Department of Electrical and Computer Engineering
North South University

Junior Design Project

CSE299.4

E-Voting System

Group 5

Ariful Alam Abir **2122236642**

MD. Saiful Islam **2132105642**

Apurba Krishna Dash **2222691642**

Faculty Advisor:

Dr. Mohammad Shifat-E-Rabbi

Assistant Professor

ECE Department

Summer, 2025

Abstract

E-Voting System

This project presents the development of a secure and user-friendly E-Voting web application designed to streamline the electoral process through digital means. The system allows eligible users to register, verify their identity through OTP-based authentication, and securely log in to cast their vote. Built using HTML, CSS, JavaScript for the frontend, and PHP with MySQL for the backend, the application ensures efficient data handling, secure storage, and smooth user interaction. Core functionalities include voter registration, secure login, and structured data storage through a relational database. The project emphasizes accessibility, simplicity, and formal design standards while maintaining data integrity and security throughout the voting process. The system was developed and tested in a local environment using XAMPP, and it demonstrates the practical potential of web-based voting systems to modernize conventional voting methods.

TABLE OF CONTENTS

Chapter 1 Introduction

1.1 Background and Motivation

As Bangladesh moves toward becoming a more digital nation, there is a growing need to make public services faster, safer, and more accessible. One key area that can benefit from this digital shift is the voting system. Traditional voting methods often require a lot of time, money, and manpower, and they can be prone to errors or misuse. These issues can lower public trust and reduce voter participation.

An E-Voting system offers a modern solution by making the voting process more efficient, transparent, and easier for people—especially those living in remote areas. This project supports the vision of "Digital Bangladesh" by showing how technology can improve how elections are run. It also serves as a way to learn about secure web development, data handling, and user verification, which are all important for building future digital services.

1.2 Purpose and Goal of the Project

The objective of this project is to develop a functional and secure E-Voting web application that provides an end-to-end digital solution for voter registration and authentication, aligning with the broader goals of national digitization and e-governance. The system is designed to address several limitations of traditional paper-based voting methods, such as inefficiency, lack of accessibility, and vulnerability to tampering or error.

The core contributions of this project are as follows:

A. Integrated Voter Registration and Authentication: The system allows users to register with all necessary personal information, including document uploads (photo and signature), and verifies identity through an OTP-based mechanism to prevent fraudulent access.
B. User-Centric Design: Emphasis is placed on a formal, accessible interface that can be used by a wide range of users with varying levels of digital literacy.
C. Secure Backend Architecture: PHP and MySQL are used to build a secure and structured backend that supports efficient data handling, protection of user credentials, and proper session management.

D. Scalability and Reusability: The modular structure of the application allows for future extension, such as vote casting, admin control panels, and analytics dashboards.
E. Alignment with National Digitization Efforts: The system directly supports the ongoing objectives of initiatives such as “Digital Bangladesh” and the future vision of “Smart Bangladesh,” where civic services are digitized for broader accessibility and accountability.

The novelty of the project lies in its integration of commonly available web technologies to simulate a secure voting environment tailored for local contexts. Unlike generic voting, this system specifically incorporates national identity application principles, localized data fields, and security layers that reflect real-world deployment considerations. This approach provides a practical framework that can be further developed into a real-world civic tool under proper legal and infrastructural support.

1.3 Organization of the Report

This report is organized into five chapters. Chapter 1 introduces the background, motivation, and objectives of the project. Chapter 2 outlines the methodology followed during the development of the E-Voting system, including system design and implementation details. Chapter 3 presents the investigation and experimentation process, followed by the analysis and discussion of the results. Chapter 4 addresses the complex engineering problems and activities involved in the project. Finally, Chapter 5 concludes the report by summarizing the key outcomes, limitations, and possible future improvements.

Chapter 2 Methodology

2.1 System Design

The system design of the E-Voting platform follows a modular and layered architecture to ensure functionality, scalability, and ease of maintenance. The project is primarily based on a web-based client-server model, where users interact through a browser interface while server-side scripts manage data processing and storage.

The design can be broken down into the following components:

1. User Flowchart:
A user flowchart outlines the sequence of operations from user registration to authentication. It includes the following steps:

A. User accesses the registration page
B. Inputs personal and contact information
C. Uploads a photograph and signature
D. Submits the form for verification
E. Receives and enters OTP
F. Registration success/failure feedback is provided

2. Block Diagram:
The high-level block diagram consists of:

A. Frontend (HTML/CSS/JavaScript): User interface for input and feedback
B. Backend (PHP): Handles form submission, file validation, and database transactions
C. Database (MySQL): Stores user data securely
D. OTP Module: Simulated via client-side JavaScript for authentication

3. Database Design:
The MySQL database contains structured tables such as:

A. voters – to sign up applicant details onto database and leads to log in to dashboard
B. birth applications – to store applicant birth details
C. Fields include text data, enumerated types, and binary data (photos, signatures)

2.2 Hardware and/or Software Components

This project is entirely software-based and does not require any specialized hardware components beyond a standard computing device capable of running a local server environment. The implementation involves a full-stack web application architecture, with both frontend and backend components integrated through a relational database system. Below is a detailed breakdown of the software components used throughout the project.

A. Frontend Components

The frontend of the E-Voting system is responsible for presenting the user interface, capturing user inputs, and performing basic client-side validations. It includes:

1. HTML5: Used to define the structure and layout of web pages, including the registration form, login page, and dashboard.
2. CSS3: Used to style the UI with a clean, formal look. Consistent design practices were followed to enhance usability and accessibility.
3. JavaScript: Handles client-side validations, dynamic behavior such as OTP input timing, and real-time feedback to users.

B. Backend Components

The backend handles server-side processing, data validation, OTP generation, and communication with the database:

1. PHP (v7.4+): Acts as the server-side scripting language to receive form data, process OTP requests, and manage user sessions.
2. MySQL: A relational database management system used to securely store voter information, OTP codes, and uploaded documents.
3. dp.php: A centralized database connection file that encapsulates database credentials and connection logic to ensure reusability and maintainability.

C. Data Management & File Handling

1. Form Data Storage: Submitted user data is sanitized and inserted into MySQL tables using SQL queries.
2. File Uploads: Applicant photo and signature files are uploaded to a server directory, and their file paths are saved in the database for retrieval.
3. OTP Verification: Simulated OTP generation is used for identity confirmation before data is finalized and stored.

TABLE I. DEVELOPMENT AND DEPLOYMENT ENVIRONMENT TABLE

Component	**Description**
Operating System	Windows 11 (Local Development)
Development Server	XAMPP (PHP + MySQL bundle)
Code Editor	Visual Studio Code
Browser	Google Chrome (for testing and debugging)
File Storage	Local storage used for saving uploaded images and files

2.3 Hardware and/or Software Implementation

This section details the step-by-step implementation of the E-Voting web application, highlighting the software modules, technologies, and key development practices employed to build a functional and secure system.

A. Frontend Implementation

I. The frontend user interface was created using HTML5 for semantic structuring, CSS3 for styling, and JavaScript for interactivity and client-side validation.

II. Registration and login forms include real-time input validation using JavaScript to ensure mandatory fields are completed and data formats (e.g., date of birth, mobile number) are correct before form submission.

III. JavaScript also handles the OTP entry interface with input masking and timer controls to simulate OTP expiry, improving user experience.

B. Backend Implementation

I. The backend was developed in PHP 7.4, running on an Apache server via XAMPP.

II. The PHP scripts are modularized, with a dedicated dp.php file managing the MySQL database connection using PDO (PHP Data Objects) to support prepared statements, thus mitigating risks of SQL injection.

III. Upon form submission, user inputs are sanitized using PHP filter functions, then verified against existing records to prevent duplicate registrations.

IV. The OTP verification logic involves generating a random numeric code, storing it temporarily in the database, and validating user input against this stored value.

V. File uploads for applicant photo and signature utilize PHP's file handling functions with validations on file type and size. Uploaded files are renamed uniquely based on user IDs and timestamps to avoid overwrite and stored in secure server directories.

VI. Session management scripts ensure that after successful login, users gain access to restricted dashboard pages, while unauthorized access attempts are redirected appropriately.

C. Database Implementation

I. A MySQL relational database was designed with tables such as voters and votes.

II. The database schema enforces data integrity using appropriate data types, primary keys, and indexing on frequently queried fields like mobile number and voter ID.

III. SQL queries utilize prepared statements and parameterized inputs to enhance security and efficiency.

IV. Stored file paths link uploaded images to user records, enabling retrieval for verification or display in the user dashboard.

D. Testing and Debugging

I. The system was rigorously tested in a local environment using XAMPP on Windows 11.

II. Functional testing covered form validations, OTP workflows, file upload limits, and database insertions.

III. Error handling routines were implemented to provide user-friendly messages and prevent application crashes on invalid inputs or server issues.

IV. Cross-browser compatibility checks were performed primarily on Google Chrome.

Chapter 3 Investigation/Experiment, Result, Analysis and Discussion

3.1 Experiment Setup

To evaluate the performance, reliability, and usability of the developed E-Voting web application, a series of controlled experiments were conducted within a local testing environment using XAMPP on Windows 11. The primary focus areas included:

1. Form Input Validation: Ensuring all required fields are correctly filled and conform to expected data formats.
2. OTP Generation and Verification: Testing the accuracy and security of the identity verification process.
3. File Upload Processing: Assessing the system's handling of photo and signature uploads with respect to file type and size constraints.
4. Database Transactions: Verifying data integrity during insertion, retrieval, and updates.
5. Authentication Workflow: Confirming that login procedures restrict unauthorized access effectively.

These tests were designed to mimic real-world user interactions, including both valid and invalid input scenarios.

3.2 Results

3.2.1 Form Validation Testing

Test Case	**Description**	**Expected Behavior**	**Observed Behavior**	**Status**
TC-01	Complete, valid data submission	Form submission succeeds	Form submitted successfully	Passed

TC-02	Missing required fields	Validation error displayed	Validation error displayed	Passed
TC-03	Incorrect mobile number format	Input rejected with error message	Input rejected with error message	Passed
TC-04	Uploading files exceeding size limit	Upload rejected with warning	Upload rejected with warning	Passed
Test Case	Description	Expected Behavior	Observed Behavior	Status

Table 3.1: Results of form validation test cases.

3.2.2 OTP Verification

The OTP mechanism generated a random six-digit code, temporarily stored in the database for validation purposes. Users entering the correct OTP were successfully verified, granting access to further system functionalities. Incorrect OTP inputs triggered clear error notifications, prompting users to retry. The system simulated OTP expiration by limiting entry attempts within a defined timeframe, ensuring timely verification.

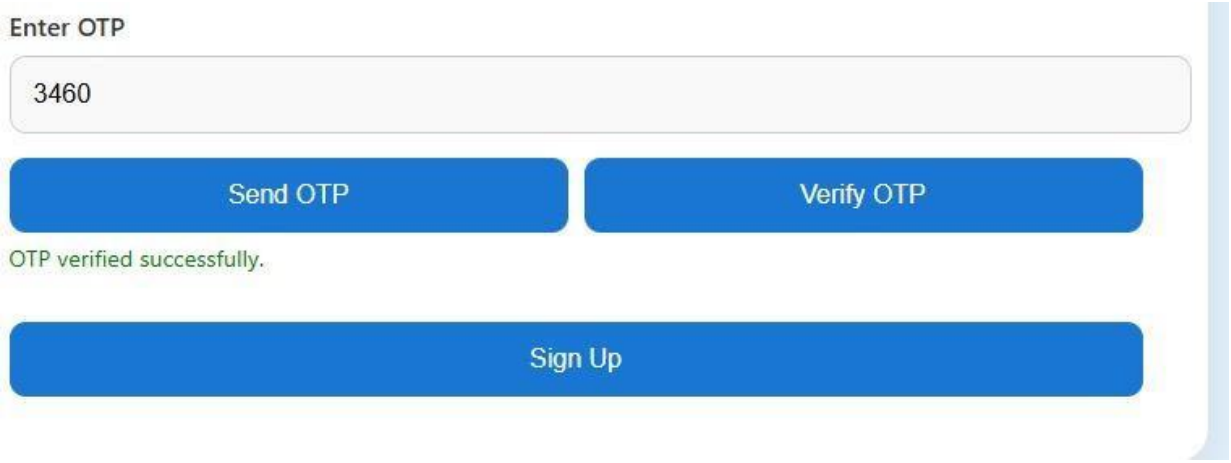

Figure 3.1 illustrates the OTP input interface and corresponding success and failure notifications.

3.2.3 Database Operations

Data persistence tests confirmed that voter details, along with associated uploaded file paths, were correctly stored in the database upon successful OTP verification. Attempts to register multiple accounts using the same mobile number were effectively blocked, preserving data consistency and preventing duplication.

3.3 Analysis

The experimental outcomes affirm that the E-Voting system enforces robust client-side and server-side validations, ensuring data accuracy and integrity. The OTP verification module, although simulated without SMS gateway integration, logically secures the registration process by preventing unauthorized entries. File upload constraints successfully mitigate risks associated with large or incompatible files, protecting server resources and enhancing security. The backend's use of prepared statements and sanitized inputs addresses common web vulnerabilities such as SQL injection. However, the absence of a real-time OTP delivery mechanism limits practical deployment. Future integration with an SMS gateway is essential to enable real-world authentication scenarios.

3.4 Discussion

The system meets its goal of offering a secure and easy-to-use platform for voter registration and OTP-based authentication. It has a clear and formal design, making it accessible to all users. The backend is built with good security and data practices, creating a reliable foundation. This project shows that standard web tools can be used to build an effective E-Voting system. To use it in real elections, it will need real SMS integration, stronger security, and proper system testing.

Chapter 4 Complex Engineering Problems and Activities

4.1 Complex Engineering Problems (CEP)

The E-Voting system involves several complex engineering problem attributes that require the application of deep knowledge, careful design decisions, and consideration of real-world implementation challenges. The following table outlines how the project addresses these attributes:

TABLE II. A SAMPLE COMPLEX ENGINEERING PROBLEM ATTRIBUTES TABLE

Attributes		**Addressing the complex engineering problems (P) in the project**
P1	Depth of knowledge required (K3-K7)	The project requires knowledge of Electrical Circuits, Electronics (K3), Wireless Communication, Embedded System, Sensors and Instrumentations (K4), Designing and Simulation (K5), Engineering & IT (Circuit Design/Smartphone Application) Tools (K6), Involve Environmental Effects (K7), Scientific Research Papers (WK8).
P2	Range of conflicting requirements	In the prototype, the strength of the structure (mass) and capability of weightlifting (# of sensors) is directly related to the capacity of the motors.
P3	Depth of analysis required	No unique way to design. Depth of analysis needed to select a specific solution from many alternatives. (Static/mobile/drone. Various microcontrollers. Various sensors)

P4	Familiarity of issues	Various air quality sensors, Raspberry Pi/Arduino Mega/Nano/Uno/NodeMCU Microcontroller.
P5	Extent of applicable codes	There is no existing code or standard for this project.
P6	Extent of stakeholder involvement	There are several stakeholders needs to be involved including the owner of the device, installing places, Ministry of Environment, etc.
P7	Interdependence	Project involves a number of interdependent sub-systems such as microcontrollers, sensors, wireless communication system, circuit designing tools, mobile apps.

Table I demonstrates a complex engineering problem attribute.

P1: Depth of knowledge required (K3-K7):
The project requires web development knowledge including front-end (HTML, CSS, JavaScript) and back-end (PHP, MySQL) technologies (K3), knowledge of authentication protocols (K4), secure database and file handling (K5), use of development environments and testing tools (K6), understanding of user privacy and data protection policies (K7)

P2:Range of conflicting requirements:

The system must be user-friendly while also enforcing strict security. Increased security features (e.g., file size limits, OTP checks) can affect user experience and speed. There's also a trade-off between ease of access and protection against unauthorized access.

P3: Depth of analysis required:

The project required evaluating different methods for user verification, data storage, and form validation. Various design choices were considered for UI/UX, database structure, and OTP generation logic. Final choices were based on usability, security, and resource constraints.

P4: Familiarity of issues:
The implementation faced practical issues such as file validation, cross-browser compatibility, and securing user data. Server-side security (e.g., SQL injection prevention) and frontend usability had to be balanced.

P6: Extent of stakeholder involvement:

Stakeholders include voters (users), system administrators, government authorities (e.g., Election Commission), and security professionals. Each has different expectations regarding usability, security, and functionality

P7:Interdependence:

The system integrates several dependent components: front-end interface, backend server logic, database operations, OTP module, and file validation system. These modules must work together smoothly to ensure proper function and security.

4.2 Complex Engineering Activities (CEA)

The implementation of the E-Voting system required the integration of multiple technologies, collaboration among team members, and consideration of societal impacts. The following table outlines the key complex engineering activities addressed in this project:

TABLE III. A SAMPLE COMPLEX ENGINEERING PROBLEM ACTIVITIES TABLE

Attributes		Addressing the complex engineering activities (A) in the project
A1	Range of resources	This project involves human resource, money, modern tools (simulation software/mobile APP), hardware components, etc.
A2	Level of interactions	. Involves interactions between different stakeholders including group members to design the device, installing places, Ministry of Environment to collect data, etc

A3	Innovation	. Employs innovative skills of engineering by introducing technology in a different manner in the environment and IoT sector
A4	Consequences to society / Environment	Impact in our environment since it helps to monitors the air quality data and measure AQI
A5	Familiarity	Needs to be familiar with the various sensors, microcontrollers, wireless communication system, circuit designing tools, mobile apps. UN SDG #04: Quality education; UN SDG #10: Reduce inequality

A1:Range of resources :
The project utilizes a variety of resources, including skilled human effort in programming and UI design, web development tools (HTML, CSS, JS, PHP), database management systems (MySQL), hosting servers (XAMPP), and secure communication protocols.

A2:Level of interactions
The system requires coordination between frontend and backend developers, interactions with potential users for feedback, and possible future collaboration with government authorities or telecom service providers for SMS integration.

A3: Innovation:
This project applies common web technologies in an innovative manner by adapting them to simulate a secure digital voter registration system, providing a foundation for future actual voting mechanisms in a digital governance framework.

A4: Consequences to society / Environment:
The platform contributes to digital governance, increases accessibility to electoral services, and reduces the need for paper-based processes, promoting environmental sustainability. It supports the goals of transparency and civic engagement

A6: Familiarity:
Developers had to become proficient in user authentication methods, secure web architecture, data validation, and backend handling of sensitive information.

Chapter 5 Conclusions

5.1 Summary

This project developed a complete E-Voting website where users can register, verify their identity using an OTP, and cast their votes online. The system uses HTML, CSS, and JavaScript for the frontend, and PHP with MySQL for the backend. It provides a simple and secure way to handle voter registration, authentication, and voting, supporting the goal of digital transformation in elections. The website was tested locally and shows how voting can be done safely and conveniently using web technology.

5.2 Limitations

Although the system works as intended, it has some limitations. The OTP verification is simulated and does not send real SMS messages, which limits its use in actual elections. The security measures implemented are basic and do not include strong encryption or advanced authentication methods, which are important for protecting voter data and votes. The system was tested with a limited number of users and may face performance issues if used for large-scale elections. Additionally, there is no full-featured administrative panel for election officials to manage or monitor the voting process.

5.3 Future Improvement

To make the system more practical and secure for real-world use, several improvements can be made in the future. Integrating the OTP system with a real SMS service would allow actual delivery of verification codes to voters. Adding stronger security features such as encrypting votes and using multi-factor authentication would better protect voter information and the voting process. Improving the backend to support many simultaneous users and deploying the system on a reliable server or cloud platform would help handle large-scale elections. Developing a comprehensive administrative dashboard would allow election officials to effectively manage registrations, voting, and monitoring. Finally, making the website fully mobile-friendly would allow voters to participate easily from any device.