AUTOMATIC BRIDGE LIFTING SYSTEM USING IoT

Minor project-II report submitted
in partial fulfillment of the requirement for award of the degree of

Bachelor of Technology
in
Computer Science and Design

By

J. VENKATESWARAO (21UEDL0013) **(VTU19860)**
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Under the guidance of
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DEPARTMENT OF COMPUTER SCIENCE AND DESIGN
SCHOOL OF COMPUTING

VEL TECH RANGARAJAN DR. SAGUNTHALA R&D INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University Estd u/s 3 of UGC Act, 1956)
Accredited by NAAC with A++ Grade
CHENNAI 600 062, TAMILNADU, INDIA

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CERTIFICATE

It is certified that the work contained in the project report titled “AUTOMATIC BRIDGE LIFTING SYSTEM USING IoT” by “JADA. VENKATESWARAO (21UEDL0013), KUNAPANENI. GOPI CHAND (21UEDL0017), KAMATHAM. KASI REDDY (21UECE0029)” has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

<table>
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Computer Science & Engineering
School of Computing
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Institute of Science & Technology
May, 2024</td><td align="right">Signature of Professor In-charge
Computer Science and Design
School of Computing
Vel Tech Rangarajan Dr. Sagunthala R&D
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DECLARATION

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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APPROVAL SHEET

This project report entitled "AUTOMATIC BRIDGE LIFTING SYSTEM USING IoT" by K. KASI REDDY (21UEDL0029), K. GOPI CHAND (21UEDL0017), J. VENKATESWARAO (21UEDL0013) is approved for the degree of B.Tech in Computer Science and Design.

Examiners | **Supervisor**

Mr. R. ANTO PRAVIN, M.E.,

Date: / /

Place:

ACKNOWLEDGEMENT

We express our deepest gratitude to our respected **Founder Chancellor and President Col. Prof. Dr. R. RANGARAJAN B.E. (EEE), B.E. (MECH), M.S (AUTO),D.Sc., Foundress President Dr. R. SAGUNTHALA RANGARAJAN M.B.B.S.** Chairperson Managing Trustee and Vice President.

We are very much grateful to our beloved **Vice Chancellor Prof. S. SALIVAHANAN,** for providing us with an environment to complete our project successfully.

We record indebtedness to our **Professor & Dean, School of Computing, Dr. V. SRINIVASA RAO, M.Tech., Ph.D.,** for immense care and encouragement towards us throughout the course of this project.

We are thankful to our **Head, Department of Computer Science and Design, Dr. R. PARTHASARATHY, M.E., Ph.D.,** for providing immense support in all our endeavors.

We also take this opportunity to express a deep sense of gratitude to our **Internal Supervisor Supervisor Mr. R. ANTO PRAVIN, M.E.,** for his cordial support, valuable information and guidance, he helped us in completing this project through various stages.

A special thanks to our **Project Coordinator Mr. V. KARTHIKEYAN, M.E.,** for his valuable guidance and support throughout the course of the project.

We thank our department faculty, supporting staff and friends for their help and guidance to complete this project.

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ABSTRACT

The Automatic Bridge Lifting System is an innovative technology designed to provide effective protection against rain-included challenges or floods. This system employs automated mechanisms to deploy and manage bridges height in response to changing water conditions. By integrating sensors and actuators, the system detects the onset of rain and promptly initiates the deployment of protective measures, minimizing exposure of the bridge to flooded water for various objects or environments. Key features of the Automatic Bridge Lifting System include real-time water monitoring, intelligent decision-making algorithms and seamless automation. The deployment and retraction of bridge's height is excluded efficiently, ensuring timely and reliable protection. This system finds applications in diverse sectors, such as outdoors events, transportation and infrastructure enhancing overall resilience to adverse flood conditions. Applications of the Automatic Bridge Lifting System extend across sectors such as public transportation. By mitigating the impact of rain, this system contributes to the enhancement of operational continuity, user comfort and the overall resilience of outdoor environments in the face of unpredictable river water conditions. This project addresses the challenges faced by people in transportation, especially during heavy rainfalls. This is a very significant issue as the broken bridges during heavy rainfalls is immense and impacts the country's economy.

Keywords: Actuators, Retraction, Resilience, Sensors, Rain Detection, Transportation, Infrastructure, Bridge Height Management.

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ABLS	Automatic Bridge Lifting System
AI	Artificial Intelligence
DC	Direct Current
GSM	Global System for Mobile Communications
IDE	Integrated Development Environment
IoT	Internet of Things
IR	Infrared Radiation
LCD	Liquid Crystal Display
MEMS	Micro Electro Mechanical System
PLC	Programmable Logic Controller

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Chapter 1

INTRODUCTION

1.1 Introduction

A bridge is a construction made for carrying the road traffic or other moving loads in order to pass through an obstacle or constructions. The required passage may be for pedestrians a road, a railway, a canal, a pipeline etc. Bridges are important structures in modern highway and railway transportation systems and generally serving as lifelines in the social infrastructure systems. Design of bridges vary depending upon the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it and the funds available to build it. Most likely the earliest bridges were fallen trees and stepping stones, while Neolithic people built broad walk bridges across marsh land.

This groundbreaking device represents a solution to mitigate the impact of unpredictable and inclement weather conditions, particularly heavy rainfall. As the frequency and intensity of rainfall events continue to rise due to climate change, the need for effective rain protection systems becomes increasingly crucial. The Automatic Bridge Lifting System is designed to provide swift and efficient shelter during unexpected downpours, ensuring that individuals, outdoor events and valuable equipment remain protected from the adverse effects of rain. This innovative technology combines smart sensors, automation and durable materials to create a responsive and reliable solution that can be deployed in various settings. By integrating advanced technologies, this system enhances productivity, optimizes resource utilization and provides real-time monitoring, the bridge construction monitoring system is a complex system that combines many components from construction structural monitoring, meteorological monitoring and image monitoring to geographic monitoring. Monitoring plays an important role in the processes of construction, construction and operation. It allows hypothetical conditions to be set during design and can affect the construction cost of the project.

1.2 Aim of the Project

This project aims to provide an Automatic Bridge Lifting System based on Internet of Things to provide proactive and efficient protection for bridges, outdoor activities or structures in the face of changing weather conditions, specifically rainfall and floods. This system utilizes technology, such as rain sensors and automated mechanisms, to detect precipitation and deploy protective shelters without requiring manual intervention. Damaging bridges from excessive rainfall helps prevent water logging. The Automatic Bridge Lifting System reduces the need for manual monitoring and intervention. It automates the response to rainfall, ensuring a timely and proactive approach to weather changes. Protecting bridges from adverse weather conditions, such as heavy rain and floods.

1.3 Project Domain

The Internet of Things refers to the network of interconnected physical devices or "things" that communicate and exchange data with each other through the Internet. These devices can include everyday objects embedded with sensors, software and other technologies to collect and share information. The concept of Internet of Things extends the capabilities of the internet beyond traditional computing devices such as computers and smartphones, enabling a seamless integration of the physical and digital worlds. Internet of Things devices rely on various communication technologies such as Global System for Mobile Communication, Bluetooth, Zigbee and cellular networks to exchange data with other devices and systems. The integration of Internet of Things technologies in bridges, often referred to as "Smart Bridges" is revolutionizing traditional bridge construction practices. Internet of Things in bridge systems leverages connected devices, sensors and data analytics to optimize various aspects of water under bridges and smart bridge management. Internet of Things devices control bridge systems, adjusting bridge height and timing based on real-time data and water conditions. The mechanical operations are driven by hydraulic or electromechanical actuators, supported by robust locking mechanisms for stability. Integrated communication systems provide critical alerts and status updates to both vehicular traffic and maritime vessels, enhancing overall safety. The design incorporates environmental considerations, backup power solutions and regulatory compliance, aiming to reduce operational disruptions.

1.4 Scope of the Project

The scope of an automatic bridge system is significant, offering a range of benefits and applications in agriculture and other transportation. It provides a proper bridge for making proper transportation due to excess rain. A user interface can be created for sending messages to the nearby control room when the level of rainwater exceeds the minimum level. By optimizing the timing and extent of shelter deployment based on real-time water detection, the system contributes to water conservation in dams. It ensures that irrigation resources are used efficiently, reducing water waste. The system's reliance on automated mechanisms and possibly sustainable energy sources, such as solar power, contributes to energy efficiency. This is particularly important for ensuring the system's autonomy and minimizing environmental impact. Automating the rain protection process reduces the need for manual monitoring and intervention by people. This not only saves labor but also allows people to focus on other aspects of transportation management. The integration of the Automatic Bridge Lifting System with Internet of Things technologies and data analytics enables real-time monitoring and decision support. This connectivity provides passengers with valuable insights into weather patterns and the impact of water on bridge conditions.

Chapter 2

LITERATURE REVIEW

Sumitoro. S et al., (2011) [1] illustrated the structural development in bridge engineering along with efficiency have got much attention in few decades. Leading to the development, Optimization of structure established on mathematical analysis emerged mostly employed strategies for productive and sustainable design in the bridge engineering. Despite the widespread knowledge, there has yet to be a rigorous examination of recent structural optimization exploration development. Thus, the primary objectives of this paper are to critically review previous structural optimization research, provide a detailed examination of optimization goals and outline recent research field limitations and provide guidelines for future research proposal in the field of bridge engineering structural optimization.

Meng. X Li et al., (2006) [2] explained the system that uses Arduino, a servo motor and an ultrasonic sensor to automatically adjust the height of a bridge based on the water level. Quadrotor is designed to meet the requirements of bridge crack detection, which can meet the requirements of flight power, flight control, flight safety, and signal stability, The servo motor is responsible for physically adjusting the height of the bridge. It receives commands from the Arduino based on the water level detected by the ultrasonic sensor and moves the bridge components up or down as needed.

Roberts G.W et al., (2011) [3] illustrated the development of an automatic water level controller using an Arduino board and a moisture sensor to detect the water level, the moisture sensor, the Arduino board activates mechanisms to control the water level. This could involve turning pumps on or off to add or remove water from a reservoir or tank, maintaining the water level within a specified range.

Zhou. J.T et al., (2017) [4] explained a servo motor control system that uses an Arduino board to control the movement of the servo motor. When the motor is overloaded or even stalled, the maximum value of the motor current can be limited to protect the safety of the motor and the controller. The speed loop gives the system better anti-load disturbance performance. The servo motor is the actuator in the system responsible for converting electrical signals from the Arduino into mechanical motion. Servo motors are commonly used in applications requiring precise control of position and speed.

Xin. J et al., (2018) [5] described the water level monitoring and control system that uses an Arduino board and a GSM module to send alerts to the user when the water level exceeds a certain threshold is proposed. The Arduino board serves as the central processing unit for the system. It collects data from the water level sensor and coordinates the control of other components based on predefined conditions. The GSM module enables communication between the water level monitoring system and the users mobile phone.

Palazzo. D et al., (2006) [6] illustrated the whole process is fully based upon Interlocking. The main modules of this project "Automated Rotating Bridge using PLC" are Reed switch, Motor and Limit switch. Initially, the Bridge is in contact with the Road. A system based on Automation using SIEMENS's PLC S7 300 model is designed. The entire process is based on an interlocking mechanism. Interlocking ensures that specific actions or operations can only be performed under certain conditions or in a particular sequence, enhancing safety and preventing accidents.

Zhao. X et al., (2015) [7] described an automated bridge is designed with the help of a Programmable Logic Controller based control system. The intelligence of the system is improved by the use of PLC. The system will start using a start switch then IR Sensors are used to detect the ship. According to the sensor output, PLC will control the servo motor. The intelligence and control of the bridge system are facilitated by a Programmable Logic Controller. PLCs are widely used in industrial automation for their reliability and programmability. In this project, the PLC is responsible for processing input signals, executing control logic and coordinating the operation of various components.

Jenkins. C.H et al., (1997) [8] explained the Wireless sensor-actuator network (WSAN) comprises of a group of distributed sensors and actuators that communicate through wireless links. Sensors are small and static devices with limited power, computation and communication capabilities responsible for observing the physical world. On the other hand, actuators are equipped with richer resources, able to move and perform appropriate actions. Sensors and actuators cooperate with each other. While sensors perform sensing, actuators make decisions and react to the environment with the right actions.

Bedon. C et al., (2018) [9] explained an deals with the realization of the four-pair terminal definition of impedance standards. A simple though reliable system is described that allows an automatic compensation of the voltage at the low potential port of impedance standards to be obtained. Such a system, which employs a commercial board and an arbitrary signal generator, is controlled through a standard PC that implements the demodulation and the control algorithms.

Lahdensivu. J et al., (2018) [10] described the GeoSHM-based project is developed. The GeoSHM sensor module comprises a range of different sensors to monitor not only the structural responses of the bridge displacement, acceleration, inclination and stresses, but also external loads that are applied on the bridge and the short-term and long-term environmental effects. In addition to structural responses, the GeoSHM module measures external loads applied to the bridge.

Meng. X et al., (2018) [11] illustrated the major challenge is to ensure that the condition of the civil infrastructure is capable of withstanding the cumulative weight of all the vehicles that travel on the bridge. In this framework, the Bluetooth protocol is used for monitoring the bridge damages that exist and these damages are identified by using various types of sensors namely fog sensor, water level sensor.

Chapter 3

PROJECT DESCRIPTION

The Automatic Bridge Lifting System is an innovative solution designed to provide efficient protection against sudden rainfall and floods. Incorporating advanced water level sensing technology, the system can accurately detect the onset of water levels in real-time. Upon detection, a motorized mechanism swiftly deploys a durable, waterproof covering over the designated area, ensuring that people, equipment or materials are shielded from adverse weather conditions.

3.1 Existing System

The existing system in the context of an Automatic Bridge Lifting System refers to the conventional infrastructure and operational processes currently in place for managing and maintaining bridges. Typically, this encompasses traditional bridge designs, manual toll collection methods and periodic inspections carried out by human operators. Traffic management on the bridge is often governed by conventional protocols and maintenance procedures involve human intervention in response to varying conditions. Understanding the intricacies of this existing system is fundamental as it forms the basis for evaluating the potential benefits and necessity of transitioning to an automated bridge system. The evaluation of the existing system extends to the user experience, considering the challenges and inconveniences faced by individuals and businesses relying on the current bridge infrastructure. This analysis helps identify areas where automation could bring about improvements in terms of efficiency, safety and overall user satisfaction. Moreover, assessing the regulatory and compliance framework governing bridge operations is crucial for ensuring that any proposed automated solution aligns with legal standards and regulatory requirements. This understanding provides the context for proposing changes that not only enhance technological capabilities but also comply with established norms.

3.2 Proposed System

In this project, a Micro Electro Mechanical System sensor is used to detect cracks. MEMS sensor works by measuring the angle, so even if a small crack occurs there will be a change in angle. Even if there is a slight change in the angle it will indicate us the next second which will be quicker and better. The vibration sensor senses any vibration in the bridge. Normally all kinds of accidents cause some vibration. So, vibration sensor monitors the occurrence of vibration. Light Dependent Resistor sensor is used to monitor the bridge lights. Here temperature sensor is also used to monitor the heat in the bridge, as an increase in heat of cables in the bridge can lead to fire accidents and a fire sensor is used to detect fire.

3.3 Feasibility Study

A feasibility study in the context of an Automatic Bridge Lifting System involves assessing the practicality and viability of implementing such a system. This study is typically conducted before the actual development and deployment of the automatic bridge system. The purpose is to determine whether the proposed system is technically, economically and operationally feasible.

3.3.1 Economic Feasibility

Economic Feasibility in an Automatic Bridge Lifting System is a critical aspect that involves a comprehensive assessment of the financial viability of implementing and maintaining such a system. The initial investment, encompassing the costs of hardware, software, sensors and infrastructure, is a primary consideration. Ongoing operational costs, including maintenance, monitoring and potential upgrades, must be evaluated to understand the financial implications over the system's lifespan. These factors collectively contribute to the determination of the project's economic feasibility, ensuring that the benefits derived from improved traffic flow, enhanced safety and potential cost savings outweigh the incurred expenses. Return on Investment serves as a key metric in this assessment, comparing the total benefits accrued from the automatic bridge system to the overall costs. Additionally, a thorough risk analysis is essential, examining potential technological, regulatory and external factors that may impact the project's financial success.

3.3.2 Technical Feasibility

Technical Feasibility in an Automatic Bridge Lifting System is a critical aspect that involves assessing the viability and practicality of the proposed technology. The evaluation begins with an analysis of the necessary technological components, including sensors, control systems and communication infrastructure. It is crucial to determine whether the identified technologies are readily available, proven and can be effectively integrated to meet the specific requirements of the automatic bridge system. The system's design and development complexity must be considered, ensuring that the proposed technological solutions align with the project's objectives and can be implemented within practical constraints. In conclusion, technical feasibility in an automatic bridge system encompasses a comprehensive evaluation of the technological aspects, from initial design and development to integration, performance, scalability and regulatory compliance. This thorough assessment is fundamental in determining whether the proposed technology can be successfully implemented and sustained to meet the intended objectives of the Automatic Bridge Lifting System.

3.3.3 Social Feasibility

Social Feasibility in the implementation in an Automatic Bridge Lifting System is a multifaceted evaluation that considers the system's acceptance and impact within the community. First and foremost, community acceptance plays a pivotal role in the success of the project. Understanding and addressing public concerns, engaging with stakeholders and incorporating feedback from the community are essential steps. Open communication channels and a transparent approach help build trust and ensure that the automatic bridge system is embraced by the people it serves. User experience and accessibility are critical components of social feasibility. The system should be designed to be user-friendly and accessible to all members of the community, including those with disabilities and diverse demographic groups. Ensuring inclusivity in design contributes to a positive social impact and enhances the overall acceptability of the Automatic Bridge Lifting System.

3.4 System Specification

3.4.1 Hardware Specification

- Ultrasonic sensor-LM393
- LCD-16x2
- Arduino Uno-ATmega328p
- Servo motor-SG90

3.4.2 Software Specification

Arduino software IDE - The Arduino Software Integrated Development Environment makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board. There are currently two versions of the Arduino IDE.

3.4.3 Standards and Policies

The Arduino Integrated Development Environment connects to the Arduino boards to upload programs and communicate with them. Programs written using Arduino Software Integrated Development Environment are called sketches. These sketches are written in the text editor and are saved with the file extension .ino.The Arduino supports the languages C and C++ using special rules of code structuring. Standard Used: ATmega328p.

Chapter 4

METHODOLOGY

For measuring different parameters different sensors are being used such as the soil moisture sensor to measure the level of the river water, load cell to measure the load on the bridge, ultrasonic sensor to measure the scour depth and pressure sensor to measure the pressure of the river water on the pier of the bridge.

4.1 General Architecture

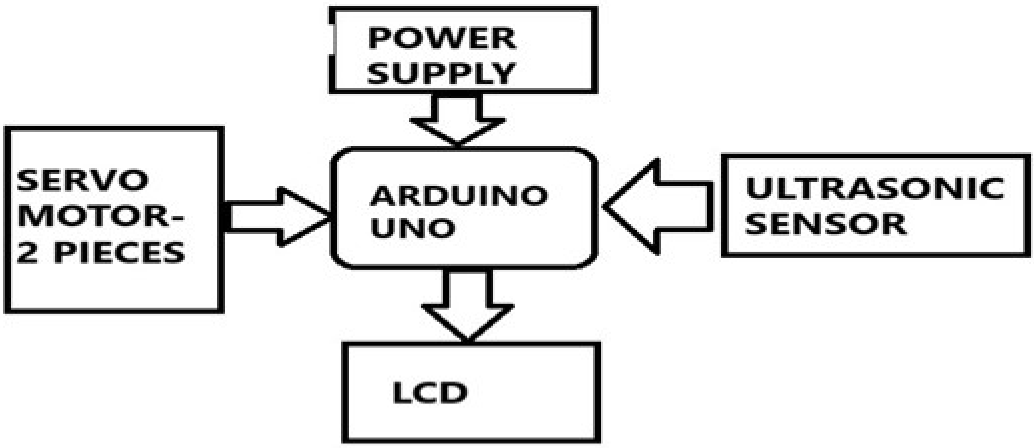

Figure 4.1: **Architecture Diagram**

Figure 4.1 shows the architecture diagram for the proposed system, this system utilizes a combination of sensors, real-time data processing and automation algorithms to monitor, control and optimize various aspects of bridge management. The ultrasonic sensor detects the distance between the water and the bridge and if it is near to it the Arduino gives the signal to the motor to lift the bridge.

4.2 Design Phase

4.2.1 Data Flow Diagram

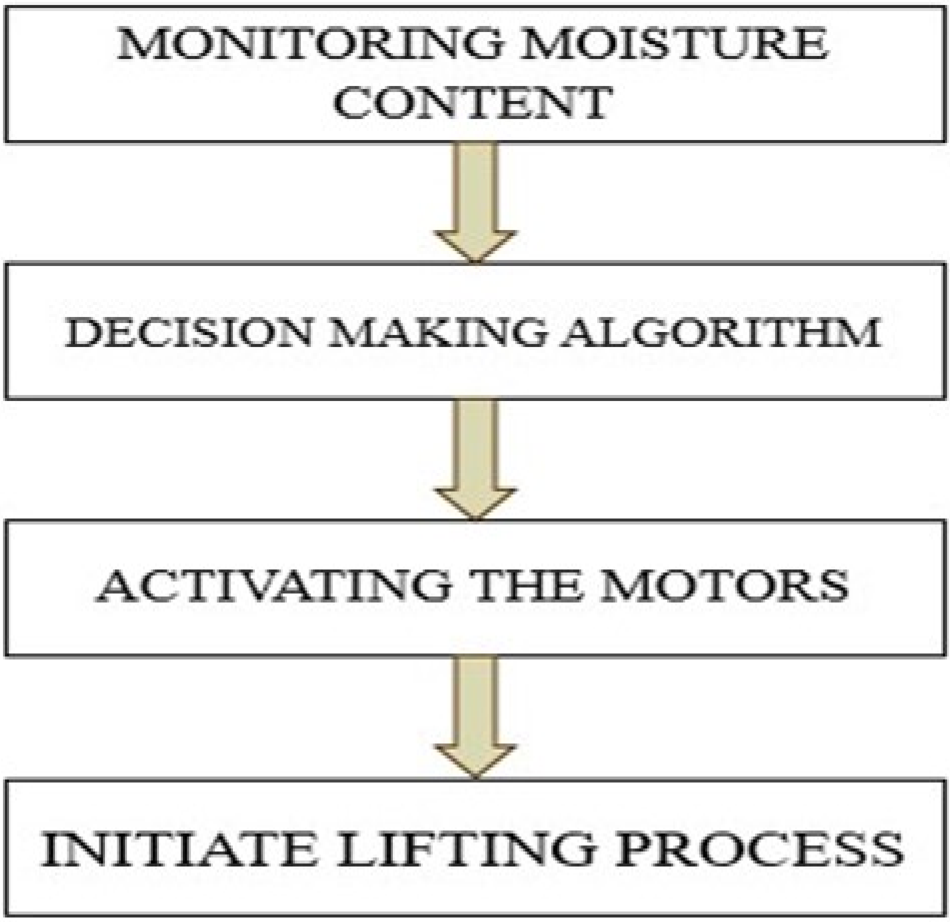

Figure 4.2: **Data Flow Diagram**

Figure 4.2 shows the data flow diagram, the data flow is divided into mainly four phases. The first step is monitoring the water levels which is done by the Ultrasonic sensor. Then the decision-making algorithm comes into play which is done by Arduino UNO, which activates the servo motors and controls all the other components of the system. If the distance between the bridge and the water is beyond the safe limit then the motors get activated and initiate the lifting process. This data flow architecture ensures that the automatic bridge lifting system can operate efficiently, make informed decisions.

4.2.2 Use Case Diagram

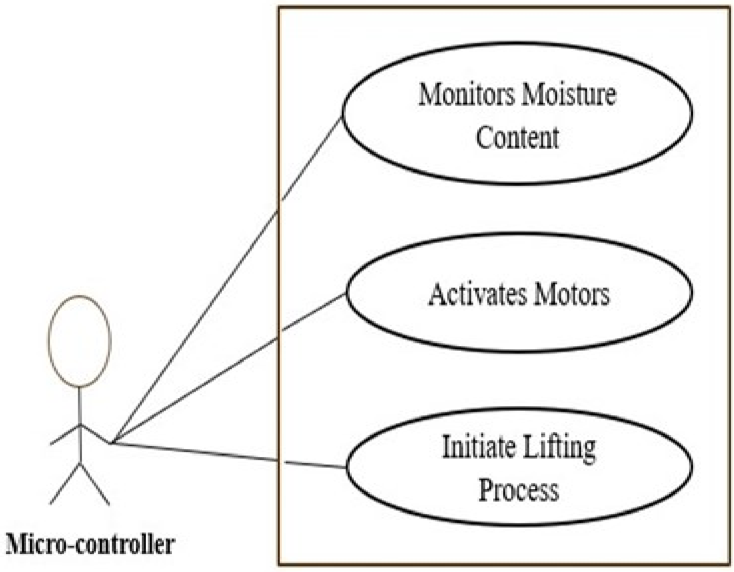

Figure 4.3: **Use Case Diagram**

Figure 4.3 shows the use case diagram, the Arduino Uno serves as the system's brain, gathering water levels from the sensor and initiating the lifting process. The motors are utilized for the lifting process. The Central Control System automatically opens or closes the bridge based on sensor data and control algorithms. An overview of the main functions of the automatic bridge system and the interactions between the actors is shown in this use case diagram. It aids in comprehending how various parts and users work together to accomplish particular objectives within the system.

4.2.3 Class Diagram

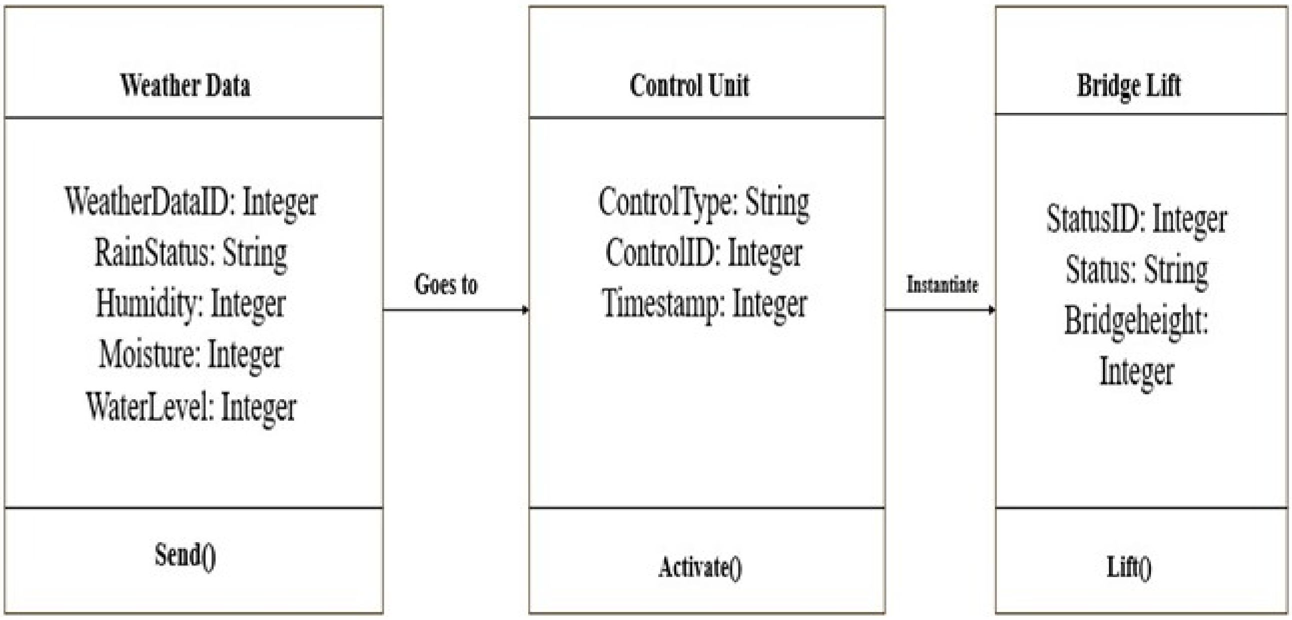

Figure 4.4: **Class Diagram**

Figure 4.4 shows the class diagram that represents the proposed system. Bridge Lift represents the main class for the Automatic Bridge Lifting System. It contains instances of Weather Data and Control Unit as attributes. Control Unit represents the control system of the bridge, which includes a decision algorithm for making decisions based on sensor data and mechanisms for controlling the bridge. This class diagram provides a conceptual representation of the key classes and their relationships within the automatic bridge lifting system.

4.2.4 Sequence Diagram

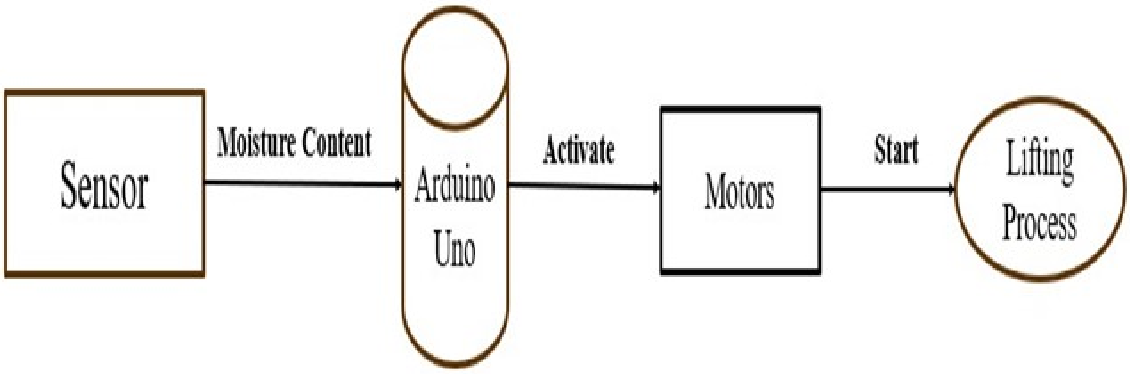

Figure 4.5: **Sequence Diagram**

Figure 4.5 shows the sequence diagram of the Automatic Bridge Lifting System is depicted. The sensor measures the water distance, transmits instructions to the Arduino UNO and activates the motors for lifting the bridge. The Sensor System measures weather parameters like temperature and humidity to consider environmental factors. The Central Control System's Decision Algorithm processes the data received from the sensors and other sources. This sequence diagram provides an overview of the interactions and message flows between the Bridge Operator, Central Control System and Sensor System during the process of opening and closing the bridge.

4.2.5 Activity Diagram

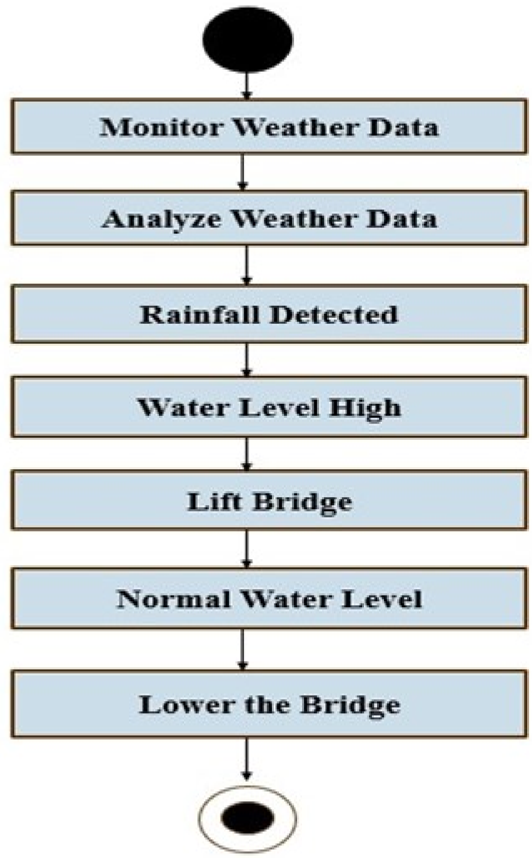

Figure 4.6: **Activity Diagram**

Figure 4.7 shows the operation of the Bridge Lifting System is shown. Here the weather data is monitored and analyzed and if raining then the bridge is lifted based on water distance. The system initializes key components, such as the sensor and motors, indicating the preparation for monitoring and responding to weather conditions. The primary activity in the system is a loop that continuously monitors the weather conditions. This loop represents the ongoing and repetitive nature of the system's operation. This activity diagram provides a visual representation of the sequential activities involved in the automatic bridge system. Each activity is represented as a rectangle and arrows indicate the flow of control between activities.

4.3 Algorithm & Pseudo Code

4.3.1 Algorithm

Step 1: An ultrasonic sensor in an automatic bridge system can be used to optimize the deployment of the bridge based on the current water height conditions.
Step 2: The Liquid Crystal Display, displays continuous readings of the distance content. The Liquid Crystal Display serves as a user interface for interacting with the bridge system.
Step 3: When the level of water content under the bridge is above the safe level then it gives signals to Arduino UNO that high water levels are detected.
Step 4: The Servo motor then starts the uplifting process and retracts when the moisture content gets back to normal.
Step 5: A user interface using the Global System for Mobile Communication module is created so that an alert message can be sent to the user to take necessary precautions.

4.3.2 Pseudo Code

```
Initialize bridgeSensor Initialize bridgeControl
function detectwater ( ) : waterIntensity = waterSensor . measureWaterIntensity ( )
  if waterIntensity > threshold :
deployuplift ( )
function deployuplift ( ) : upliftControl . extenduplift ( )
function retractuplift ( ) : upliftControl . retractuplift ( )
function mainLoop ( ) :
  loop indefinitely :
  if waterSensor . iswaterDetected ( ) :
detectwater ( )
else :
retractwater ( )
mainLoop ( )
```

4.4 Module Description

4.4.1 Data Acquisition Module

Arduino to create interactive objects, reading data from a great variety of switches and sensors and control different kind of lights, motors and other types of physical actuators. Arduino projects can be autonomous or they can communicate with other software running on a computer. The Arduino based controllers, though seems a perfect choice for the application, it has a lot of stability issues. Especially the Arduino codes run into infinite loops and this is hazardous for an autonomous system that operates offshore. Under such situations, the device should be rebooted manually. But since it takes a lot of human effort to reach the buoy, it is almost impossible for frequent manual rebooting.

4.4.2 Processing Module

The processing model for an automatic bridge lifting system involves a sophisticated integration of various components, including sensors, controllers, actuators and communication networks, all working in tandem to ensure seamless and safe operation. Central to this model are Programmable Logic Controllers and Supervisory Control and Data Acquisition systems, which provide real-time control and monitoring capabilities. The process begins with sensors detecting an approaching vessel and transmitting this data to the Programmable Logic Controller.

4.4.3 Output Module

This module interfaces with various actuators, including hydraulic pumps, motors and mechanical gears, which are responsible for the actual lifting and lowering of the bridge. When the Programmable Logic Controller processes input data from sensors and determines that the bridge needs to be lifted, it sends electrical signals to the output module. The output module then activates the appropriate actuators, initiating the lifting sequence. It also controls auxiliary systems such as traffic signals, barriers and alarms to ensure that both vehicular and maritime traffic are safely managed during the operation. The output module's design emphasizes reliability and responsiveness, incorporating redundancy to handle failures and ensure continuous operation. Further more, it is integrated with feedback loops, receiving real-time data from position sensors on the bridge structure to adjust actuator movements precisely, ensuring smooth and synchronized lifting and lowering actions.

4.5 Steps to execute/run/implement the Project

4.5.1 Planning and Acquisition

System Design:
Develop detailed engineering designs incorporating the mechanical, electrical and control systems needed for the bridge lifting mechanism.
Risk Assessment and Mitigation:
Identify potential risks, including mechanical failures, power outages, and environmental hazards. Develop mitigation strategies, such as redundancy in critical components, backup power supplies and robust emergency protocols.
Sensors play a critical role in the acquisition process by continuously monitoring key parameters such as bridge position, wind speed and direction, water levels and vessel traffic. These sensors may include proximity sensors, encoders, anemometers, water level sensors and radar systems among others.

4.5.2 Implementation

4.5.3 Tests and Improvements

Integration Testing:
Integrate all components and conduct thorough testing to ensure proper functionality. Simulate different scenarios to validate the effectiveness of the interlocking system.
Deployment:
Install the intelligent interlocking system at a test railway section. Monitor and fine-tune the system in real-world conditions.
Training and Documentation:
Provide training to operators and maintenance personnel. Document the system architecture, protocols and troubleshooting procedures.
Continuous Improvement:
Gather feedback from users and make necessary improvements. Stay updated with advancements in technology for potential enhancements.

Chapter 5

IMPLEMENTATION AND TESTING

5.1 Input and Output

5.1.1 Input Design

Figure 5.1: **Input Design**

The primary input for the proposed system is the data related to rainfall. The motion sensor is connected to a Microcontroller that will process the sensor data and make decisions. The specifications provided in the sensor datasheet are followed for proper wiring, including power supply, ground and signal connections. A stable power supply is provided to the soil moisture sensor and the Microcontroller. The voltage levels are ensured to meet the requirements of both components. The stability and resilience of the sensor's connection to the Microcontroller were examined under different environmental factors such as temperature fluctuations and humidity levels. Special attention was given to mitigating potential signal interference or data loss issues that could arise during operation.

5.1.2 Output Design

Figure 5.2: **Output Design**

The output of an Automatic Bridge Lifting System involves the actions and responses initiated by the system based on the input data received from the motion sensor. The primary output of the system is the automatic lifting of the bridge when the water is at a distance near the bridge. This action is intended to protect structures or areas from the impact of heavy rainfall. Once the rainfall intensity decreases or stops, the system triggers the retraction of the bridge to allow normal conditions. The bridge's current state is shown on the Liquid Crystal Display. This makes it easier for stakeholders and users to determine if the system is under maintenance, inactive or operational.

5.2 Testing

5.3 Types of Testing

5.3.1 Unit Testing

Unit Testing refers to the practice of testing individual components or units of hardware in isolation to ensure that they function as intended. Units can refer to various components such as integrated circuits, sensors, actuators, controllers, or other hardware modules.

Input

```
#include HX711 .h”
HX711 scale;
void setup() {
 Serial.begin(9600);
 scale.begin(5,6);
}
void loop() {
 testLoadCellAndHX711();
}
void testLoadCellAndHX711() {
 Serial.println( Running Load Cell and HX711 Test”);
 // Apply known weights and check readings
 int knownweight1 = 100;
 int knownweight2 = 200;
 scale.tare(); // Ensure the scale is zeroed
 // Test with the first known weight
 int reading1 = scale.getUnits();
 Serial.print( Reading 1: ”);
 Serial.println(reading1);
 delay(1000);
}
```

Test result

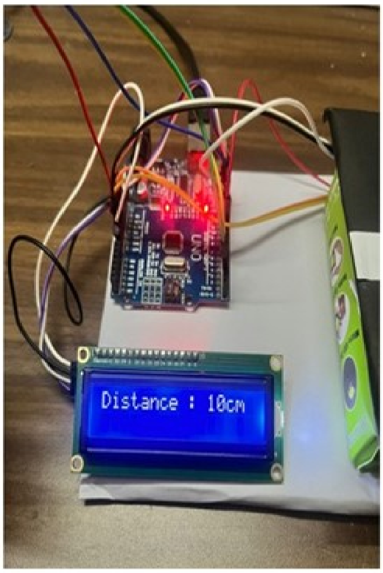

Figure 5.3: **Test Result**

Figure 5.3 shows the inclinometer is mainly used to monitor the lateral inclination of the structure and the measurement direction is divided into one direction and two directions. Owing to the long-term exposure of the pier foundation, the focus of the monitoring is on whether the bridge has a certain degree of inclination and thus a change in bearing capacity.

5.3.2 Integration Testing

Input

```
#include<Servo.h> Servo myservo; const int trigPin =3; const int echoPin =5; long
    tmeduration; int distance; void setup() { myservo.attach(9); pinMode( trigPin ,OUTPUT
    ); pinMode( echoPin , INPUT);
Serial.begin(9600);
}
void loop() { digitalWrite( trigPin ,LOW); delayMicroseconds(2); digitalWr
    ite( trigPin ,HIGH); delayMicroseconds(10); digitalWrite( trigPin ,LOW);
tmeduration= pulseIn( echoPin, HIGH); distance =(0.034* tmeduration) / 2;
if( distance <=10){
myservo.write(90);
} else {
myservo.write(0);}
Serial.print( distance : ); Serial.println( distance ); delay
    (1);
}
```

Test result

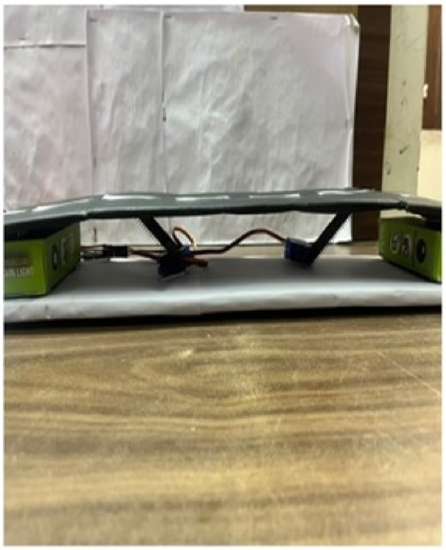

Figure 5.4: **Integration Testing**

Figure 5.4 shows the Automatic Bridge Lifting System demonstrated seamless iteraction and compatibility among its components, ensuring the system unified functionality. Sensors and actuators succesfully communicated, enabling precise bridge movements in response to vessel presence without delay. Control algorithms integrated effectively with sensors and actuators, orchestrating smooth coordination of operation.

5.3.3 System Testing

Input

```
import unittest
from xray_model import load_data, preprocess_data, create_model, train_model,
evaluate_model

class TestSystem(unittest.TestCase):
    def setUp(self):
        # Load data
        self.data = load_data()

    def test_system(self):
        # Test end-to-end system functionality
        preprocessed_data = preprocess_data(self.data)
        model = create_model()
        trained_model = train_model(model, preprocessed_data)
```

```
        evaluation_results = evaluate_model(trained_model, test_data)
        # Add assertions to validate evaluation results

if __name__ == '__main__':
    unittest.main()
```

5.3.4 Test Result

Figure 5.5: **Test Image**

Figure 5.5 shows clearly that weather the track can be used by other trains or any other train is being in rest position on the particular track. If the track is free to use then the led Indicates green else red. The emphasis is placed on verifying the reliability and robustness of the track occupancy detection and LED signaling system. Any inconsistencies in the detection of track occupancy or LED signaling are identified and addressed promptly to ensure the system's effectiveness in enhancing railway safety and efficiency.

Chapter 6

RESULTS AND DISCUSSIONS

6.1 Efficiency of the Proposed System

The proposed Automatic Bridge Lifting System exhibits remarkable efficiency through its integration of advanced technologies. Real-time monitoring capabilities, enabled by sophisticated sensors, ensure immediate detection of structural anomalies, allowing for proactive intervention and minimizing the risk of major failures. Artificial intelligence and machine learning algorithms enhance efficiency by accurately predicting maintenance needs, optimizing resource allocation and extending the operational life of bridges. Autonomous inspection and repair mechanisms further contribute to efficiency by reducing reliance on manual labor, enabling more frequent and thorough assessments and expediting issue resolution. The system's emphasis on connectivity, utilizing 5G and the Internet of Things, enhances communication and decision-making processes, facilitating swift responses to emerging issues. Overall, the proposed system's efficiency extends to cost-effectiveness, as it reduces unexpected repair frequencies, optimizes maintenance schedules and minimizes operational disruptions. Through these multifaceted efficiency improvements, the automatic bridge system promises a resilient, sustainable and economically viable approach to bridge infrastructure management. The proposed Automatic Bridge Lifting System demonstrates efficiency gains across multiple dimensions, encompassing real-time monitoring, predictive maintenance, autonomous inspection and repair, improved communication and cost-effectiveness. These efficiency improvements collectively contribute to a more resilient, sustainable and economically viable bridge infrastructure.

6.2 Comparison of Existing and Proposed System

Existing system:

The River Bridge control deals with automatic control of the process, opening and closing of the bridge with the help of Arduino Nano. The arrival of the ship is detected by the IR sensor-1 placed at the front side of the bridge. The buzzer will sound and the DC motor will open the bridge and the tollgate is closed with the help of a servo motor, then vehicles are not allowed to go on the bridge. The ship crosses the river and it is detected by the IR sensor-2 placed at the back side of the bridge. DC motor is used to close the bridge and the tollgate is opened with the help of servo motor, then the vehicles are allowed to go. The main components used in this system are Arduino Nano, Direct Current motor, Servo motor and IR sensor.

Proposed system:

Automatic Bridge Lifting System, this system aims to provide a safe, efficient and cost-effective solution for preventing accidents on the bridge. It aims to deliver a proper Bridge System. A movable bridge is created in this system. The Internet of Things integrated with the sensors presents the solution for an effective bridge. This system can be upgraded in the future according to our needs. The monitoring module is initiated to continuously observe the status of various components in the bridge lift system. The control system which is the Arduino activates the automated lifting mechanism to raise the bridge. The system ensures that all safety protocols are followed, such as securing the bridge during lifting to prevent accidents. The bridge is lifted to a predetermined height to avoid adverse conditions such as flooding. If necessary, the system waits for improved conditions before lowering the bridge. When it's safe to do so, the system lowers the bridge to its normal position.

6.3 Sample Code

```
\\
# include<Servo . h> Servo myservo ; const int trigPin =3; const int echoPin =5; long
    tmeduration ; int distance ;
void setup ( ) { myservo . attach (9) ; pinMode ( trigPin ,OUTPUT) ; pinMode ( echoPin , INPUT) ;
Serial . begin (9600) ;
}
void loop ( ) { digitalWrite ( trigPin ,LOW) ; delayMicroseconds (2) ; digitalWr
    ite ( trigPin ,HIGH) ; delayMicroseconds (10) ; digitalWrite ( trigPin ,LOW) ;
tmeduration= pulseIn ( echoPin ,HIGH) ; distance =(0.034* tmeduration ) / 2 ;
if ( distance <=10){
myservo . write (90) ;
} else {
myservo . write (0) ;}
Serial.print(  distance :  ) ; Serial.println ( distance ) ;
```

```
delay (1) ;
}
1
2
3
4
5
6
7
8
9
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37
38
39
40
```

Output

Figure 6.1: **Water Flow Detection**

Figure 6.1 depicts the motion sensor output, which displays the water flow distance on the Liquid Crystal Display. The motion sensor is responsible for monitoring the water distance continuously. In the proposed system this sensor is deployed so that it measures the water distance from the bridge. They emit ultrasonic waves and measure the time it takes for the waves to reflect off an object and return. This information helps determine the distance between the bridge and the water.

Figure 6.2: **Bridge Lift**

Figure 6.2 shows the bridge lifting and the main output of the Bridge System is displayed. The automatic bridge lifting system initiates the process in response to detected adverse conditions or other triggering events. The bridge is lifted to a predetermined height to avoid adverse conditions such as flooding. If necessary, the system waits for improved conditions before lowering the bridge. When it’s safe to do so, the system lowers the bridge to its normal position.

Chapter 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 Conclusion

In conclusion, the literature on Automatic Bridge Lifting Systems underscores the transformative potential of integrating advanced technologies into bridge engineering. The shift towards automation addresses inherent limitations in traditional inspection methods, emphasizing a commitment to enhancing safety, efficiency, and sustainability. Automation in bridge maintenance and repair, featuring robotic technologies, autonomous vehicles, and drones marks a paradigm shift in infrastructure management. These technologies not only streamline inspection processes but also contribute to cost-effectiveness, reducing downtime and extending the operational life of bridges. The literature illuminates successful global implementations, showcasing tangible safety improvements, decreased maintenance expenditures and increased overall infrastructure resilience. Looking ahead the literature review identifies ongoing challenges and research directions. Future endeavors include refining cybersecurity measures, addressing public acceptance concerns and optimizing cost-effectiveness. As a comprehensive overview, the literature positions automatic bridge systems as a pioneering force shaping the future of bridge engineering, with the potential to revolutionize industry standards and cultivate a more resilient and sustainable infrastructure.

7.2 Future Enhancements

Artificial Intelligence and Machine Learning algorithms are expected to play an increasingly integral role in data analytics, offering enhanced predictive capabilities and aiding in the early identification of potential structural issues. This evolution will contribute to more proactive decision-making and resource allocation, ultimately optimizing bridge maintenance practices. Additionally, the seamless integration of automation with robotics and drones is likely to become more prevalent, allowing for not only routine inspections but also autonomous repair and maintenance operations, minimizing human intervention and downtime. Future enhancements in the realm of Automatic Bridge Lifting Systems are poised to usher in a new era of innovation, further refining safety, efficiency and sustainability. Advancements in sensor technologies are anticipated to lead to more sophisticated Structural Health Monitoring systems, providing even finer-grained insights into bridge conditions. Integration of emerging technologies, such as distributed sensor networks and advanced materials with self-sensing capabilities, holds the potential to enhance real-time monitoring and enable more precise predictive maintenance strategies. Future enhancements will also focus on improving communication and connectivity solutions, ensuring robust and secure data exchange between bridge systems and control centers. The implementation of 5G technology and the continued development of the Internet of Things will foster a more interconnected and responsive infrastructure network. Addressing challenges such as cybersecurity, public acceptance, and regulatory frameworks will be paramount to the successful adoption and scaling of automatic bridge systems. Overall, the future promises a convergence of cutting-edge technologies, propelling automatic bridge systems to new heights and reshaping the landscape of bridge engineering.

Chapter 8

PLAGIARISM REPORT

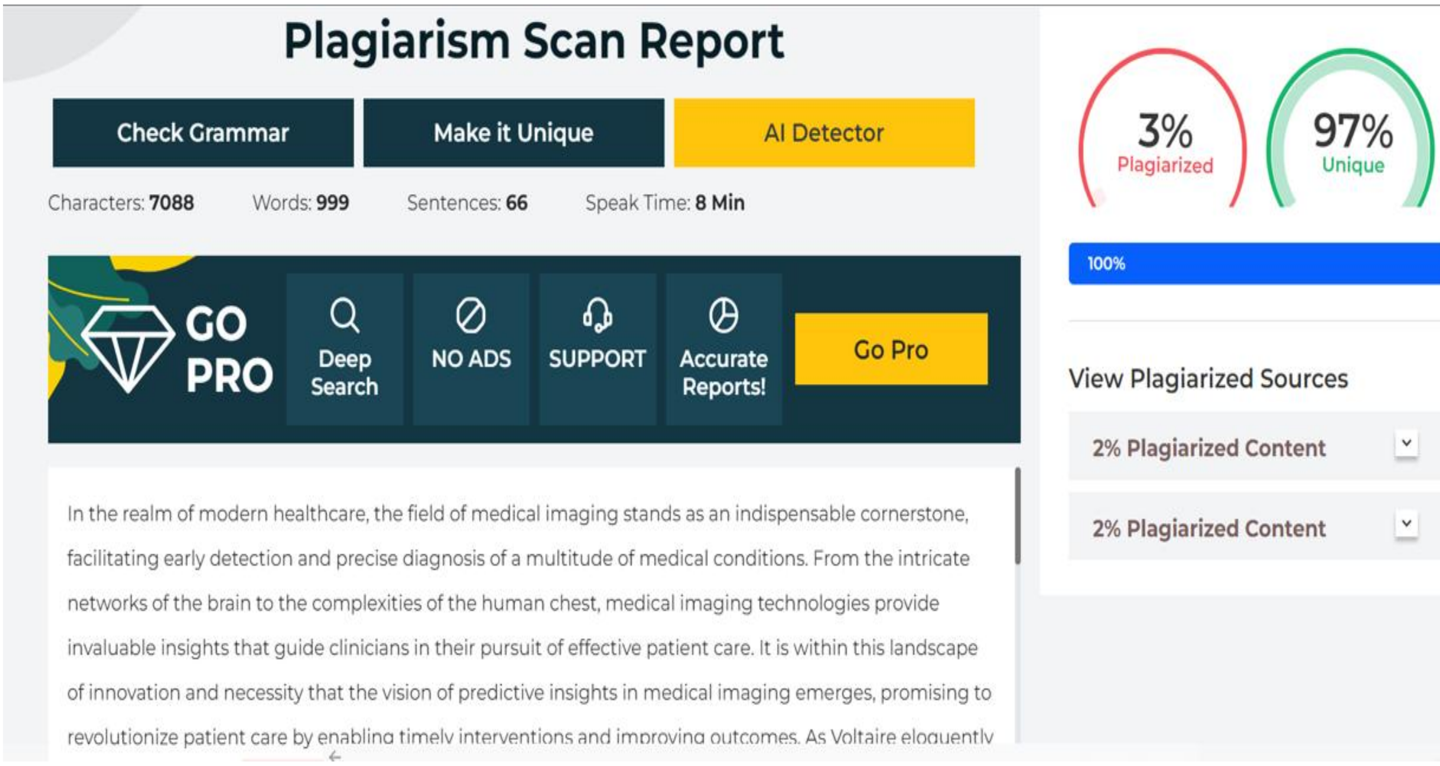

Figure 8.1: **Plagiarism Report**

Chapter 9

SOURCE CODE & POSTER PRESENTATION

9.1 Source Code

```
#include <Servo.h>
#include<LiquidCrystal.h>
Servo myservo1; // create servo object to control a servo
// RS,E,D4,D5,D6,D7
LiquidCrystal lcd (12 ,11 ,2 ,3 ,4 ,5); unsigned char j =0; int x1 , y1 , z1 , fswstate , wstate
    =0; int bzs =0;
int potpin = 0; // analog pin used to connect the potentiometer
int val; // variable to read the value from the analog pin
const int bzr =13;
const int senin =7;
const int senout =8;
unsigned char x=0;
int state = LOW; // the current state of the output pin
int reading , reading1; // the current reading from the input pin
//int reading1;
int previous = HIGH; // the previous reading from the input pin
long time = 0; // the last time the output pin was toggled
long debounce = 200; // the debounce time , increase if the output flickers
void setup () { myservo1.attach (9); //pinMode ( bzr ,OUTPUT); pinMode ( senin , INPUT);
    pinMode ( senout , INPUT); digitalWrite ( senin , 1 ); digitalWrite (
    senout , 1 ); digitalWrite ( bzr , 0 );
lcd.begin (16 ,2); delay (100); lcd.clear (); a
lcd.setCursor (0 ,0);
lcd.print ( RAIN CROP );
lcd.setCursor (0 ,1);
lcd.print ( PROTECTION );
delay (2000);
}
void loop () {
  reading = digitalRead ( senin );
  if ( reading == LOW ) {
lcd.clear (); lcd.setCursor (0 ,0); lcd.print ( RAIN IS COMMING );
lcd.setCursor (0 ,1); lcd.print ( ................ ); delay (100);
//digitalWrite ( bzr , 1 ); myservo1.write (100); delay (3000); while (
    digitalRead ( senin ) == 0){}
```

```
    //digitalWrite(bzr ,0);
} reading1  = digitalRead ( senin ) ;
    if ( reading1  ==HIGH ) {
lcd . clear () ; lcd . setCursor (0 ,0) ;
    lcd . print (  NO   RAIN      ) ;
lcd . setCursor (0 ,1) ; lcd . print (   . . . . . . . . . . . . . . . .    ) ; delay (100) ;
      myservo1 . write (0) ;
//digitalWrite(bzr , 1 ) ; delay (3000) ;
//digitalWrite(bzr ,0) ; while ( digitalRead ( senin ) == 1){} }
} // sets the servo position according to the scaled value
```

9.2 Poster Presentation

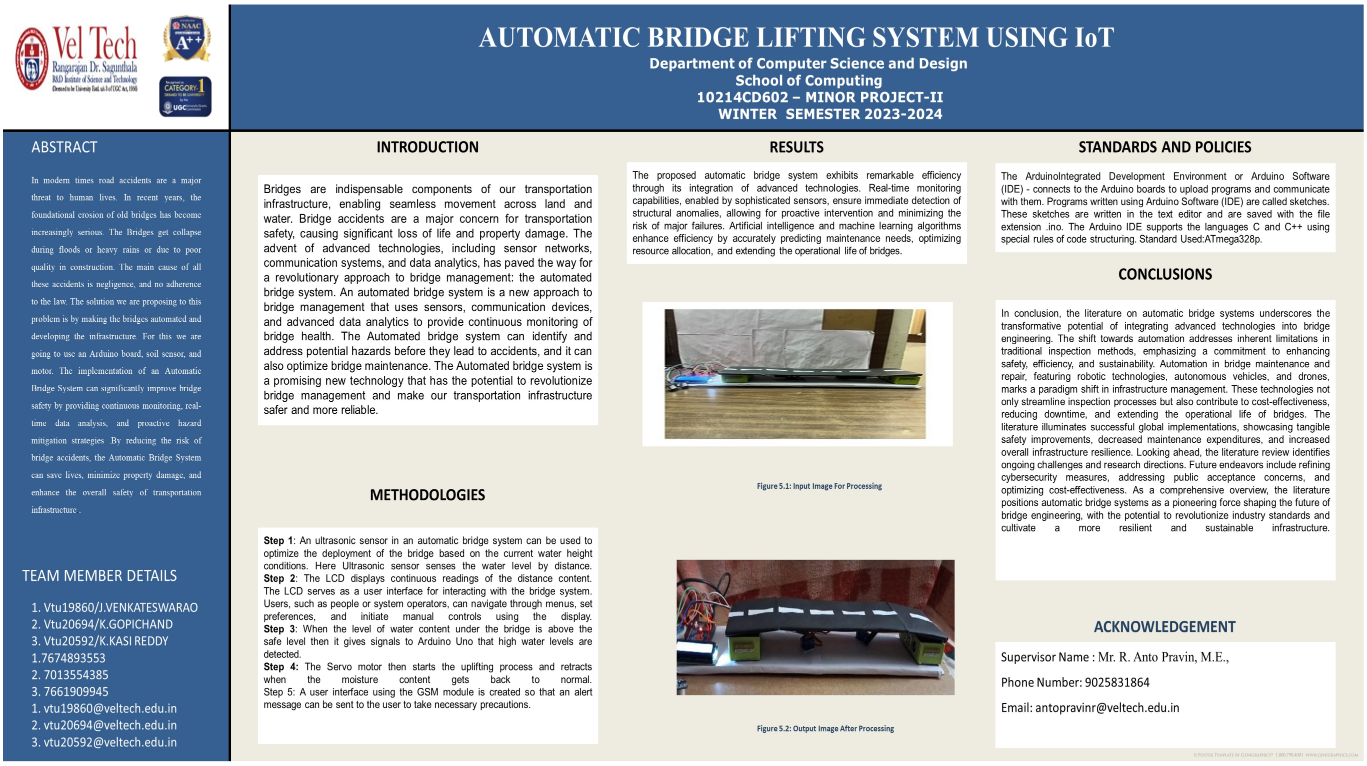

Figure 9.1: **Poster Presentation**

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