**An-Najah National University**

Faculty of Engineering and Information Technology

Computer Engineering Department

Graduation Project 2

# Childhood Memories

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Presented in partial fulfillment of the requirements for the

Bachelor’s degree in Computer engineering

**June , 2025**

# Acknowledgment

First and foremost, we say, “Thank God.” We would like to express our deepest gratitude to God for the blessings, strength, patience, and guidance that supported us throughout our graduation project journey—and every journey we have faced in our lives. His blessings and satisfaction have been a constant source of motivation and support, helping us overcome challenges and successfully complete this hardware graduation project. Truly, we can never say “Thank God” enough.

We would like to offer our special thanks and extend our deep appreciation to our supervisor, Dr. Suliman Abu Kharmeh, for his invaluable guidance and the precious advice he provided throughout our work. He consistently made time for us and never hesitated to offer constructive feedback and share his valuable experience with us. Thank you for your continuous support, which has greatly enhanced our knowledge and contributed significantly to the success of our project.

We would also like to extend our heartfelt thanks to Mr. Hussam Saa’deh for his outstanding efforts and craftsmanship in building the puppet theatre and creating the puppets for our project. His dedication, skill, and attention to detail played a vital role in bringing our vision to life. We truly appreciate the time and care he invested in supporting our work, and we are grateful for his valuable contribution to the success of our project.

Finally, we would like to extend our deepest gratitude to our beloved families and supportive friends, who stood by us with love, patience, and encouragement throughout this entire journey. In moments of stress and challenge, their words, smiles, and presence gave us the strength to keep going. This accomplished project is not only the result of our efforts but also a reflection of the incredible, unwavering support we are blessed to have. Thank you for believing in us every step of the way.

# Disclaimer Statement

This report was authored by Lama Dwikat and Fatima Nasser, students from the Department of Computer Engineering, Faculty of Engineering, An-Najah National University. The report has undergone minimal changes, limited to editorial corrections, and may still contain errors in language and content. The authors acknowledge full responsibility for any errors identified within. The views, analyses, and recommendations presented in this report are solely those of the authors and do not represent the official stance of An-Najah National University. The university assumes no responsibility or liability for any outcomes resulting from the use of this report for purposes beyond its original academic intent.

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# Chapter 1

# Abstract

In our project “Childhood Memories,” we take you on a journey back to one of our favorite childhood memories—puppet theatre. This time, we’ve reimagined it with a modern touch. We developed a fully

automated version of the traditional puppet theatre that requires no puppeteers. Everything can be controlled through a web page that is easily accessible from a mobile phone.

The theatre operates in three different modes. The first mode allows users to manually control each puppet individually. You can move its hands, legs, or the entire body left and right. This makes puppet control simple—no training in using strings is required; just press a button and the puppet moves.

The second mode, which is the core of the project, plays preprogrammed stories. Users can choose from a list of stories available in both English and Arabic. As each story plays, the theatre activates various effects based on the story’s actions, including rain, mist, internal LED lighting, and RGB lights around the theatre to enhance the experience.

The third mode includes voice recognition. Users can have simple conversations with the puppets using specific voice commands in either Arabic or English. The puppets respond and interact accordingly, creating an engaging and dynamic interaction.

This project brings back the joy of puppet theatre, adding a modern, interactive twist through current technology.

# Chapter 2

# Introduction

## 2.1 General Background

Puppet theatre has long been a cherished form of storytelling, bringing characters like Pinocchio, Little Red Riding Hood, and the Wolf to life. These beloved characters were part of our childhood—they lived in homes around the world, spoke every language, and shared their stories with us. The most magical moments were when we met them live through puppet theatre, experiencing their adventures right before our eyes. Puppet shows not only entertained us, but also taught valuable lessons through educational stories, introduced cultural heritage through folklore, and sparked joy through traditional tales featuring those familiar characters.

## 2.2 Objectives of The Work

In recent years, technological advances have transformed the entertainment field through automation and digital control. Yet, puppet theatre remains mostly manual, requiring trained puppeteers to move puppets via their strings. This limits performance and accessibility, as puppet theatre is always dependent on the presence of the puppeteer. By introducing automation, puppet shows can be enhanced—allowing shows to run anytime and anywhere without the constant need for puppeteers.

## 2.3 Significance of The Work

The integration of technology into puppet theatre is not limited to replacing puppeteers with hardware components. It represents a shift toward modernizing the entire theatre experience by incorporating technology into every element of the show. This approach introduces new interactive features, enhances performance, and makes the system more accessible and user-friendly, allowing anyone to operate and enjoy puppet shows without requiring specialized skills.

## 2.4 Organization of the report

This report is organized showing a comprehensive overview of fully automated puppet theatre. It is divided into several chapters, each focusing on different aspects of the project:

**Introduction**: This chapter provides the general background, objectives, and significance of the project. To set the context for the reader.

**Literature Review**: This chapter reviews existing research related to puppets theatres. By focusing on its importance and attempts to develop it

**Methodology**: This chapter details the standards and specifications used, as well as the materials and components involved, also the design and construction process, software development, and constraints and considerations. It provides a complete explanation of how this puppet theater is built and what features it includes.

**Results & Discussion**: This part presents the results of the project. It discusses the problem resolution, contributions, logical implications, and limitations. It provides an analysis of how well ship meets its objectives and the potential impact of the project.

**Conclusion & Recommendations**: This final section summarizes the project. It draws conclusions based on the results. It also offers recommendations for future improvements and work. By organizing the report in this manner ensures that each aspect of fully automated puppet theatre development is completely covered. It remains easily accessible to the reader.

# Chapter 3

# Literature Review

Puppet theatre has long been a universal form of storytelling, used across cultures and languages around the world. It has served as a source of entertainment for centuries and is celebrated globally through festivals such as the Charleville-Mézières World Puppet Theatre Festival in France, held every three years and featuring hundreds of companies from around the world [1].

However, the role of puppet theatre extends beyond entertainment—it is also a powerful educational tool. Puppets provide children with a symbolic medium to express emotions, resolve conflicts, and share their perspectives on the real world. They help teachers better understand children's feelings and challenges, enabling quicker and more engaging achievement of curricular goals. Thus, puppet-performed theatre has a positive impact on developing children’s imagination and creativity [2].

Despite the widespread popularity and cultural significance of puppet theatre worldwide—often regarded as a means through which nations express their heritage—its performances have gradually declined over time. One key reason is that traditional puppet shows require professionally trained puppeteers, who are now increasingly scarce. In response to this challenge, researchers and developers have explored the integration of technology to simulate puppet performances without relying on human puppeteers. As a result, various applications have been developed that enable users to perform shadow puppet plays virtually. In the preliminary evaluation of one such method, both experts and non-experts provided encouraging feedback, noting improved control, faster operation, and more realistic movement of the virtual puppets [3].

The development of virtual puppet theatre has seen significant improvements, with some applications focusing on enabling users to perform puppet shows using computer-based systems. For example, the "Leap Motion" application captures the user's hand gestures and translates them into puppet movements on the computer screen. Users can choose different puppets, scenes, and background music within the system, making it easy for anyone to create and perform a puppet show independently [4].

Although software-based virtual puppet theatre applications focus on eliminating the need for human puppeteers, this shift can make puppet theatre less engaging. Transforming puppet performances into purely digital experiences may cause them to resemble animated films or cartoons, especially for children who are typically drawn to the excitement of meeting puppets live and listening to their stories in person. Instead of relying solely on software, an alternative approach would be to preserve the traditional format by using motors to control physical puppets. This would allow for automation while still maintaining the tangible and cultural essence of traditional puppet theatre.

Integrating technology into puppet theatre offers opportunities not only to automate performances but also to enhance and modernize the overall experience. By introducing hardware components, the theatre can become more visually engaging and interactive, encouraging interaction between the audience and the puppets. This technological enhancement preserves the traditional essence of puppet theatre while making it more appealing and relevant to contemporary audiences.

# Chapter 4

# Methodology

The hardware components utilized to construct the system, their connections, and the overall system design will all be covered in this chapter. We will also go through how the system functions, as well as how the software and web page.

## 4.1 Hardware Components

### 4.1.1 Microcontrollers

#### 1. Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It features 54 digital I/O pins (14 of which support pulse-width modulation), 16 analog inputs, and 256 KB of flash memory. It also includes four hardware serial ports (UARTs), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

In this project, the Arduino Mega 2560 serves as the main controller. It manages various components including motors, lights, a water pump, a DFPlayer audio module, and a mist maker. It also communicates via serial connection with both the ESP8266 Wi-Fi module and the Voice/Speech Recognition Module V3.

This board was selected due to its high number of I/O pins and multiple hardware serial ports, which are essential for handling multiple devices simultaneously without communication conflicts.

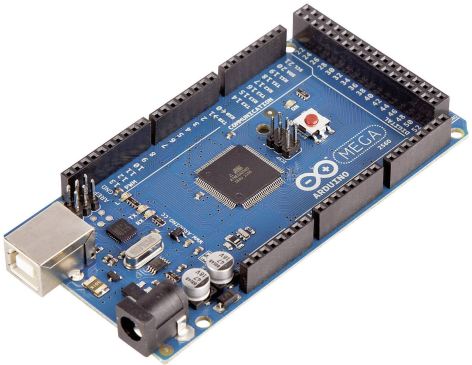


Figure 4.1: Arduino Mega 2560

## 2. ESP8266 wifi module

The ESP8266 is a low-cost Wi-Fi module that operates at 3.3V and allows microcontrollers to connect to 2.4 GHz wireless networks using the IEEE 802.11 b/g/n standards. It includes a full TCP/IP protocol stack and supports control of its GPIOs, making it capable of handling data processing tasks. The module can operate in two modes: as a Wi-Fi adapter for external microcontrollers using the ESP-AT firmware, or as a standalone microcontroller running its own code via an RTOS-based SDK.

In this project, the ESP8266 is connected via a serial interface to the Arduino Mega. It creates a local Wi-Fi network named "Fatima-Lama", which hosts a web-based interface for controlling the puppet theatre.

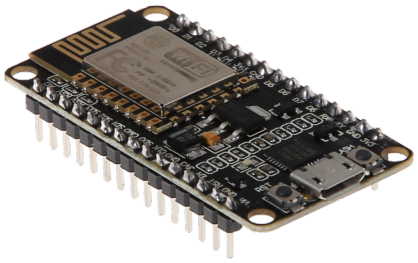


Figure 4.2: ESP8266 Wifi Module

## 3. Voice/Speech Recognition Module V3

The Voice Recognition Module V3 is a compact and user-friendly module designed for embedded systems to recognize and respond to voice commands. Operating at 5V, it is well-suited for applications in home automation, robotics, and interactive systems. The module can store up to 80 voice commands, with 7 commands active and recognizable at any given time.

In this project, the module is used to enable voice interaction with the puppets. We programmed 7 commands in Arabic, and 7 commands in English. Each command triggers a unique response from the puppets, allowing for an engaging and interactive experience.

Figure 4.3: Voice/Speech Recognition Module V3

## 4.1.2 Actuators

### 1. Servo Motor

A servo motor is a rotary or linear actuator that allows for precise control of position, velocity, and acceleration in mechanical systems. It is a type of DC motor equipped with a gear train, position encoder, and control circuitry, which enables accurate position control. Servo motors commonly operate at 5V and are widely used in applications such as remote-controlled model airplanes, robotics, and industrial automation.

In our project, we used eight servo motors to move the strings of the puppets. Each puppet was controlled by four servo motors — one for each hand and each leg — allowing for individual movement control.

Figure 4.4: Servo Motor

### 2. Stepper Motor

Stepper motors convert electrical energy into precise rotational movement. Each pulse of electricity moves the motor by a fixed step, allowing for highly accurate control over position and speed. Typically operating at 12V, they are ideal for applications that require controlled and repeatable motion.

In the puppet theatre, we used two NEMA 23 stepper motors — one for each puppet — to move them left and right along the theatre .

Figure 4.5: NEMA 23 Stepper Motor

### 3. Water Pump

A water pump is a device used to move water from one location to another, often utilized in automation and special effects.

In this project, a 12V water pump is used to produce a rain effect that runs during story playback whenever the selected story includes rainy weather.

Figure 4.6: Water Pump

### 4. Mist Maker

A mist maker, also known as an ultrasonic fogger or humidifier, is a device that uses ultrasonic vibrations to create a fine mist from water, It operates at 24V.

In our project, it is used to create a mist effect during story scenes that involve rainy or cloudy weather.

Figure 4.7: Mist Maker

### 5. Fan

A fan is generally used for thermal management, specifically to cool down components and prevent overheating. It operates at 12V and works by creating airflow that dissipates heat generated by electronic components, ensuring optimal performance and longevity.

In our project, the fan was used to direct the mist inward toward the theatre, enhancing the visual effect inside the theatre.


Figure 4.8: Fan

### 4.1.3 Output Devices

#### 1. DFPlayer

The DFPlayer Mini MP3 Player is a small, low-cost MP3 module that provides simplified output directly to a speaker. It operates at 5V and can function as a standalone device when connected to a battery, speaker, and push buttons, or it can be controlled by microcontrollers such as Arduino, ESP32, Raspberry Pi, or any other microcontroller with UART capability .

In our project, it is used to play prerecorded story voices stored on an SD card.

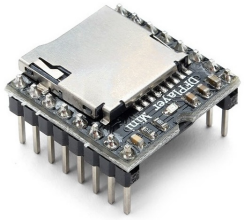


Figure 4.9: DFPlayer

#### 2. Speakers

The DFPlayer Mini reads prerecorded voices from the SD card and sends audio signals to the connected speaker, which converts these signals into audible sound.

Figure 4.10: Speakers

### 3. Colorful Led Lamp

A colorful LED lamp is a light-emitting diode (LED) lamp that can change colors. It operates at 12V and uses RGB (Red, Green, Blue) LED technology to produce a wide range of hues by mixing different intensities of red, green, and blue light.

We used it inside the puppet theatre to make the performance more attractive and exciting for the audience.

Figure 4.11: Colorful Light Lamp

### 4. RGB Led Strip

An RGB LED is an LED module that can produce almost any color using the three primary additive colors: red, green, and blue. It operates at 12V.

We placed RGB LEDs at the edges of the theatre to create dynamic lighting effects that enhance the atmosphere and match the mood of each scene in the performance.

Figure 4.12: RGB Led Strip

## 4.1.4 Input Devices

### 1. Limit Switch

A limit switch is an electromechanical device used to detect the presence or position of an object through physical contact, commonly found in industrial and automation applications.

In this project, we used two limit switches—one for each puppet—to return the puppets to their starting positions at the end of each story and before the beginning of a new one. We connected the limit switches to the Arduino and ground to enable accurate detection and control.


Figure 4.13: Limit Switch

## 4.1.5 Storage Devices

### 1. SD Card

SD (Secure Digital) card is a small, portable memory storage device used to store digital data. In this project, the prerecorded story voices are stored on an SD card, which is inserted into the DFPlayer Mini to enable audio playback.


Figure 4.14: SD Card

## 4.1.6 Structural and Fluid Components

### 1. Water Tube

It was used with a water pump to create a rain effect, with several holes made in the piping and placed along the theatre to simulate falling rain.

Figure 4.15: Water Tube

### 2. Plastic Jar with Screw Lid

We used a plastic jar to hold the mist maker, as it needs to be submerged in water to operate. We modified the screw lid by cutting an opening in the center and placing a fan over the hole to direct the mist toward the theatre.

Figure 4.16: Plastic Jar with Screw Lid

## 4.7 Power Components

### 1. N-Channel MOSTFET

An N-channel MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) is a three-terminal device (Gate, Drain, Source) that controls current flow through an N-type channel. When a positive voltage is applied to the gate, it allows current to flow from drain to source.

In this project, N-channel MOSFETs are used with RGB LED strips to control color and brightness via PWM signals, while safely handling the high current required by the strips.

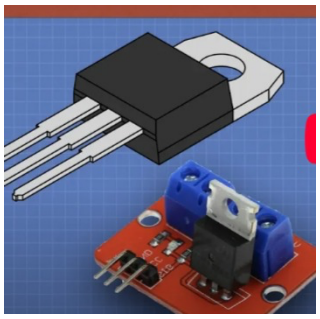


Figure 4.17: N-Channel MOSFET

### 2. Relay

A relay is an electrically operated switch that uses a low-power signal to control a higher-power circuit. It acts like a gatekeeper, allowing small electrical signals to safely control larger electrical loads. Relays are commonly used in a wide range of applications, from simple systems like car headlights to complex industrial control panels.

In our project, we used four single-channel relays to control the water pump, the colorful light lamp, fan, and the mist maker, allowing them to be switched on and off as needed.


Figure 4.18: Single Channel Relay

### 3. 5A Stepper Motor Driver (YS-DIV268N-5A)

The YS-DIV268N-5A is a stepper motor driver for two-phase hybrid motors, supporting up to 5A current. It provides precise control over motor movement, making it suitable for accurate positioning.

We used two of these drivers to control the two stepper motors in our project.


Figure 4.19: 5A Stepper Motor Driver ( YS-DIV268N-5A )

### 4. PC Power Supply

A PC power supply unit (PSU) converts alternating current (AC) from a wall outlet into the direct current (DC) that a computer's components need to operate .

It was used in this project to power the components that need 5 volt which are the servo motors and Voice/speech recognition module , DFPlayer . Also to power devices that need 12 v which are the drivers of the stepper motor , and relays that are connected with the water pump , colorful led lamp , fan to power them, N-Channel MSSFET that connected with led strip to power it .

Figure 4.20: PC Power Supply

### 5. 24 Voltage Adapter

A 24V adapter, also known as a 24V power supply, is a device that converts standard AC (alternating current) voltage—such as 120V or 240V from a wall outlet—into a stable 24V DC (direct current) output.

In our project, it was used to with the relay that connected with the mist maker power the mist maker.

Figure 4.21 : 24 Voltage Adapter

## 4.1.8 Wiring & Connectors

### 1. Female Dupont Connector Housing

A female Dupont connector housing is a plastic enclosure that holds and protects female terminals, allowing the creation of custom jumper cables to connect electronic components.

In our project, it was used to distribute power from the voltage source to multiple hardware components .

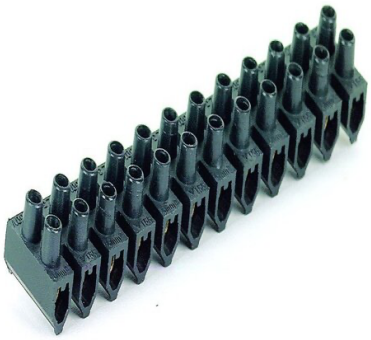


Figure 4.22: Female Dupont Connector Housing

## 2. Connection Wires

Connection wires, also known as electrical wires or conductors, are materials designed to carry electrical current between different points in a circuit.

In this project, we used various types of connection wires, including female-to-female, female-to-male, and male-to-male connectors.

Figure 4.23: Connection Wires Female to Female

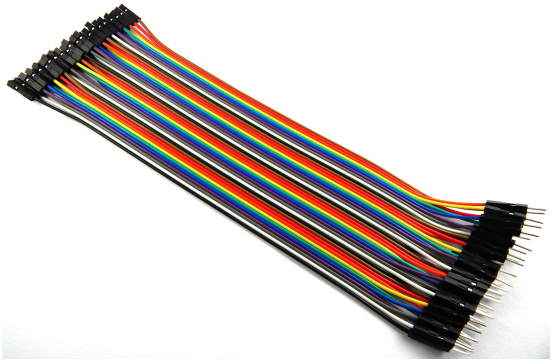


Figure  4.24: Connection Wires Female to Male

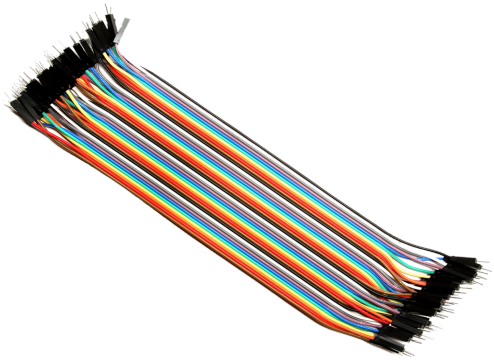


Figure 4.25 : Connection Wires Male to Male

## 4.2 Hardware Implementation

After integrating all the mentioned hardware components, we achieved this automated puppet theatre as the final result, which is primarily controlled via a web page.


Figure 4.26: Puppet Theatre

By connecting to our Local network “ Fatima-Lama" you can open the web page with ip “192.168.4.1.” you can open the web page Through this web page the user can access three control modes :

**Mode 1**: Manual control of each puppet individually, so user can control the movements of the body part of each puppet and can move it left and right .

**Mode 2**: Story mode, where the user selects from a list of predefined stories that can be played, restarted, or stopped.

**Mode 3**: Chat mode, which allows the user to have a simple text-based chat with the puppets. The puppets respond using pre-programmed messages, creating an interactive experience.

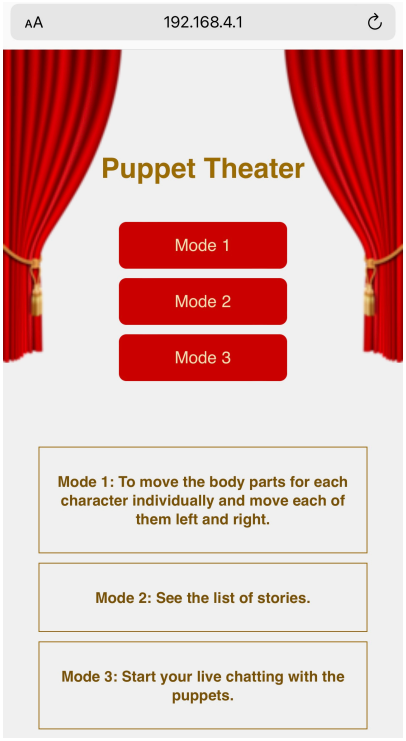
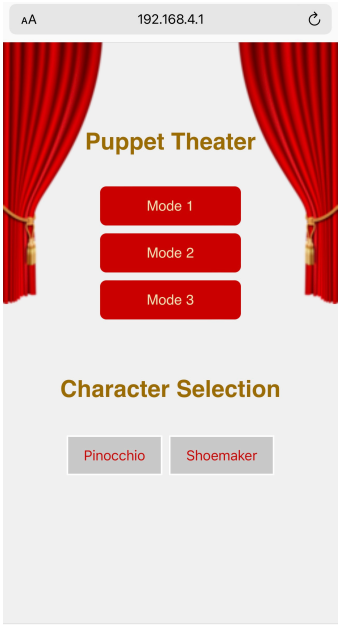
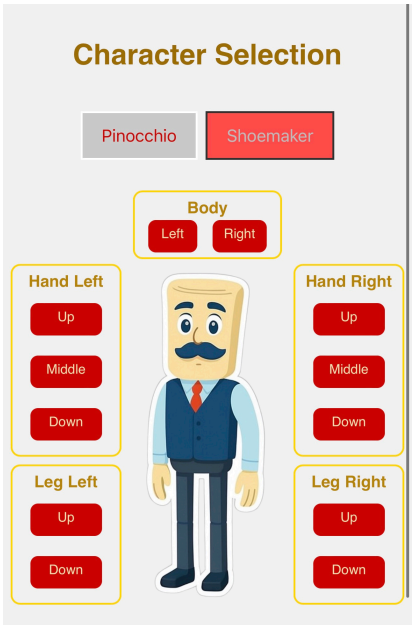



Figure 4.27 : Web Page-Main Page

I f you select the first mode you can have the full controlling at the movements of each puppet



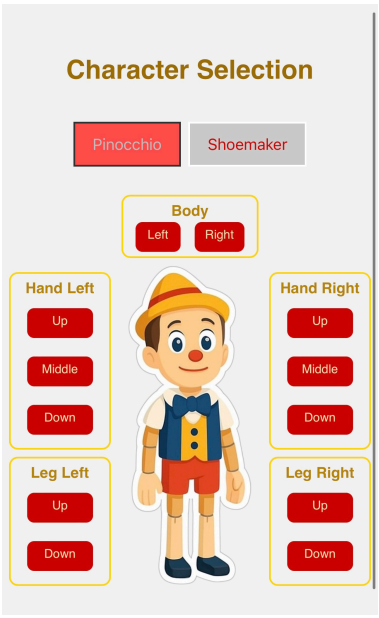




Figure 4.28 : Web Page -Mode1-A Figure 4.29 : Web Page -Mode1-B Figure 4.30 : Web Page -Mode1-C

- For Example if user click the button Pinocchio Hand Right up , it will be up

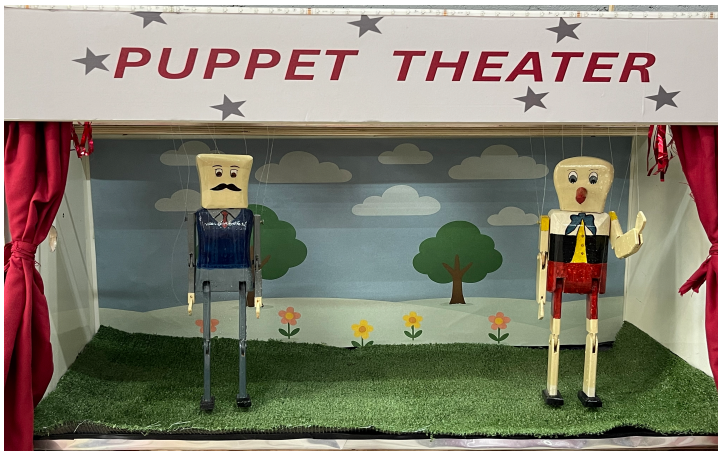
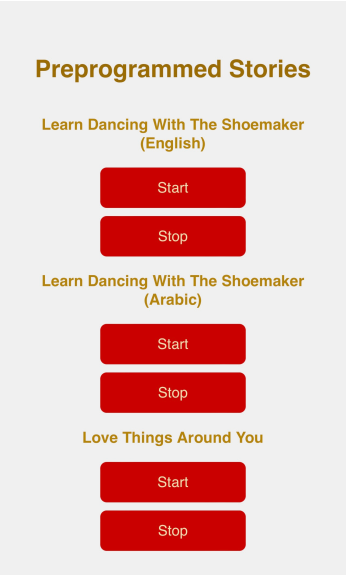



Figure 4.31: Related Interaction From the Web Page at the Actual Theatre

When Mode 2 is selected, the user can choose from a list of stories available in both Arabic and English. They can play any story they like at any time by clicking the 'Start' button. If a story is already playing, clicking 'Start' will restart it. Clicking the 'Stop' button will stop the currently playing story.




4.32 : Web Page -Mode 2

For Mode 3, we designed it to activate the voice recognition feature only when needed, preventing the voice module from constantly detecting and recognizing unwanted voices. It is simply activated by clicking the 'Start Chat' button and deactivated by clicking the 'End Chat' button.

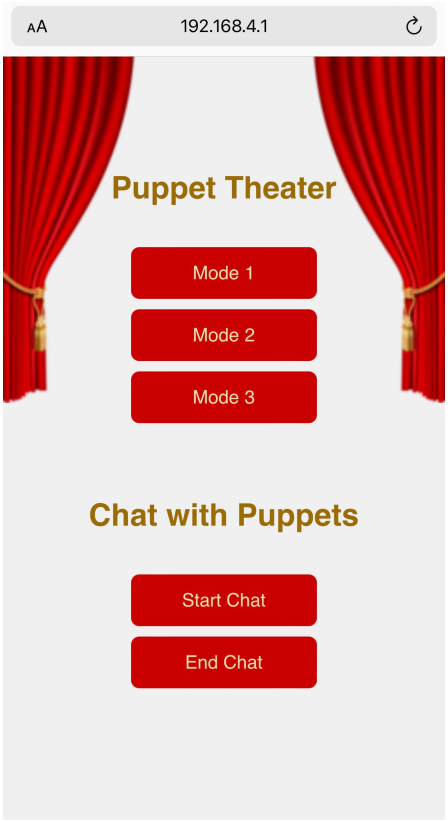



Figure 4.33 : Web Page –Mode 3

## 4.3 Software Implementation

We created two libraries, since each puppet has different reset servo angles. These libraries include all the expected movements for each puppet and provide reusable functions that were used to program the individual stories. Each story was implemented as a separate function and called from the main Arduino code.

To control the puppets interactively, we established serial communication between the ESP8266 (which hosted the web page) and the Arduino. When a button was clicked on the web page, a corresponding command was sent over the serial interface to the Arduino, which then executed the appropriate code snippet based on the received command.

## 4. 4 Constraints and Limitations

Project Size and Mobility: One of the main limitations of the project was the size and portability of the automated puppet theatre. Since the goal was to create a user-friendly system that could be used in homes, kindergartens, children's clubs, festivals, and other child-related activities, the theatre had to be compact and easy to move. However, this imposed a constraint on the internal design, as it was also essential to leave enough space for the puppets to move freely. Each puppet has its own directional movement limitations, so the challenge was to balance the need for mobility with the functional space required for proper puppet operation.

Lack of Existing Reference Designs: As integration of technology into traditional puppet theaters is still a developing concept, there was a significant limitation in finding modernized, hardware-based puppet theatre systems. This presented a major challenge during the planning phase, as there were no existing, practical examples or reference designs to guide us. As a result, we had to develop the entire system from scratch—defining principles, designing components, and implementing features without any established framework to rely on.

Audio Quality and Amplification: Since the puppet theatre includes story narration and is intended for large audiences in settings like festivals and children's events, delivering loud and clear audio was essential. We initially used high-watt speakers with an amplifier to achieve the required volume, but this setup resulted in significant audio noise from the speakers themselves, affecting the clarity of the story voice. To overcome this, we switched to using PC speakers with built-in amplifiers, which provided better sound quality with reduced noise. Additionally, we used software-based audio amplification during programming to ensure the story voice was sufficiently loud and clear for the audience.

Accuracy in Story Playback: To deliver an engaging and accurate story show, it is essential that puppet movements are precisely synchronized with the narration. Additionally, integrating other features such as rain effects, lighting, and mist requires them to be activated and deactivated at exact moments. Ensuring this precise timing and coordination poses a significant challenge during the programming and execution of each story.

# Chapter 5

# Results and Discussion

The "Puppet Theater" project is a creative project that blends art and technology. A smart theater system was designed to deliver a fully automated story without direct human intervention during the performance. The theater relies on complete automation, where the puppet movements are coordinated with the sound and effects displayed synchronously, providing an enjoyable and interactive entertainment experience, especially for children.

We chose Pinocchio and his friend as the show's protagonists. Several short scenarios were created, featuring humorous situations revolving around a light and funny lie from Pinocchio. Each scenario was carefully selected to maximize the theater's smart features, utilizing key features such as visual and audio effects, and interactive puppet movements. These movements included acting scenes such as speaking, walking, and even dancing, helping to highlight the theater's maximum potential and making the show as enjoyable as possible.

The theater was controlled using an Arduino, with several servos connected to move the various limbs of each puppet. We faced difficulties with the limited space allocated to installing these servos to ensure the maximum possible distance for the puppets' movement. This forced us to install the servos upside down in some locations, stacking them on top of each other. The DFPlayer Mini was also used to play the audio clips, including dialogue and effects. The script and dialogue were designed to perfectly align with the movements, and each time moment was precisely defined within the code to ensure synchronization.

There was also a problem with the noise generated by the motors and servos, especially when using more than one motor simultaneously, which sometimes affected the clarity of the sound. To avoid system shutdowns during the show, we avoided using delay() and instead relied on non-blocking time loops for movement. One of the elements that added a special liveliness to the theater was the theatrical effects that were intelligently and thoughtfully integrated into the story. The most prominent of these effects was the rain and smoke effect, where a small fog unit was used to produce steam. In some scenarios, this fog was employed to appear as natural fog in a rainy outdoor scene, reflecting a cold or humid atmosphere. In other scenarios, the same effect was used to create a smoke effect resulting from a sudden event.

Lighting was used in two different ways within the show. The first type was dynamic colored lighting, used during moments such as dancing or the active movement of the puppets, with the colors constantly changing to add a playful feel to the scene. The second type of lighting was intended for use during moments of lying and to decorate the stage.

One of the challenges we faced during the project was the tense security situation in the region, as the war intensified during the project's development phase. This directly impacted the ability to progress at certain times, both due to difficulty accessing the university and unstable psychological conditions. However, we were able to overcome these obstacles thanks to perseverance, continuous teamwork, and making the necessary adjustments within the team to suit the available resources.

Despite all these difficulties, we were able to develop an integrated model that worked efficiently and produced very satisfactory results. But our vision for the future goes beyond this prototype. Ultimately, the project has succeeded in achieving its goals of providing a comprehensive educational entertainment show, opening the door to a promising future for smart theater and interactive puppets.

# Chapter 6

# Conclusion and Recommendations

## 6.1 Conclusion

The Puppet Theater project is a practical demonstration of how programming and mechanical systems can be integrated with creative and artistic concepts to deliver an engaging entertainment experience. We successfully designed a system that operates independently, without human intervention during the show. This required precise synchronization between recorded voices, puppet movements via servo motors and stepper motors , visual effects like lighting , rain and mist .

Throughout the project, we discovered that applying theoretical ideas in practice was more challenging than anticipated, particularly due to limited space and hardware constraints. Scenes that seemed simple during planning were sometimes not feasible when implemented—either because the required puppet movements were mechanically difficult or overly complex, or because the desired effects required more equipment than the theater could support.

Despite these challenges, the project met its objectives, delivering an automated and synchronized puppet performance, while also laying the foundation for more advanced future development in smart, interactive theater systems.

## 6.2 Recommendations

Recommendations Build scenarios gradually: Begin with testing the available movements and effects, then write the story based on what’s practically achievable. This approach reduces wasted effort and ensures that scenes are realistic and implementable.

Structure and document code clearly: Since the theater relies heavily on precise timing and coordination, it's essential to keep the code well-organized and thoroughly documented. This practice simplifies future modifications and troubleshooting. Consider creating libraries for all predicted movements that will be used, so they can be easily reused and adapted throughout the performance.

## 6.3 Future Work

Future Work We envision expanding the Puppet Theater project both in functionality and application. Planned enhancements include:

Educational Integration: Transforming the theater into an educational tool for schools and learning centers, making education more interactive and enjoyable for children. Character Enhancements: Adding new characters and enabling finer movements such as eye and mouth animation. AI Integration: Connecting the theater to an AI system that generates unique stories dynamically, based on audience interaction or random prompts, for greater engagement. Pinocchio Mechanism: Designing a mechanical system to extend Pinocchio's nose each time he tells a lie, using internal mechanisms that do not affect the puppet's appearance.

Custom Story Uploading: Allow users to write and upload their own stories to be performed by the puppets. Additionally, users should be able to select which puppets from the existing set they want to activate in their show.

Dynamic Background: We aim to develop a dynamic background system that changes automatically in accordance with the story and scene progression. This dynamic background, along with synchronized sound effects and lighting, will adapt seamlessly as the performance unfolds, enhancing the immersive experience.

Audience Interaction via Camera: Using a camera to detect audience emotions (e.g., smiles, applause) and make the puppets respond interactively.

These developments aim to enrich the user experience, increase flexibility, and make the puppet theater more intelligent, adaptable, and educational.

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