WIRELESS LIQUID LEVEL CONTROL AND MONITORING SYSTEM USING LabVIEW

Mini-Project Report submitted to the SASTRA Deemed to be University

in partial fulfillment of the requirements

for the award of the degree of

B. Tech. Electronics & Instrumentation Engineering

Submitted by

KEERTHANA R

(Reg. No.:126006018, B.Tech. EIE)

NIVETHA E

(Reg. No.: 126006029, B.Tech. EIE)

KALKI S

(Reg. No.: 126006056, B.Tech. EIE)

APRIL 2025

THINK MERIT | THINK TRANSPARENCY | THINK SASTRA

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

THANJAVUR, TAMIL NADU, INDIA-613401

SASTRA

ENGINEERING · MANAGEMENT · LAW · SCIENCES · HUMANITIES · EDUCATION

DEEMED TO BE UNIVERSITY

(U/S 3 of the UGC Act, 1956)

THINK MERIT | THINK TRANSPARENCY | THINK SASTRA

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

THANJAVUR – 613 401

Bonafide Certificate

This is to certify that the report titled **Wireless Liquid Level Control and Monitoring System Using LabVIEW** submitted as of the requirements for the award of the degree of B. Tech. Electrical & Electronics Engineering to the SASTRA Deemed to be University, is a bona-fide record of the work done by **Ms. KEERTHANA R(Reg. No.:126006018, B.Tech. EIE), Ms. NIVETHA E(Reg. No.: 126006029, B.Tech. EIE), Ms. KALKI S(Reg. No.: 126006056, B.Tech. EIE)** during the Sixth semester of the academic year 2024-25, in the **School of Electrical & Electronics Engineering**, under my supervision. This report has not formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title to any candidate of any University.

Signature of Project Supervisor :

Name with Affiliation :

Date :

Project *Viva voc*e held on ________________

Examiner 1 **Examiner 2** **Examiner 3**

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

THANJAVUR – 613 401

Declaration

We declare that the report titled "**Wireless Liquid Level Control and Monitoring System Using LabVIEW**" submitted by us is an original work done by us under the guidance of **Dr. G. Balasubramanian, Associate Professor, School of Electrical and Electronics Engineering, SASTRA Deemed to be University** during the Sixth semester of the academic year **2024-25**, in the **School of Electrical and Electronics Engineering**. The work is original and wherever we have used materials from other sources, we have given due credit and cited them in the text of the report. This report has not formed the basis for the award of any degree, diploma, associate-ship, fellowship or other similar title to any candidate of any University.

Signature of the candidate(s): E. Nitha.

Keerthana R

Kalki S

Name of the candidate(s) : **KEERTHANA R, NIVETHA E, KALKI S**

Date :**06-05-2025**

Acknowledgments

First and foremost, we are very thankful to God Almighty for giving us the strength and potential to work on this project fruitfully. We would like to express our special gratitude and thanks to SASTRA Deemed to be University for the facilities provided.

We extend our gratitude to **Dr. S. Vaidhyasubramaniam**, Vice- Chancellor, SASTRA Deemed to be University for providing us with an encouraging platform for the course of study. We would also like to thank

Dr. R. Chandramouli, Registrar for the providing us the opportunity to work in SEEE, SASTRA Deemed to be University for the course of work.

We would like to express our gratitude towards **Dr. K. Thenmozhi**, Dean, SEEE and **Dr. A. Krishnamoorthy**, Associate Dean, SASTRA Deemed to be University and all the members of the Electronics and Instrumentation department for their kind co-operation and encouragement which helped me in the completion of this project.

We are highly in debt to **Dr. G. Balasubramanian**, Associate Professor, EIE, SEEE for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing the project.

The intriguing questions raised by our panel members **Dr. Vijaya Bhaskar B**, SAP, EIE and **Dr. Ghousiya Begum K**, Asst. Professor-III, EIE from School of Electrical and Electronics Engineering helped us in shaping our project. We also take this opportunity to thank all our volunteers who helped us to complete this project.

LIST OF FIGURES

ABBREVIATIONS

• **LabVIEW**	Laboratory Virtual Instrument Engineering Workbench
• **IoT**	Internet of Things
• **Wi-Fi**	Wireless Fidelity
• **LoRa**	Long Range
• **SCADA**	Supervisory control and Data Acquisition
• **bps**	Bytes per second
• **PC**	Personal computer
• **DC**	Direct current
• **PWM**	Pulse width Modulation

ABSTRACT

This is a wireless liquid level monitoring and control system utilizing LabVIEW for real-time automation and remote monitoring. The system utilizes an ultrasonic sensor for liquid level measurement, sends signals wirelessly through Bluetooth, and has a control mechanism in LabVIEW to adjust a setpoint. A PWM signal is provided to control a DC water pump through an L298 driver module. The project reduces the need for manual intervention, enhances precision, and facilitates smart irrigation or industrial fluid management. It proves the efficacy of combining sensor feedback, wireless communication, and automation software in a closed-loop system.

SPECIFIC CONTRIBUTION

LabVIEW Programming - Designs the LabVIEW interface for real-time monitoring and control. - Works on data acquisition, processing, and automation logic.

SPECIFIC LEARNING

Developed skills in creating real-time data monitoring interfaces using LabVIEW. Learned how to process incoming sensor data and implement pump control and alert systems. Improved knowledge of optimizing LabVIEW programs for system reliability and faster response.

Signature of Guide: Students Reg. No:126006018

Name: DR. G. Balasubramaian, Associate Professor/SEEE Name: KEERTHANA

ABSTRACT

Water level monitoring and control are critical in smart infrastructure and industry. This project deploys a LabVIEW-driven wireless solution to control a liquid level control system. The HC-SR04 ultrasonic sensor is used to measure the water level, while a Bluetooth module facilitates communication to a LabVIEW interface for control and visualization. PWM output from LabVIEW drives a pump to adjust the level accordingly. The system provides affordable automation, expandability, and reliability, with applications in agriculture, water supply, and small industrial environments.

SPECIFIC CONTRIBUTION

Hardware & Sensor Integration - Researches suitable liquid level sensors and wireless modules. - Plans the circuit design and prepares for hardware integration.

SPECIFIC LEARNING

Learned how to select and interface ultrasonic sensors for accurate liquid level detection. Gained practical knowledge of setting up wireless communication using Bluetooth modules. Understood challenges like signal interference and how to troubleshoot wireless data transmission

Signature of Guide: Students Reg. No:126006029

Name: DR. G. Balasubramaian, Associate Professor/SEEE Name: NIVETHA E

ABSTRACT

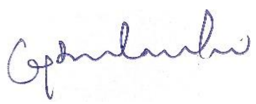
This mini-project involves the design of a wireless controlled water level system with LabVIEW. The system measures real-time liquid level through an ultrasonic sensor, transmits data to LabVIEW via Bluetooth, and controls a DC pump according to the output. The system architecture is made adaptable, low maintenance, and user-friendly. The LabVIEW front panel provides visualization, tuning, and control. It demonstrates the collaboration of embedded systems and graphical programming to effectively resolve real-world automation issues.

SPECIFIC CONTRIBUTION

Wireless Communication & Testing - Studies wireless communication methods for data transmission. - Plans system testing and documentation for project progress

SPECIFIC LEARNING

Acquired experience in systematically testing the system under different operating conditions. Learned to analyse real-world applications like water management and smart irrigation. Improved technical writing skills through preparing project reports and documenting system limitations.



Signature of Guide: Students Reg. No:126006056

Name: DR. G. Balasubramaian, Associate Professor/SEEE Name: KALKI S

TABLE OF CONTENTS

CHAPTER 1

1.INTRODUCTION

1.1 Background and Need for Liquid Level Monitoring

Liquid level monitoring and control is an important requirement in many fields like industries, water treatment plants, oil and gas facilities, and agriculture. Keeping the liquid at the correct level is necessary to avoid overflows, damages, equipment failures, and product losses. It also helps in saving water, chemicals, and energy, which is very important nowadays for sustainability. Traditionally, wired systems are used for monitoring, but they have limitations like maintenance problems, complicated wiring, and less flexibility. In today's world, with the focus on automation, efficiency, and smart technology, there is a growing need for better and more advanced liquid level control methods that are easy to maintain and expand.

1.2 Challenges in Traditional Systems

Although wired systems are still common, they are not always convenient in modern applications. Installing and maintaining wired systems becomes difficult and costly, especially when monitoring multiple tanks or large plants. Every time there is an expansion, re-routing cables and setting up new connections is time-consuming. Fault detection and repairs are also difficult due to hidden wiring. Apart from this, wired systems usually do not allow remote monitoring, which forces operators to manually check levels. This increases the risk of human errors and delays in taking action during critical situations.

1.3 Advances in Wireless Monitoring Technologies

Wireless communication has changed how monitoring and control systems are designed today. Technologies like Bluetooth, Wi-Fi, LoRa, and ZigBee allow sensors to send data without needing a wired connection. Wireless systems are more flexible, easier to install, and cheaper in the long run. Research shows that wireless monitoring combined with automatic control systems gives better results by maintaining stable operation and quick response to changes. Especially in short-range applications, Bluetooth is simple, reliable, and low-cost, making it a good option for small industries, research projects, and smart water systems.

1.4 Overview of LabVIEW in Control Systems

LabVIEW is a popular graphical programming tool used in industries and academic projects for measurement, control, and automation. Unlike traditional coding, LabVIEW allows users to develop applications visually by connecting functional blocks. It supports easy data acquisition from sensors, data processing, real-time monitoring, and control system development. LabVIEW also provides built-in tools for alarm generation, and data visualization. In this project, LabVIEW is used to create a real-time monitoring interface that shows the liquid level, controls the pump/valve based on setpoint conditions through the front panel controls.

1.5 Problem Statement

Even though liquid level monitoring is a well-known requirement, many of the existing systems still rely heavily on wired setups and manual monitoring. These setups are difficult to maintain, expensive to modify, and do not offer real-time decision-making capabilities. Many small industries and farms require an affordable system that is wireless, easy to install, and automated. Therefore, this project aims to design a **wireless liquid level control and monitoring system** using **LabVIEW** and **Bluetooth communication**. This system will provide real-time level measurement, automated control, and a user-friendly interface, making it suitable for small-scale as well as large-scale applications.

1.6 Motivation

The motivation behind this project is to address the need for smarter, easier, and more efficient water and liquid management systems. With rapid developments in wireless technology and automation tools like LabVIEW, it is now possible to build systems that can perform complex tasks while being simple to use. This project aims to make use of these technologies to develop a wireless, real-time liquid level monitoring and control system that can be expanded in the future to include IoT cloud monitoring, remote notifications, and predictive maintenance. It will help industries, farms, and water conservation projects by reducing manual efforts, saving time, improving accuracy, and promoting sustainable water usage practices.

CHAPTER 2

2.LITERATURE SURVEY

2.1 Design of Water Tank PID Control System through LabVIEW-Based Simulation

The paper introduces an automatic water level monitoring and controlling PID control system based on LabVIEW for use in industrial water tanks. The primary aim is to enhance reliability, accuracy, and automation for sustaining desired levels of water utilizing a graphical-based interface with less programming expertise. The system features a USB-2815 DAQ module and WL705 ultrasonic sensors that measure water depth non-invasive and offer real-time data for the LabVIEW platform.

The authors constructed a mathematical model of the tank by experimental analysis, which was the foundation for simulation and control in LabVIEW. The architecture of the system incorporates sensors to feed data to USB-2815 and then to interface with LabVIEW for visualization and control logic implementation. The design of the simulation includes upper and lower-level thresholds (set point and peak value), and employs the use of control valves and pump switching in regulating the level. Water is permitted to enter when the level drops below a certain point, and the inlet valve and pump will cut off when the tank fills to a set maximum. A number of graphical interfaces in LabVIEW were developed, such as gauges, graphs, and digital meters to display real-time water levels and control valve positions. The system proved to be stable under three scenarios: (1) low level—turning on the pump and valve, (2) at set point—maintaining the system on, and (3) above the threshold—automatically turning off the pump and closing valves.

The paper concludes that the system is effective, user-friendly, and versatile for diverse industrial and building automation applications. It saves manual intervention, reduces error, and conserves water through accurate control, providing a cost-effective, scalable solution for automated liquid level systems.

2.2 Liquid Tank Level Control Using PID and LabVIEW

In this study, Kadhim and Raheem introduce a full setup for liquid level control in a tank with a PID controller programmed in LabVIEW. The primary objective of their project was to create an automatic control system that holds a specified liquid level by controlling the speed of a pump through feedback from a level sensor. They employed an Arduino board for data acquisition and LabVIEW for processing, monitoring, and control.

The system operates by taking the current liquid level from a sensor in real-time, sending it to LabVIEW, comparing it with the user-established setpoint, and using the error (setpoint minus current level) to determine the action needed from the PID controller, which in this scenario would be adjusting the pump operation to restore the level to the desired position. Their efforts involve PID parameter tuning in a precise manner (proportional, integral, and derivative gains) for improved stability, response speed, and minimum overshoot.

One significant conclusion of their research is that LabVIEW facilitates easier development of a graphical user interface for operators while, simultaneously, providing integration of intricate control algorithms without the necessity for conventional programming. This research informed our project directly in creating a PID control system in LabVIEW to automatically control water levels and in selecting Arduino as an interfacing device. It also showed that PID controllers can greatly enhance the performance of liquid level control systems.

2.3 Implementation of PID controller for liquid level system using mGWO and integration of IoT application

This work introduces a real-time liquid level control system based on a PID controller optimized through a modified Grey Wolf Optimization (mGWO) algorithm and coupled with an IoT-based monitoring application. The control system is deployed on an ESP32 microcontroller and monitored through a mobile app developed on the Blynk platform.

The goal is to regulate the liquid level in a cylindrical tank to a desired reference level. A mathematical model of the tank is formulated, and PID parameters are optimized with mGWO in MATLAB. Control logic is coded in the ESP32 using Arduino IDE, which also processes real-time data from the plant through a differential pressure sensor in the form of a voltage signal. It is processed to drive a pneumatic valve by PWM signals.

The mGWO algorithm enhances the conventional Grey Wolf Optimizer by adding nonlinear control of exploration-exploitation balance, preventing local minima and enhancing convergence rate. Benchmark comparisons validate that mGWO performs better than other metaheuristics like PSO, DE, and SCA in performance tuning.

Experimental data reveal that the new mGWO-tuned PID controller offers improved rise time, settling time, and overshoot performance compared to conventional Ziegler–Nichols and SIMC tuning practices. Remote monitoring and control capabilities are enabled with the ability to update PID parameters and setpoints in real-time through a smartphone application. The system is tested for different flow rates, setpoints, and even disturbances, and exhibits good robust performance along with fast recovery.

This study shows the power of integrating optimization techniques with IoT technology in current industrial process control, providing better flexibility, accuracy, and automation.

2.4 Cascade PID Control Loop for Liquid Tank Level in LabVIEW

This paper presents an advanced control technique for liquid level regulation by using a cascade PID control setup in LabVIEW. Instead of using a simple single-loop PID controller, a cascade control structure uses two PID controllers — a primary and a secondary controller. The primary controller controls the liquid level, and the secondary controller controls the flow rate, making the system more stable and faster in response to disturbances.

The authors implemented the system using a PC-based LabVIEW setup connected to an Arduino Mega, and used simulated sensors for testing. They found that cascade PID control provided better disturbance rejection and smoother level control compared to single-loop control. Their experimental results showed reduced overshoot, faster settling time, and improved robustness against sensor noise and disturbances.

This paper motivated us to think about how PID control can be tuned further for better performance. Although our project initially uses a basic single-loop PID control, the idea of extending to cascade control or using multi-loop control strategies could be an area of future improvement. It also reinforced the importance of fine-tuning PID parameters to achieve optimal system performance.

2.5 Enhancing Water Conservation Efforts with Arduino-Based Systems

This research paper explores how Arduino-based smart water management systems can help conserve water resources by automating monitoring and control tasks. The project mainly involves using water level sensors, Arduino microcontrollers, wireless communication modules, and mobile applications to allow users to monitor and control water usage efficiently. Their system alerts users when water levels are too low or too high and automatically operates pumps and valves to manage the water supply.

The authors emphasize the importance of making low-cost, reliable systems that can be easily installed in rural or semi-urban areas where advanced SCADA (Supervisory Control and Data Acquisition) systems are not feasible. They also explain how automating water level management reduces wastage, improves resource usage, and minimizes human errors.

This study supports our project's approach of using Arduino as the main hardware platform due to its affordability, flexibility, and ease of programming.

It also inspired the idea of adding features like real-time alerts and making the system accessible for small industries and agricultural fields. In the future, we could extend our project by adding features like SMS alerts, mobile app control, and further integration with cloud monitoring.

CHAPTER 3

3.EXPERIMENTAL WORK/METHODOLOGY

3.1 EXPERIMENTAL WORK

3.1.1 Objective

The objective of this project is to develop a wireless liquid level control system using an ultrasonic sensor and Bluetooth communication. The real-time tank level is sent to LabVIEW, where a measured value compares it with a setpoint. Based on the output, a PWM signal is generated to control a DC water pump through an L298 motor driver. The system adjusts the pump speed automatically to maintain the desired water level. This project aims to achieve accurate, real-time control with minimal manual effort. It also promotes efficient water management through automation.

3.1.2 Components Required

- **Ultrasonic Sensor** (HC-SR04) – for level measurement
- **Bluetooth Module** (HC-05) – for wireless data transfer
- **LabVIEW Software** – for system interfacing
- **Motor Driver Module** (L298) – for controlling the pump
- **12V R365 DC Water Pump** – to fill the tank
- **Arduino Board**
- **Water Tank**
- **Power Supply** (12V DC for pump and motor driver)
- **12 V Battery**

3.1.3 Experimental Setup

The ultrasonic sensor is mounted vertically over the water tank to detect the water level.

The sensor output is sent wirelessly using Bluetooth to LabVIEW.

LabVIEW takes the tank level reading, compares it against the user-adjusted setpoint.

Depending on the output, LabVIEW forwards a corresponding PWM control signal to the L298 motor driver.

The L298 driver drives the R365 water pump to fill the tank to the setpoint level.

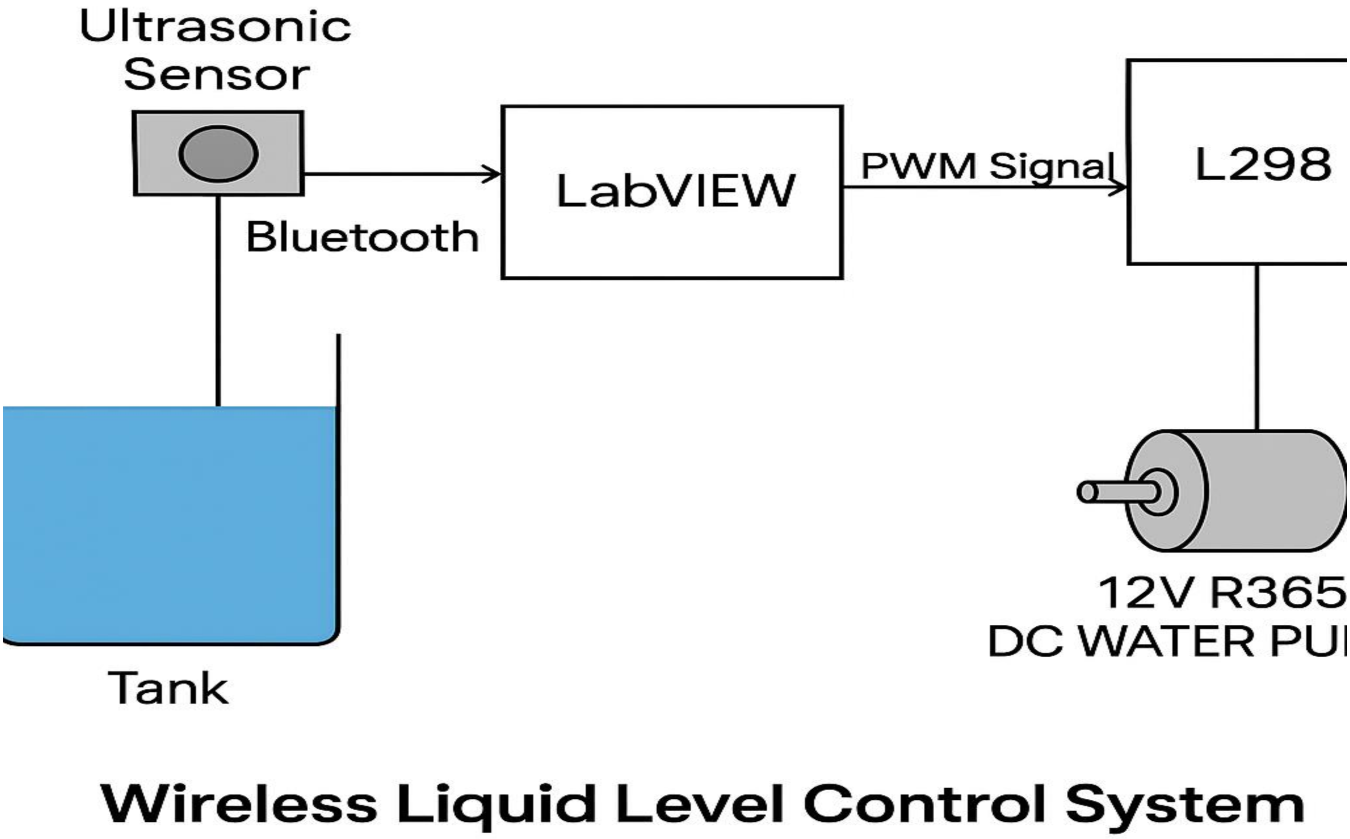


figure 1

3.2 METHODOLOGY

3.2.1. Ultrasonic Sensor Level Measurement

- The ultrasonic sensor measures the distance from the sensor to the water surface continuously.
- The distance is translated into an equivalent water level using a straightforward formula:

Water Level=Tank Height−Measured Distance

- The measured level data is transmitted through Bluetooth to LabVIEW.

3.2.2. Bluetooth Communication Setup

- Set up the Bluetooth module with a baud rate (9600 bps).
- Make sure there is proper pairing between the sensor side and the LabVIEW side (PC Bluetooth).
- LabVIEW keeps reading serial Bluetooth data coming in and reading out water level details.

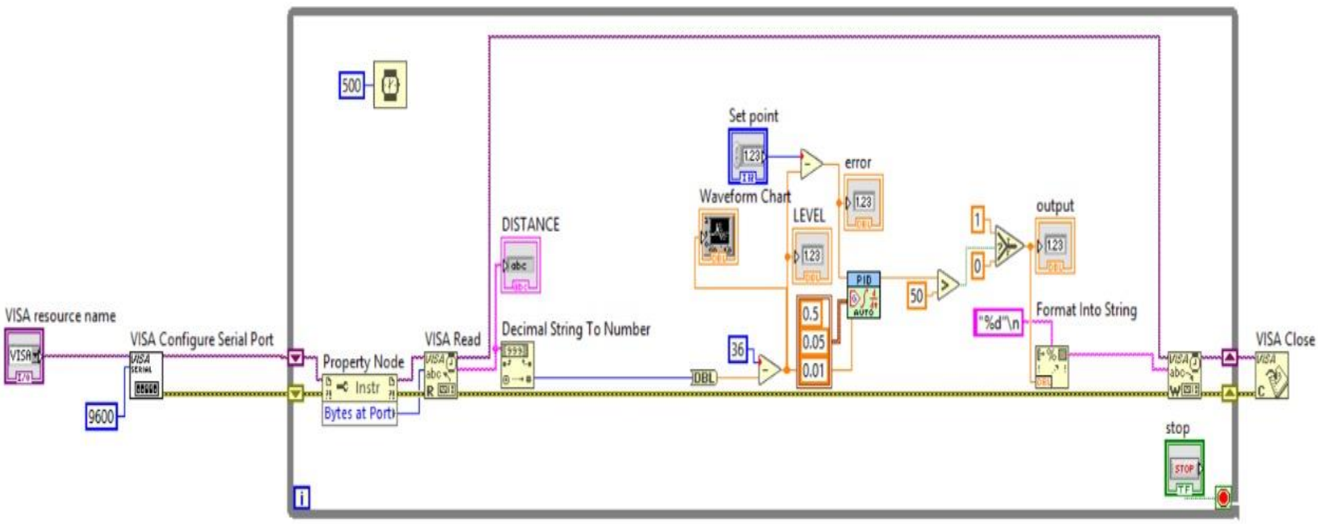


figure 2

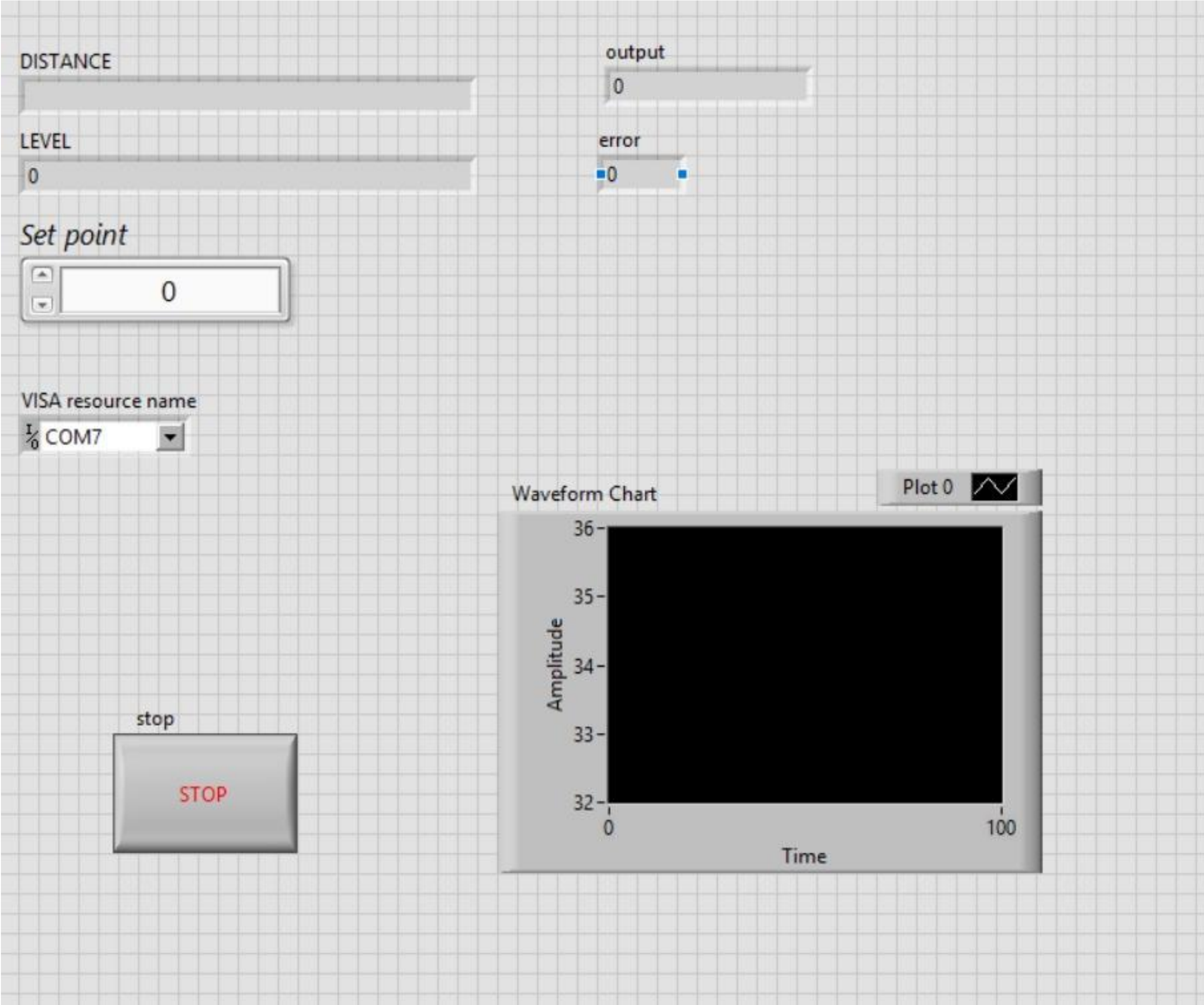


figure 3

3.2.3. PWM Signal Transmission

• LabVIEW sends the PWM signal to an Arduino.

• The PWM signal is transmitted to the L298 motor driver input**.**

3.2.4. Motor Driver and Pump Control

• The L298 motor driver accepts the PWM signal.

• According to the duty cycle, the L298 controls the power supplied to the 12V R365 DC pump.

• Greater PWM → Quicker pump → Faster tank filling.

• The system dynamically controls the pump speed to keep the water level close to the setpoint**.**

3.2.5. Closed-Loop Operation

• During the filling of the tank, the changing level is detected by the ultrasonic sensor.

• Feed-back level data is constantly sent to LabVIEW.

• Real-time adjustment of the pump speed is made by the LabVIEW to bring the water level to the desired setpoint as shown in figure 4.

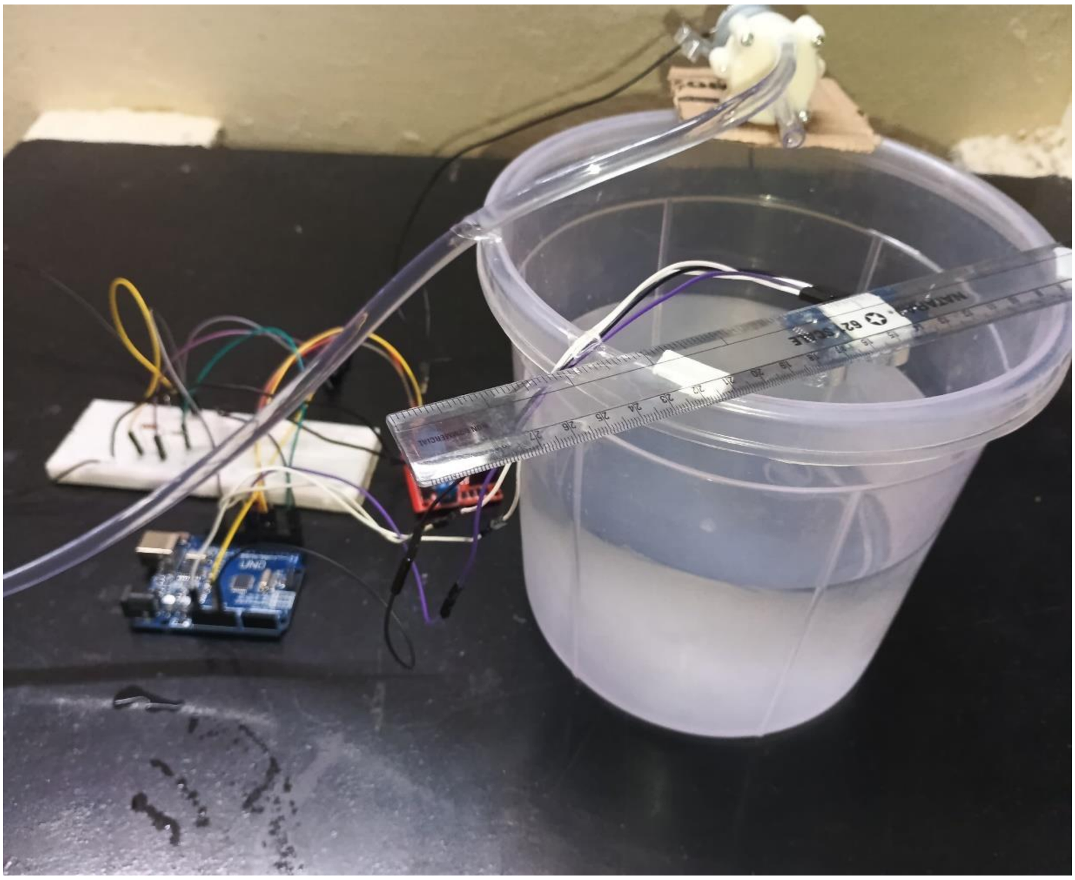


figure 4

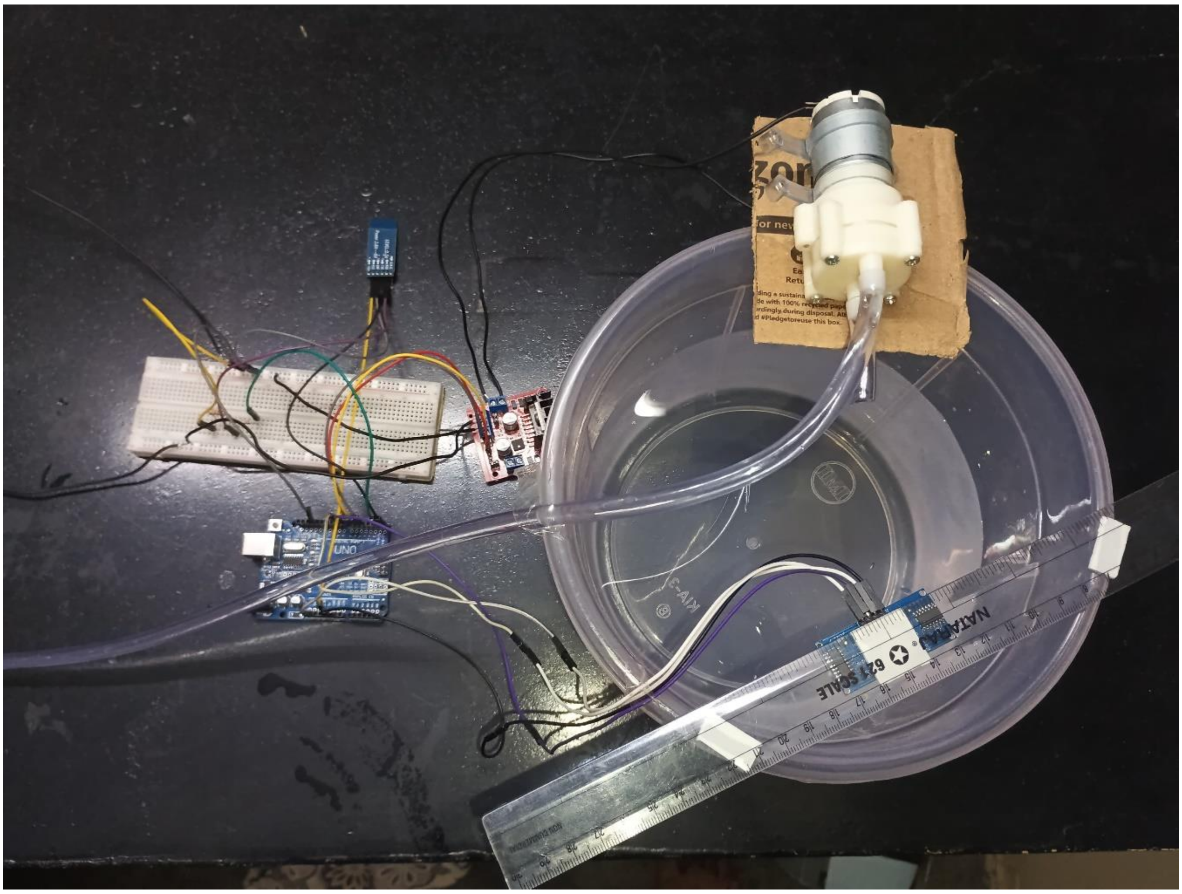


Figure 5

CHAPTER 4

4.RESULTS AND DISCUSSION

4.1 WORKING OF ULTRASONIC SENSOR

The ultrasonic sensor successfully gauged the level of liquid inside the tank. The accuracy of the sensor was tested by measuring the sensor with manual readings. The error percentage was small, and the sensor gave uniform results under different conditions of the tank.

• Accuracy and Precision: The ultrasonic sensor could accurately give readings with a minimal amount of error (± 1 cm).

•Response Time: The response time of the sensor was quick enough to give real-time data for control, with very little delay between measurement and LabVIEW processing.

4.2 WATER PUMP CONTROL

The PWM output from LabVIEW controlled the L298 driver module, which in turn regulated the speed of the 12V R365 DC water pump. The water pump was turned on when the liquid level fell below the setpoint and was switched off once the setpoint was achieved.

•Accuracy of PWM Signal: The PWM signal produced by LabVIEW was precise and stable, leading to a smooth control over the operation of the water pump.

•Response of Pump: The pump reacted instantly to the control signals, filling the tank in an efficient manner without overshooting the level to be reached. The pump kept a proper rate of flow, which allowed the system to reach the target water level without causing too much oscillation.

4.3 SYSTEM STABILITY AND RELIABLITY

The stability of the complete system was verified under different conditions, like the variation in the liquid volume inside the tank and disturbances (e.g., variations in the water flow). The system proved to be robust, with control over the water pump and regulation of the liquid level inside the desired range.

•Stability Analysis: The system proved good stability with no noticeable oscillations or instability upon reaching the setpoint.

•Reliability: The system was found to be reliable under different test conditions, such as changing environmental conditions, showing its viability for real-world applications in automated liquid level control.

4.4 WIRELESS COMMUNICATION (Bluetooth)

The Bluetooth communication between the ultrasonic sensor and LabVIEW was instrumental in the operation of the system. It enabled the wireless transmission of sensor data, providing flexibility in the system setup as mentioned in Figure 6.

•Range of Communication: The range of communication of Bluetooth was adequate for general use in a small to medium-sized configuration. It permitted data transmission with minimal loss or delay of signal.

•Data Integrity: The data integrity transmitted using Bluetooth remained uncompromised throughout testing, and there was no data corruption or loss.

4.5 LIMITATIONS

The system worked fine, but there were a couple of limitations discovered while testing:

•Temperature Sensitivity: The performance of the ultrasonic sensor may be impacted by changes in temperature, which may add small measurement errors.

•Power Consumption: The power consumption of the system as a whole may be minimized by using more efficient components, particularly for the water pump and Bluetooth module.

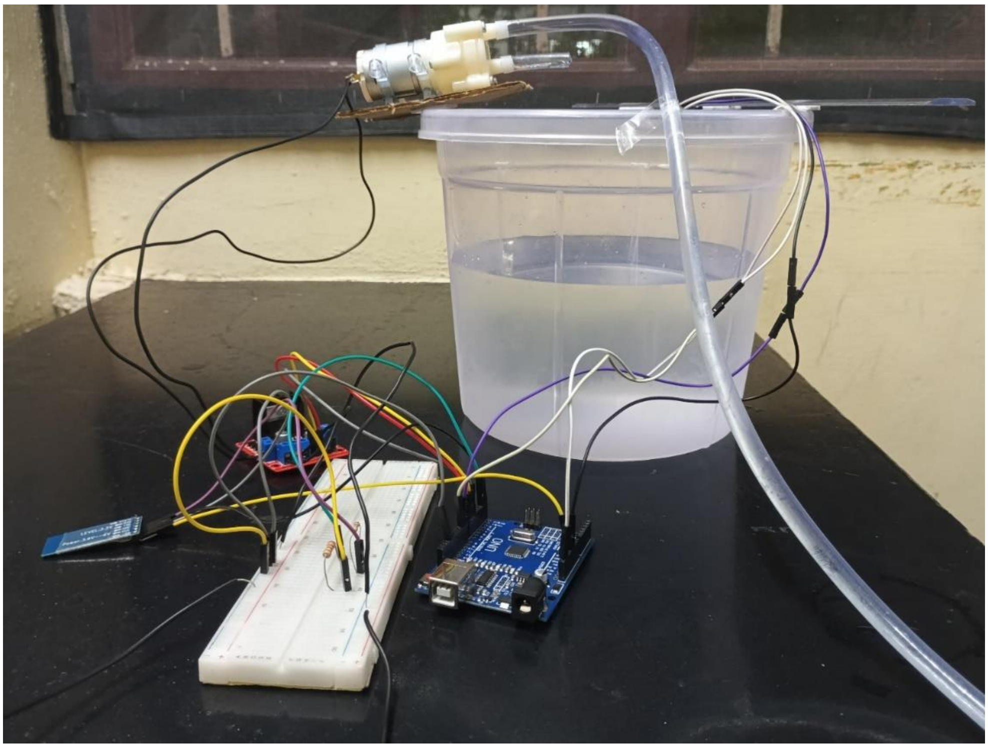


Figure 6

4.7 RESULT

The wireless liquid level control system using an ultrasonic sensor, and Bluetooth communication has been successfully implemented with the stable result as shown in figure 7. The system demonstrated reliable and accurate control over the liquid level, providing a practical solution for automated liquid level management. With further optimizations, this system could be adapted for a wide range of industrial and domestic applications.

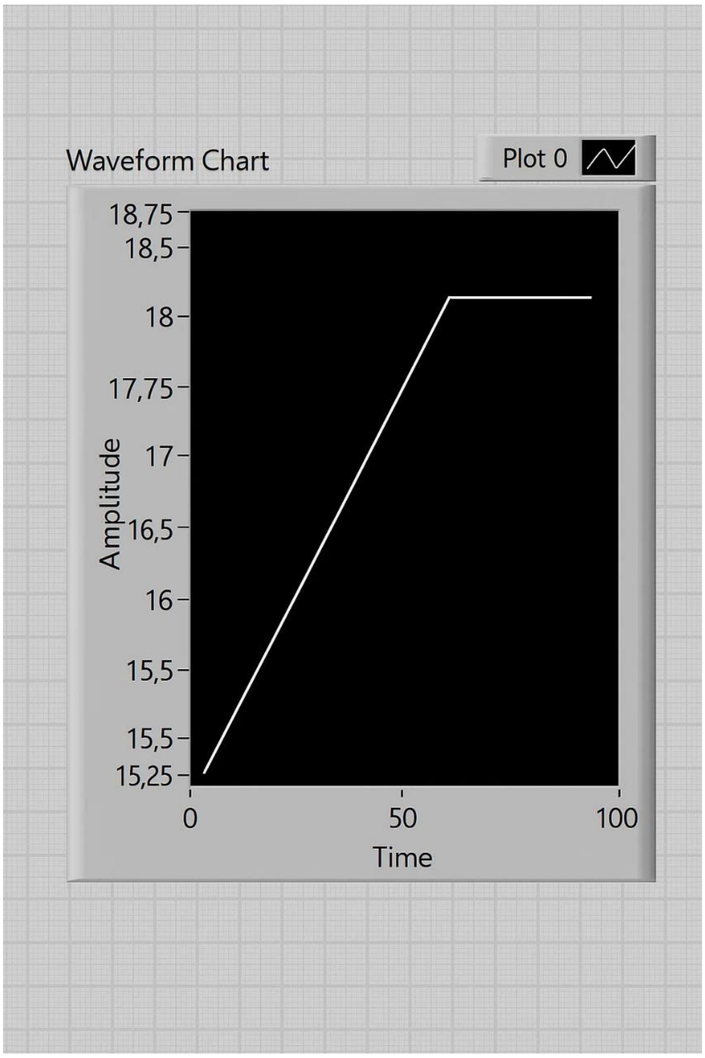


figure7

CHAPTER 5

5.CONCLUSION AND FURTHER WORKS

5.1 CONCLUSION

The project successfully demonstrated a wireless liquid level control system using LabVIEW with effective real-time monitoring. The transmission of sensor data via Bluetooth was stable and accurate, and the DC pump responded well to keep the setpoint. The closed-loop control had minimal overshoot and settling time. The system demonstrated robustness in different tank conditions and can be expanded to other applications. It provides a workable, flexible, and affordable solution for domestic and industrial water management operations.

Signature of the Guide

Student Reg. No.: 126006029

Name of the Guide: Dr. G. Balasubramanian

Name: NIVETHA E

5.1 CONCLUSION

The system that has been developed combines sensor-based measurement, wireless communication, and LabVIEW interface into one platform for liquid level automation. It effectively controls pump operations through feedback, leading to minimal human intervention and improved system stability. The findings validate the possibility of applying wireless feedback control with accuracy using off-the-shelf components. Future research can include advanced tuning techniques, IoT integration for cloud monitoring, and extension to multi-tank systems.

Signature of the Guide

Name of the Guide: Dr. G. Balasubramanian

Student Reg. No.: 126006018

Name: KEERTHANA R

5.1 CONCLUSION

The wireless liquid level control system met its objective of automatic tank control with the aid of real-time data acquisition in LabVIEW. The coupling of ultrasonic sensing and Bluetooth communication allowed the system to have a versatile and user-friendly interface. The system had stable operation and can be modified for wide application in irrigation, industrial fluid systems, or smart buildings. With additional enhancements like cloud connectivity and security features, it can be developed into a strong IoT-based solution for water management.

Signature of the Guide | Student Reg. No.: 126006056

Name of the Guide: Dr. G. Balasubramanian | Name: KALKI S

5.2. FURTHER WORKS

Although the system performed well, several areas can be considered for future improvements and expansions:

5.2.1. Advanced PID Tuning

- Implement adaptive or self-tuning PID algorithms that automatically adjust the PID parameters depending on operating conditions.
- Use optimization algorithms (like Ziegler–Nicholas method, Particle Swarm Optimization, etc.) for more precise controller tuning.

5.2.2. IoT Integration

- Connect the system to IoT platforms like Blynk, ThingSpeak, or custom cloud servers to enable real-time remote monitoring, data logging, and control from mobile apps or web dashboards.

5.2.3. Multi-Tank Control System

- Expand the system to monitor and control multiple tanks simultaneously, including load sharing between pumps if needed.
- Introduce a hierarchical control system to prioritize tanks based on urgency.

5.2.4. Energy Efficiency Improvements

- Use a low-power Bluetooth module (such as Bluetooth Low Energy - BLE) to reduce power consumption.
- Implement sleep modes for sensors and communication modules when the system is idle.

5.2.5. Fault Detection and Alarming

- Add features to detect sensor malfunctions, pump failures, or communication issues.
- Implement alarms (visual, audible, or via mobile notifications) to alert users of system faults or abnormal levels.

5.2.6. Safety Features

- Include overflow protection by adding a secondary sensor or cutoff mechanism.
- Add low-water-level detection to prevent the pump from dry running, protecting the motor from damage.

CHAPTER 6

6.REFERENCES

1. **P. S. Jadhav, P. B. Ghuge, and S. R. Patil**, *"Implementation of Water Level Monitoring and Control System using IoT and LabVIEW,"* International Research Journal of Engineering and Technology (IRJET), vol. 7, no. 5, 2021.
2. **M. M. Rahman and A. H. M. Z. Alam**, *"Design and Implementation of a Wireless Water Level Monitoring System Using IoT and Bluetooth,"* International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 7, 2021.
3. **G. Prasanna, K. Suganya, and M. Kavitha**, *"Water Level Control Using Ultrasonic Sensors and LabVIEW-Based PID Control,"* Springer Advances in Intelligent Systems and Computing, 2022.
4. **R. Kumar, S. Pandian, and S. Rajesh, "A Smart Liquid Level Control System Using Wireless Sensors and LabVIEW,"** International Journal of Advanced Research in Science, Engineering, and Technology (IJARSET), vol. 9, no. 3, 2022.
5. **Praseed Kumar, Shamim S. Pathan, Bipin Mashilkar**, *"Liquid Level Control using PID Controller Based on LabVIEW & MATLAB Software,"* International Journal of Engineering Research & Technology (IJERT), Vol. 3, Issue 10, October 2014.
6. **Harsh Kaji, Shruti Annigeri, Prafulla Patil**, "*Designing PID Controller using LabVIEW for Controlling Fluid Level of Vessel,"* International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 2, March-April 2013, pp. 1329-1333.
7. **Said Sulaimn Ambu Saidi et al**., "*Arduino Based Smart Phone Liquid Level Monitoring System Using Ultrasonic Sensor,"* International Journal of Engineering Research and Applications (IJERA), Vol. 11, Issue 8, August 2021, pp. 41-45.
8. **Laith Abed Sabri, Hussein Ahmed AL-Mshat**, "*Implementation of Fuzzy and PID Controller to Water Level System Using LabVIEW,"* International Journal of Computer Applications, April 2015.
9. **A. Sharma, R. Verma, and S. Gupta**, *"Design and Implementation of a Wireless Water Level Monitoring System Using IoT and LabVIEW,*" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), vol. 9, no. 6, 2020.
10. **M. K. Singh and P. K. Jain***, "Smart Water Level Monitoring and Control Using LabVIEW and IoT,"* International Journal of Engineering and Advanced Technology (IJEAT), vol. 9, no. 3, 2020.

CHAPTER 7

APPENDICES

Keerthana mini project report

by Balasubramanian Ganesan

General metrics

26,193	3,747	260	14 min 59 sec	28 min 49 sec
characters	words	sentences	reading time	speaking time

Score

84

This text scores better than 84% of all texts checked by Grammarly

Writing Issues

136 Issues left

22 Critical

114 Advanced

Writing Issues

22	**Correctness**
5	Confused words
5	Improper formatting
2	Incorrect verb forms
1	Incorrect noun number
2	Comma misuse within clauses
4	Incorrect punctuation
2	Misspelled words