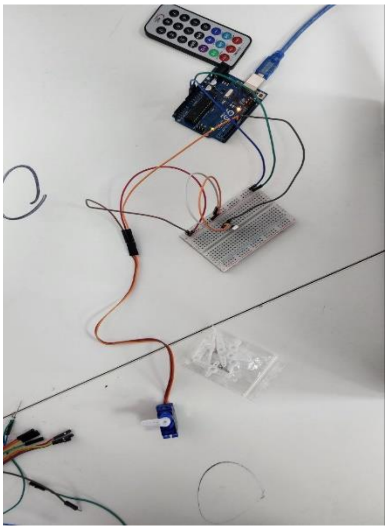

Figure 12. *Prototype 0000 (Servo Motor Test Setup).*

Prototype 000 Source code (Servo motor)

```
#include <IRremote.h>
#include <Servo.h>

#define IR_PIN 2
#define SERVO_PIN 9

#define BTN_PLUS  0xFF18E7
#define BTN_MINUS 0xFF4AB5

Servo servo;
int angleStart = 0;
int angleTurn  = 90;

void setup() {
  Serial.begin(9600);

  IrReceiver.begin(IR_PIN, ENABLE_LED_FEEDBACK);
  servo.attach(SERVO_PIN);
  servo.write(angleStart);
}

void loop() {
  if (IrReceiver.decode()) {
    unsigned long code =
IrReceiver.decodedIRData.decodedRawData;
    Serial.println(code, HEX);

    if (code == BTN_PLUS) {
      servo.write(angleTurn);
    }

    if (code == BTN_MINUS) {
      servo.write(angleStart);
    }

    IrReceiver.resume();
  }
}
```

Listing 1*. Arduino source code for Prototype 0000*

Prototype 0001 (Stepper motor test, dual input, and initial frame)

• Purpose: To serve comparison purposes for the actuation performance as well as input redundancy. Initial phase of the actual construction has started.

• Description: The Stepper Motor with ULN2003 Driver had a high degree of accuracy integrated with IR Receiver and Bluetooth Module. A simple laboratory setup was built to check whether it can power a practical device. The performance of this setup demonstrated that it can power all the interfaces, though it was slower compared to a function.

• Control System Operation: The process of controlling the IR remote and Bluetooth module is such that upon pressing from the user, the button on the IR remote sends the command to Arduino so that it executes the required operation. Similarly, the Bluetooth module is operated by carrying out actions using the commands received in the mobile app. Refer to Listing 1 below.

• Components Used (Electronic):

Arduino Uno R3 (Fig. 2),

Stepper Motor 28BYJ-48 (Fig. 8),

Driver ULN

• Construction: First frame and foundation using Bambook Sticks and Foamed PVC.

• Visual Documentation: The control code in Listing 2, the electronic configuration in Figure 13, and the initial configuration in Figure 14.

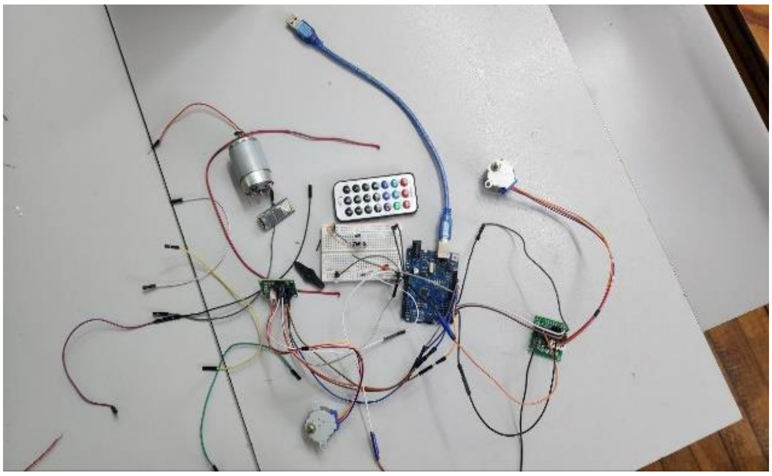

Figure 13. *Prototype 0001.*

Figure 14. *Prototype 0001 Initial Construction Frame.*

Prototype 001 source code (Stepper motor)

```
#include <IRremote.h>
#include <Stepper.h>

#define IR_PIN 2

#define BTN_PLUS  0xFF18E7
#define BTN_MINUS 0xFF4AB5

const int stepsPerRevolution = 2048;

Stepper stepperMotor(
  stepsPerRevolution,
  8, 10, 9, 11
);

void setup() {
  Serial.begin(9600);
  IrReceiver.begin(IR_PIN, ENABLE_LED_FEEDBACK);

  stepperMotor.setSpeed(10);
}

void loop() {
  if (IrReceiver.decode()) {
    unsigned long code =
IrReceiver.decodedIRData.decodedRawData;
    Serial.println(code, HEX);

    if (code == BTN_PLUS) {
      stepperMotor.step(512);
    }

    if (code == BTN_MINUS) {
      stepperMotor.step(-512);
    }

    IrReceiver.resume();
  }
```

Listing 2*. Arduino source code for Prototype 0001*

Prototype 0002 (DC motor, mechanical coupling, and frame refinement)

• Purpose: The purpose is to solve the torque problem and design a workable mechanical drive system.

• Description: Switched to a powerful DC Motor with an L298N Driver. Refined the structural frame to fix the high-speed DC motor and ensure that the linear rail was straight and stable.

• Result: The torque problem was solved. High motor speed caused a positional overshoot, hence requiring software calibration.

• Components Used (Electronic): DC Motor 12V Ab. 3, L298N Motor Driver Ab. 5, External Power Supply Ab. 11.

• CONSTRUCTION: A fine tuning of the Bambook Panel base and creating reliable fixation points.

Visual Documentation: The control code is in Listing 3; the prototype setup in Figure 15, and the refined construction in Figure 16

Figure 15. *Prototype 0002 Electronic Setup.*

Figure 16. *Prototype 0002 Mechanical Construction.*

Final source code (DC motor control)

```
int val;
int nb;

void setup() {
  Serial.begin(9600);
  pinMode(9, OUTPUT);
  pinMode(8, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(6, INPUT);
}

void loop() {
  if (Serial.available() > 0) {
    int data = Serial.read();
    Serial.println("Stop");
    Stop();

    if (data == 82) {
      Serial.println("Right");
      digitalWrite(9, HIGH);
      digitalWrite(8, LOW);
      digitalWrite(6, HIGH);
      digitalWrite(7, LOW);
    }
    else if (data == 76) {
      Serial.println("Left");
      digitalWrite(9, LOW);
      digitalWrite(8, HIGH);
      digitalWrite(6, LOW);
      digitalWrite(7, HIGH);
    }
  }
}

void Stop() {
  digitalWrite(9, LOW);
  digitalWrite(8, LOW);
  digitalWrite(6, LOW);
  digitalWrite(7, LOW);
}
```

Listing 3. *Arduino source code for Prototype 0002*

Prototype 0003 (Positional calibration and application finalization)

• Purpose: Freeze the software interface, enable accurate and repeatable positional control, while ensuring an unintimidating control experience for the user.

• Position Description: For positional control, a comprehensive calibration was carried out based on time within the Arduino code. The primary concern of this stage was focused on integrating the mobile control application. The application delivers command characters to the system through the HC-05 Bluetooth module illustrated in Figure 4. The Thread drive system is complete – "Genius" Solution, Section 8.

Application Interface & Operation: It is intuitive in nature and assists the user in carrying out connections and controls. The best features associated with its interface are as follows:

- o Disconnected State: First control screen when not yet paired, in Dark Theme Figure 17 and in Light Theme Figure 18.

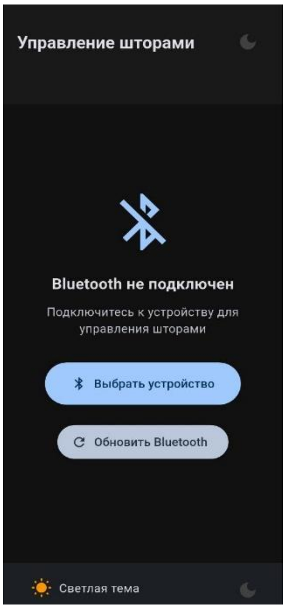

Figure 17. *Control Interface (Dark Theme), Bluetooth Disconnected.*

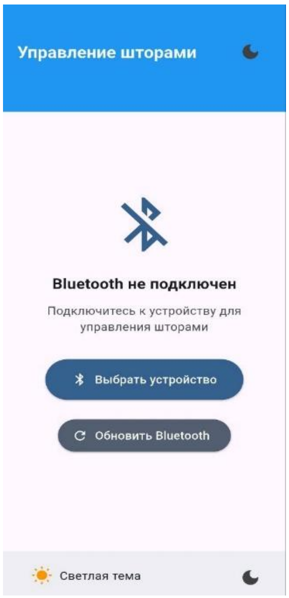

Figure 18. *Control Interface (Light Theme), Bluetooth Disconnected.*

- **Control State (Connected):** After establishing a connection, the control panel activates, allowing the user to send commands. The active control interface is shown in **Light Theme (*Figure 19*)** and **Dark Theme (*Figure 20*)**.

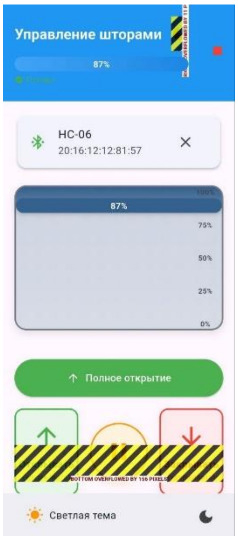

Figure 19. *Control Interface (Light Theme), Connected and Ready.*

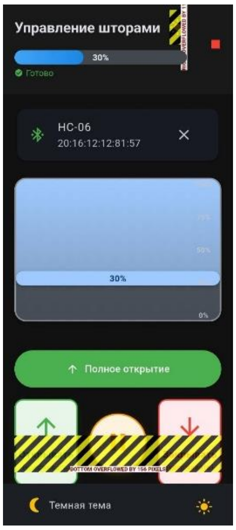

Figure 20. *Control Interface (Dark Theme), Connected and Ready.*

- **Movement State:** The interface displays when the curtain is actively moving in response to a command is shown in **Dark Theme (*Figure 21*)** and **Light Theme (*Figure 22*)**.

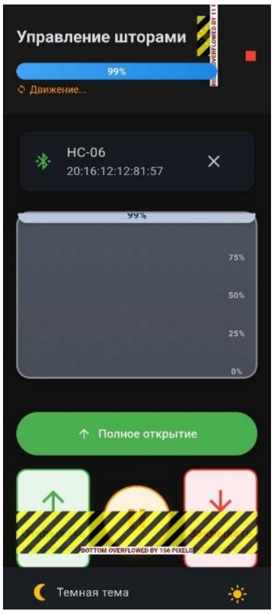

Figure 21. *Control Interface (Dark Theme), Curtain in Motion*

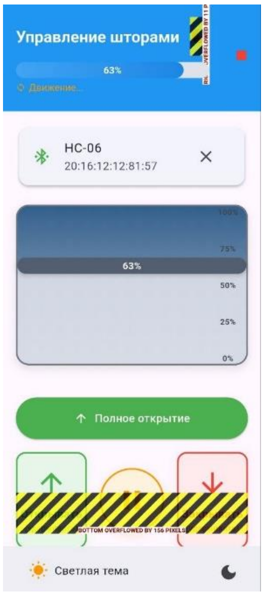

Figure 22. *Control Interface (Light Theme), Curtain in Motion.*

• Result: The reliable stop positions were developed using a time-control system, and finally, user interface design work was completed.

• Components Used (Electronic): V0002 components, including Bluetooth and IR.

“• Construction: final structural design for the mock-up with Foamed PVC Sheet for the window and integration of the Thread drive system.”

• Visual Documentation (Hardware): The prototype electronic circuit is depicted in Figure 23.

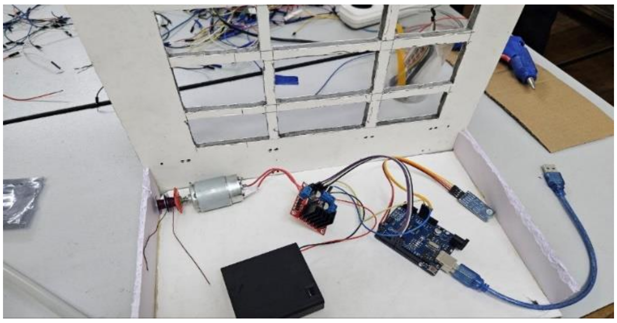

Figure 23. *Prototype 0003 Integrated Electronic Setup.*

Final version (V0004)

The final system integration is shown below in Figure 24. In order to ensure the electrical logic is understandable for future disassembly purposes, a schematic diagram is shown below in Figure 25. Final Project Circuit Schematic.

Figure 24. *Final Automated Curtain System V5 Assembly (Overall View).*

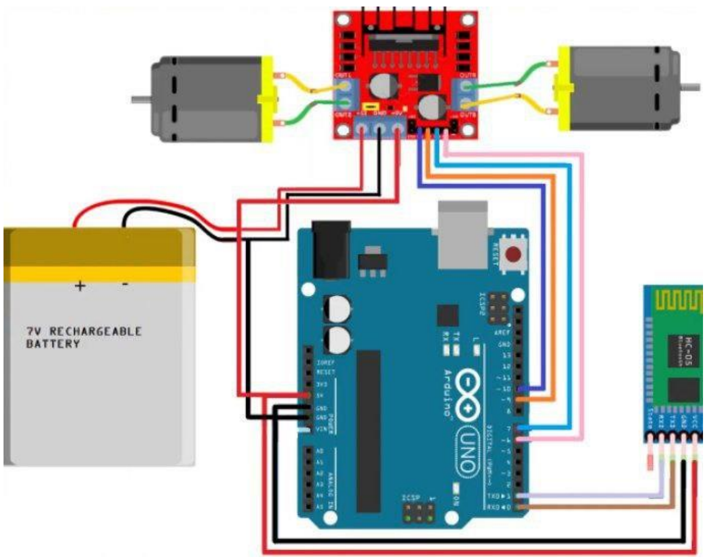

Figure 25. *Final Project Circuit Schematic.*

Mechanical challenges: problem and solution

The group was faced with quite a number of mechanical issues related to friction during the final assembly stages when trying to incorporate the electrical mechanism with the physical structure.
Problem 1: High Sliding Friction due to Curtain Attachment

One major resistance encountered when moving the curtains was at the point where it is attached. This was achieved by a wooden skewer, used as a linkage between the curtain and the movement thread, resulting in high friction as it slides along the rail. The force was too strong for the DC motor.

•Solution 1: The Electrical Tape Method. The group had considered a number of ways to resolve this problem. Eventually, an inexpensive and reasonably uncomplicated approach was adopted-applying a layer of electrical tape to the wooden skewer. This helped create on the latter a smoother, less friction-efficient surface, owing to which it passed through the curtain with much ease.

Problem 2: Insufficient Force because of Drive Threads Resistance

The resistance of
Though the first solution worked to relieve the motor's problem quite considerably, this mechanism proved not powerful enough in order to completely open or close curtains. It was concluded that this remaining power loss was due to friction and resistance at the structural beam/support along which the drive thread passed in order to keep tension toward the motor.
• Solution 2: To reduce resistance from the thread, the team repeated the technique from Solution 1. Electrical tape was taped to the surface of the structural support/beam in which the thread rubbed on. This would allow a smooth passage for the drive thread with minimal mechanical resistance. It was this final solution that was crucial for allowing full movement of the motor.

Testing & results

Testing is conducted at different levels of the system in order to guarantee the proper working of the remotes and accuracy elements.

Test	Functional Requirement Addressed	Result and Comment
Bidirectional Movement	System must open and close curtains.	**Successful.** The L298N driver reliably controlled the DC motor direction.
Positional Accuracy	System must stop at defined 0% and 100% positions.	**High Reliability.** Achieved by careful software calibration of the run time (delay()) in V0003.
Bluetooth Reliability	System must respond to remote commands via app.	**Successful.** Commands executed reliably within the HC-05 range.
IR Control	System must respond to secondary remote input.	**Successful.** IR signals were decoded correctly, confirming input redundancy.

Table 3. *System Testing Procedures and Validation Results*

Discussion (Problems, limitations, & trade-offs)

The main goals of the project were completed successfully. However, when developing this, several critical technical issues were handled.

1. Motor Trade-off: The high-precision Stepper motor (V0001) was traded off for the high-speed DC motor V0002, hence compromising on its positional precision to meet the required speed and torque.

2. Positional Control Challenge: This DC motor had too much inertia and required the use of a time-based control system (V0003). While efficient, this control system shows resistance to changes in power, where any drop in voltage will result in positional errors.

3. Mechanical Friction: The success relied strongly on the mechanical solutions below, reducing friction with cheap materials like electrical tape.

4. Range Limitation: The range limitation of the Bluetooth module of HC-05/06 confines the control of the system.

Conclusion & future work

Conclusion in the proposed project, the Arduino board-based system design for automating curtains using a DC motor with remote controlling capability through Bluetooth and IR has been achieved, and the system demonstrated its capability of being controlled through the smartphone app and ability to drive motors efficiently in this compact system. Also, the activation process of the last version of V5 has been ensured as reliable with efficiently good efficiency in fulfilling all major objectives identified in this project proposal.

Future Work "Some of the improvements that could be made in the future to enhance its dependability and connectivity are:

• Positional Feedback (Dependability): Implement the use of Limit Switches or Motor Encoders to replace the time-dependent system. This will provide absolute feedback of the position; thus, the time-dependent error due to the voltage and the change in load values will not have any effect on the system.

• Internet of Things (IoT) Enhancement: Implement the use of the Wi-Fi microcontroller ESP32 to replace the Bluetooth module HC05 used in the circuit. Thus, this gives the ability to remotely operate the system over the internet; thus, the concept of IoT will successfully be implemented into this project.

• Aesthetic Packaging: Implement 3D printing for the development of an aesthetic package for the electronics and motor setup.

References

- Arduino (2023) *Arduino Uno Rev3 Technical Specifications*. Available at: https://docs.arduino.cc/hardware/uno-rev3 (Accessed: 10 December 2025).
- Patil, N., Kale, G. and Kathe, P. (2020) 'Design and implementation of automated window curtains using Arduino and Bluetooth', *International Research Journal of Engineering and Technology (IRJET)*, 7(5), pp. 2932–2935. Available at: https://www.irjet.net/archives/V7/i5/IRJET-V7I5552.pdf (Accessed: 10 December 2025).
- Pololu Corporation (2018) *Stepper motor basics and characteristics*. Available at: https://www.pololu.com/docs/0J88 (Accessed: 10 December 2025).
- STMicroelectronics (2014) *L298: Dual full-bridge driver datasheet*. Available at: https://www.st.com/resource/en/datasheet/l298.pdf (Accessed: 10 December 2025).
- Arduino (2023) *IRremote Library Documentation*. Available at: https://github.com/Arduino-IRremote/Arduino-IRremote (Accessed: 10 December 2025).
- Arduino (2023) *Servo Library Reference*. Available at: https://www.arduino.cc/reference/en/libraries/servo/ (Accessed: 10 December 2025).
- Arduino (2023) *Stepper Library Reference*. Available at: https://www.arduino.cc/reference/en/libraries/stepper/ (Accessed: 10 December 2025).

Appendices (Code, circuit diagrams, extra data)

- **Appendix A: Full Source Code** (V0004 Code for Arduino, including Bluetooth and IR logic).
- **Appendix B: Full Circuit Diagram** (Final Version V5 schematic).
- **Appendix C: Mobile Application Documentation**.
- **Appendix D: Project Digital Resources**

The following resources provide direct access to the project's digital materials, including the full source code and a demonstration video on the **Table 4**.

Resource	**Description**	**Value / Image Reference**
GitHub Repository	Full Arduino C/C++ source code and circuit diagrams.	Let's Start! https://github.com/ChynChyngyz/ArduinoAutoCurtain-
YouTube Video	Demonstration of the final V5 prototype in operation.	SCAN ME https://youtube.com/watch?v=njQnXLjv-mE&si=feejZnD6uXRWI1OW

Table 4. Project Digital Resources and Online Documentation