ADVANCED SOLUTION FOR MONITORING PESTICIDE POLLUTION IN FRUITS AND VEGETABLES

A MINOR PROJECT- IV

Submitted by

SUBHIKA D	**927622BEC209**
SWETHA M	**927622BEC228**
SWETHA M	**927622BEC229**
THANISHKA K	**927622BEC230**

BACHELOR OF ENGINEERING

in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING

(Autonomous)

KARUR – 639 113

MAY 2025

ADVANCED SOLUTION FOR MONITORING PESTICIDE POLLUTION IN FRUITS AND VEGETABLES

A MINOR PROJECT- IV

Submitted by

SUBHIKA D	**927622BEC209**
SWETHA M	**927622BEC228**
SWETHA M	**927622BEC229**
THANISHKA K	**927622BEC230**

BACHELOR OF ENGINEERING

in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING

(Autonomous)

KARUR – 639 113

MAY 2025

M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

BONAFIDE CERTIFICATE

Certified that this **18ECP106L - Minor Project IV** report "**ADVANCED SOLUTION FOR MONITORING PESTICIDE POLLUTION IN FRUITS AND VEGETABLES"** is the Bonafide work of "**SUBHIKA D (927622BEC209), SWETHA M (927622BEC228), SWETHA M (927622BEC229), THANISHKA K (927622BEC230)"** who carried out the project work under my supervision in the academic year 2024 - 2025 **EVEN**.

SIGNATURE	**SIGNATURE**
Dr.A.KAVITHA, B.E., M.E., Ph.D.,	**Dr.C.NANDAGOPAL.,M.E.,Ph.D.,**
HEAD OF THE DEPARTMENT,	**SUPERVISIOR,**
Professor,	**Assistant Professor,**
Department of Electronics and	Department of Electronics and
Communication Engineering,	Communication Engineering,
M.Kumarasamy College of Engineering,	M.Kumarasamy College of Engineering,
Thalavapalayam,	Thalavapalayam,
Karur-639113.	Karur-639113.

This report has been submitted for the **18ECP106L – Minor Project IV** final review held at M. Kumarasamy College of Engineering, Karur on _____.

PROJECT COORDINATOR

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully - engaged, learner - centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO's, PO's AND PSO's

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives

PEO1: **Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

Program Outcomes

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

Abstract	Matching with POs,PSOs
Sensor Simulation, Pesticide Detection, ESP32, Real-time Monitoring	**PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO10, PO12, PSO1, PSO2**

ACKNOWLEDGEMENT

We gratefully remember our beloved **Founder Chairman, (Late) Thiru. M. Kumarasamy**, whose vision and legacy laid the foundation for our education and inspired us to successfully complete this project.

We extend our sincere thanks to **Dr. K. Ramakrishnan, Chairman**, and **Mr. K. R. Charun Kumar, Joint Secretary**, for providing excellent infrastructure and continuous support throughout our academic journey.

We are privileged to extend our heartfelt thanks to our respected Principal, **Dr. B. S. Murugan, B.Tech., M.Tech., Ph.D.,** for providing us with a conducive environment and constant encouragement to pursue this project work.

We sincerely thank **Dr. A. Kavitha, B.E., M.E., Ph.D.,** Professor and **Head, Department of Electronics and Communication Engineering**, for her continuous support, valuable guidance, and motivation throughout the course of this project.

Our special thanks and deep sense of appreciation go to our **Project Supervisor, Dr.C. Nandagoapal, B.E., M.E.,** Assistant Professor, **Department of Electronics and Communication Engineering,** for her exceptional guidance, continuous supervision, constructive suggestions, and unwavering support, all of which have been instrumental in the successful execution of this project.

We would also like to acknowledge **Dr. K. Sheikdavood, B.E., M.E., Ph.D.,** Assistant Professor, **our Class Advisor,** and **Mrs. L. Kavitha, B.E., M.E.,** Assistant Professor, **our Project Coordinator**, for their constant encouragement and coordination that contributed to the smooth progress and completion of our project work.

We gratefully thank all the **Faculty Members of the Department of Electronics and Communication Engineering** for their timely assistance, valuable insights, and constant support during various phases of the project.

Finally, we extend our profound gratitude to our **Parents and Friends** for their encouragement, moral support, and motivation, without which the successful completion of this project would not have been possible.

ABSTRACT

The increasing use of pesticides in agriculture has led to serious health concerns due to residue contamination in fruits and vegetables. Conventional methods for detecting pesticide levels, including laboratory testing and hardware-based sensors, are accurate but often costly and inaccessible to the average consumer. This project introduces a software-based simulation model as a cost-effective and accessible alternative for pesticide pollution monitoring. A mobile application developed using Flutter simulates pesticide contamination levels using random data generation and visually classifies produce as either "Safe to Eat" or "Unsafe!" based on predefined thresholds. The app features real-time updates, color-coded indicators, and graphical representations to enhance user understanding and promote food safety awareness. This approach eliminates the need for physical sensors or lab equipment and lays the foundation for future integration of machine learning algorithms to improve prediction accuracy. The project demonstrates the potential of software-driven solutions in addressing public health concerns associated with pesticide exposure in everyday diets.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACRONYMS		ABBREVATION
LED	-	Light Emitting Diode
MEMS	-	Micro- Electromechanical system
LCD	-	Light Crystal Display
USB	-	Universal Serial Bus
SAP	-	Super Absorbent Polymer
RAM	-	Random Access Memory

CHAPTER 1

INTRODUCTION

The growing demand for higher agricultural yields has led to the increased use of chemical pesticides to protect crops from pests and diseases. While effective in enhancing productivity, this widespread pesticide usage poses significant health risks when residues remain on fresh fruits and vegetables. Long-term exposure to such residues can lead to severe health complications, including hormonal imbalances, neurological disorders, and even cancer.

As a result, monitoring pesticide levels in food has become a critical aspect of ensuring public health and food safety. Traditional methods for pesticide detection, such as chromatography and spectroscopy, though highly accurate, are limited by their high cost, need for specialized equipment, and requirement for laboratory conditions. Similarly, hardware-based detection systems using biosensors or IoT- enabled devices, while portable and efficient, may still be inaccessible to general consumers due to affordability and maintenance concerns. In response to these challenges, this project proposes a software-based simulation approach to estimate pesticide contamination levels without the use of physical sensors or laboratory tools. By utilizing random data generation and user-friendly mobile technology, the system aims to simulate pesticide levels and classify produce as “Safe to Eat” or “Unsafe!” based on safety thresholds. The solution is developed as a mobile application using Flutter, focusing on real-time data visualization, automated classification, and increased awareness about pesticide exposure.

This project not only addresses the issue of accessibility in pesticide monitoring but also serves as a foundation for future developments in AI-based food safety systems, ensuring a healthier and more informed society.

1.1 OBJECTIVES OF THE PROJECT

- The primary objective of this project is to develop a software-based simulation model that monitors pesticide pollution in fresh fruits and vegetables through a user-friendly mobile application.
- This system aims to simulate pesticide contamination levels using random or user-input data and provide a clear numerical and visual representation of the results. It classifies produce as either "Safe to Eat" or "Unsafe!" based on predefined pesticide thresholds, thereby aiding in quick decision-making.
- The project also seeks to automate real-time data updates and enhance accessibility by implementing the model in a cross-platform mobile application using Flutter. Additionally, the app focuses on intuitive data visualization through color codes, graphs, and dynamic indicators to improve user understanding.
- Ultimately, the project strives to raise public awareness about the health risks associated with pesticide residues and promote proactive food safety practices through a cost-effective, hardware-free approach.

1.2 KEY FEATURES OF PROJECT

- This project introduces several innovative features that make it a practical and accessible tool for pesticide pollution monitoring in fruits and vegetables. One of the most significant features is its hardware-free design, eliminating the need for expensive sensors or laboratory equipment. Instead, it uses software-based simulations to generate random pesticide contamination levels, offering a cost-effective solution for everyday consumers.
- The mobile application, built using the Flutter framework, ensures cross-platform compatibility and delivers a smooth, interactive user experience. It provides real-time data visualization using color indicators, numerical values, and simple graphs to help users easily interpret the level of contamination. The app automatically classifies produce as "Safe to Eat" or "Unsafe!" based on a defined threshold, making it simple for users to understand food safety at a glance. Moreover, the application is designed to be scalable, with future integration plans for AI-based predictions, historical data tracking, and trend analysis. Together, these features make the project a powerful and user-friendly tool for promoting food safety awareness.

1.2.1 DESCRIPTION OF THE PROJECT

This project focuses on developing a mobile application that simulates pesticide contamination levels in fresh fruits and vegetables. The core idea is to offer a software based solution to monitor and classify food safety without relying on expensive or specialized hardware. The application is built using Flutter, a cross platform framework, ensuring compatibility across both Android and iOS devices.

The app functions by generating random data to simulate pesticide contamination levels in fruits and vegetables. These levels are represented as percentages ranging from 0% to 100%, with each value corresponding to the degree of pesticide contamination. Once the data is simulated, the app classifies the produce into one of two categories: “Safe to Eat” (if the pesticide level is below the safety threshold) and “Unsafe!” (if the pesticide level exceeds the safety threshold). The threshold can be adjusted, but a default level of 30% contamination is used, based on standard safety guidelines.

The app also provides real-time data visualization, displaying pesticide levels using a combination of numerical values, color-coded indicators, and graphs. These visual cues help users quickly assess the safety of the produce. In addition, the application aims to raise awareness by offering educational content on the health risks of pesticide exposure and the importance of monitoring food safety.

Ultimately, the project provides a comprehensive, cost-effective solution that can be accessed by consumers anywhere, making it an essential tool for promoting safe food practices.

1.2.2 SCOPE OF THE PROJECT

The scope of this project encompasses the development of a software-based pesticide monitoring system aimed at providing consumers with a simple, accessible, and cost-effective tool for evaluating pesticide contamination in fruits and vegetables. This project focuses primarily on creating a mobile application that simulates pesticide levels, displays real-time contamination data, and categorizes produce as either “Safe to Eat” or “Unsafe!” based on predefined safety thresholds.

The system’s scope is limited to simulation-based pesticide level monitoring rather than direct physical testing, making it a practical alternative for everyday users. By using random data generation or user input, the app can simulate different contamination levels, providing quick feedback without the need for expensive sensors or laboratory equipment. It also ensures that the system is accessible to a wide range of users by developing the application on the Flutter framework, allowing for cross-platform functionality on both Android and iOS devices.

Although the current version of the app provides basic pesticide level simulation and classification, the scope of the project also includes future enhancements, such as the potential integration of AI-based predictions, historical data analysis, and trend tracking. These advancements aim to improve the app’s accuracy and usability over time. Furthermore, the project encourages food safety awareness by providing educational content within the app, highlighting the importance of pesticide monitoring for public health.

CHAPTER 2

LITERATURE SURVEY

1. Chemical Based Analysis

Laboratory-based techniques such as Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Liquid Chromatography (HPLC) are considered gold standards for pesticide residue detection due to their high precision and sensitivity. However, these methods require expensive instruments, trained professionals, and significant time for analysis, making them unsuitable for routine or large-scale consumer use. Spectroscopy techniques like UV-Visible and FTIR spectroscopy have also been explored for rapid screening of pesticide residues, but they still depend on controlled lab conditions and may lack real-time accessibility.

Recent advancements have introduced portable pesticide detection systems using electrochemical biosensors and IoT-enabled devices. These systems detect pesticide molecules based on their electrical or chemical interactions. Projects using microcontrollers like Arduino and Raspberry Pi integrate sensors to provide real-time feedback and remote monitoring. While these systems improve accessibility, their reliance on physical hardware makes them prone to environmental interference, calibration issues, and increased cost.

2. Software Based Simulation Approaches

With the growth of mobile technologies and AI, software-based approaches have gained popularity. Mathematical modeling has been employed to simulate pesticide degradation over time based on environmental factors such as temperature and humidity. Machine Learning (ML) algorithms are also used to predict contamination levels based on historical and environmental data.

Several mobile applications have been developed to display food contamination levels. For instance, the "Development of a Mobile App for Food Contaminant Monitoring" (2020) demonstrated a system that uses stored data to alert users about unsafe food. Similarly, "Simulation of Pesticide Degradation in Fruits and Vegetables" (2021) presented a model that simulates residue decline patterns. A more recent project, "A Study on Pesticide Residue Detection Using IoT and Cloud Computing" (2022), combined sensors and cloud platforms for real-time monitoring and remote access.

CHAPTER 3

EXISTING METHODS

Chemical Based Analysis

The existing system for chemical-based analysis of pesticide pollution primarily relies on traditional laboratory-based methods involving multiple stages of sample handling and sophisticated instrumentation. Initially, environmental samples such as soil, water, or agricultural produce are collected and prepared through processes like filtration, centrifugation, and pH adjustment. Pesticide residues are then extracted using chemical solvents through techniques like liquid-liquid extraction or solid-phase extraction. The extracted compounds are analyzed using advanced analytical instruments such as Gas Chromatography (GC), Liquid Chromatography (LC), Mass Spectrometry (MS), or High-Performance Liquid Chromatography (HPLC). These instruments allow for highly sensitive and specific detection of pesticide molecules, often down to trace levels. After detection, the data undergoes rigorous analysis and comparison against known standards to identify and quantify the contaminants. While the system provides accurate and reliable results, it is time-consuming, requires skilled personnel, expensive equipment, and is typically limited to laboratory environments rather than on-site, real-time analysis.

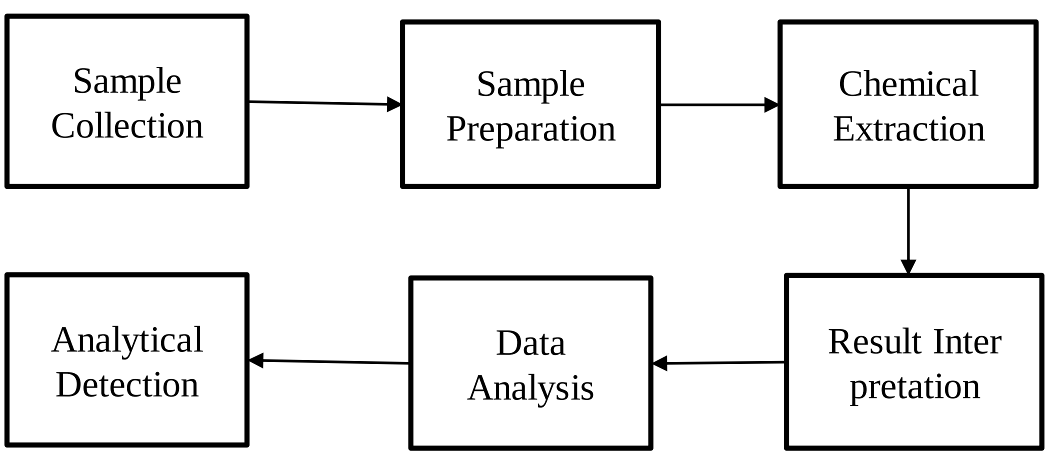

Fig.no.3.1 Block Diagram for Existing Method

CHAPTER 4

PROPOSED METHOD

4.1 BLOCK DIAGRAM

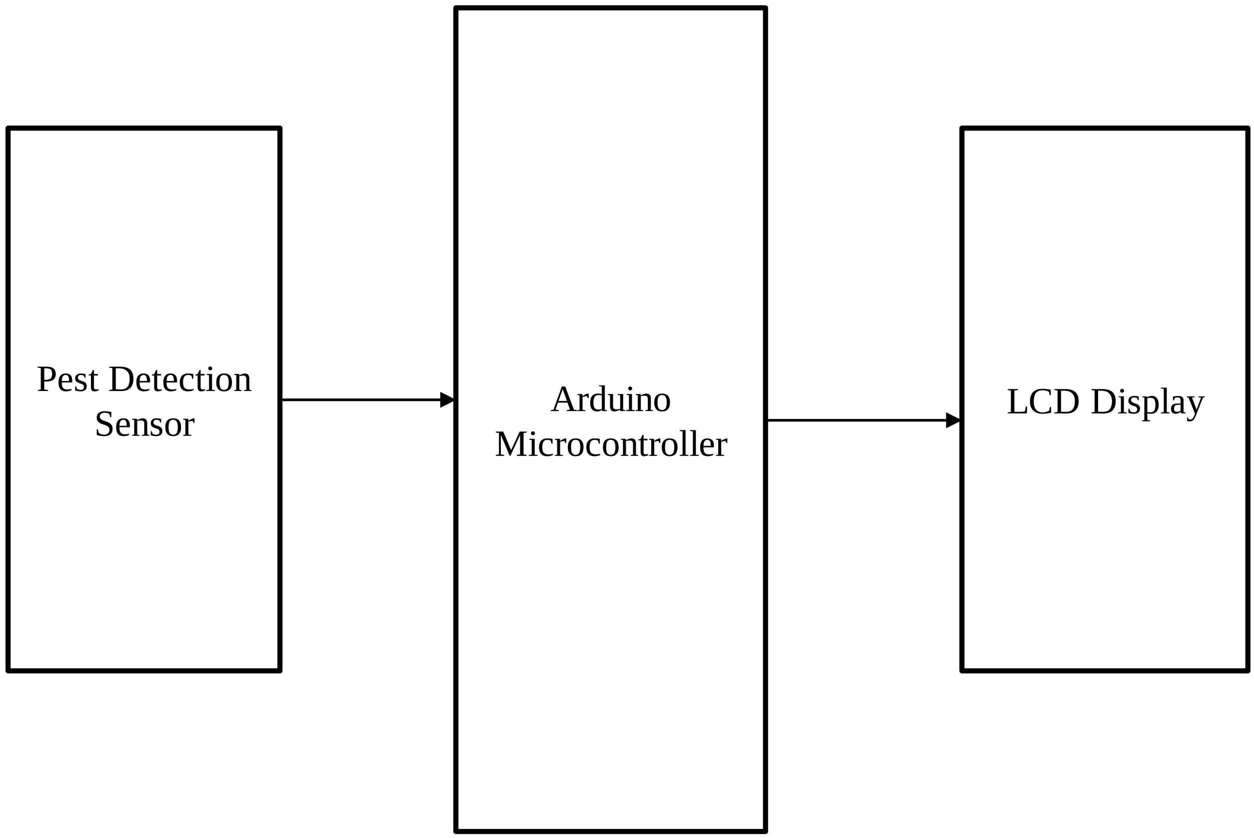

Fig.no.4.1 Block Diagram

4.2 FEATURES TO OVERCOME EXISTING CHALLENGES

The proposed system is a software-based simulation model designed to estimate pesticide contamination levels in fruits and vegetables through a mobile application. Unlike traditional pesticide detection methods that rely on costly laboratory equipment or physical sensors, this system provides a virtual monitoring solution that is both affordable and accessible to the general public.

The mobile application is developed using Flutter, ensuring cross-platform compatibility and a seamless user experience. It uses random number generation algorithms to simulate pesticide levels in percentages (0–100%). These values represent the potential contamination in selected fruits or vegetables. The system then applies a simple decision-making algorithm to classify the produce: if the contamination level is below 30%, the item is marked as “Safe to Eat,” otherwise it is labeled as “Unsafe!”

To enhance user understanding, the app includes real-time data visualization through color indicators, percentage displays, and simple graphs. For example, green may indicate safe levels, while red signifies unsafe contamination. The user interface is designed to be intuitive, making it easy for people of all age groups to monitor and interpret results.

The system also includes informational features to educate users about pesticide risks and encourage conscious food choices. In future developments, the app may incorporate AI-driven prediction models, allowing users to get more accurate results based on historical patterns, weather data, or crop type.

Overall, the proposed system offers a cost-effective, portable, and user-friendly alternative to hardware-based pesticide detection methods, empowering consumers to make safer food decisions using just their smartphones.

CHAPTER 5

METHODOLOGY

The methodology for this project outlines the step-by-step process involved in designing and implementing a software-based system to simulate and monitor pesticide pollution levels in fruits and vegetables. The approach combines frontend mobile development with backend logic to generate, process, and display simulated contamination data.

1. PROBLEM IDENTIFICATION

The project begins by recognizing the limitations of traditional pesticide detection methods, which are often expensive, hardware-dependent, and inaccessible to regular consumers. This leads to the need for a cost-effective, software-only solution.

2. SYSTEM DESIGN

- Input Data: Pesticide levels are simulated using random number generation algorithms ranging from 0% to 100%.
- Processing Logic: The app processes these values using a simple decision- making algorithm to assess whether the produce is safe to consume.
- Output: The result is visualized through an intuitive mobile interface, offering immediate feedback on food safety.

3. SOFTWARE IMPLEMENTATION

Frontend (Flutter):

The user interface is built using the Flutter framework, providing cross-platform compatibility. It includes features such as fruit/vegetable selection, simulated pesticide readings, safety classification, and alerts.

Backend Logic:

The core functionality involves generating random pesticide values and classifying them:

If level $< 30\%$ → Safe to Eat If level $\geq$

30% → Unsafe!

Visual elements such as color codes and graphs are also updated based on these values.

4. TESTING AND DEBUGGING

The application is tested across multiple devices and emulators to ensure a consistent and smooth user experience. Bugs and inconsistencies are identified and resolved during this phase.

5. DEPLOYMENT AND FUTURE SCOPE

Once verified, the application is deployed on Android devices. In future iterations, the system may be enhanced with features like machine learning models for more accurate prediction, historical data tracking, and user-customizable thresholds for better control.

SOFTWARE REQUIRED

Flutter SDK

Used for designing and developing the mobile application's frontend and user interface. Flutter allows for seamless cross-platform development.

Dart Programming language

Utilized for writing the application's core logic, including user interaction handling, data processing, and decision-making algorithms.

Visual Studio Code

Integrated Development Environments (IDEs) used for coding, testing, and running the Flutter application. Android Studio is also used for mobile emulation.

WOKWI Simulation Platform

An online electronics simulator used to virtually model sensor behavior and pesticide level detection logic. Though hardware isn't physically implemented, Wokwi helped in simulating how sensors would typically behave in a real-world scenario, giving a conceptual link between the virtual pesticide levels and embedded systems.

Random Number Generator (RNG) Logic

Implements simulated pesticide values within the app using backend algorithms that generate random contamination levels (0–100%).

Graphical and Color Visualization

Used Flutter widgets to create color indicators, progress bars, and simple graphs to visually communicate pesticide level status.

Decision Making Algorithm

Logic implemented in Dart to categorize produce as “Safe to Eat” or “Unsafe!” based on contamination thresholds.

ARDUINO UNO FEATURES

The features of an Arduino Uno mainly include the following.

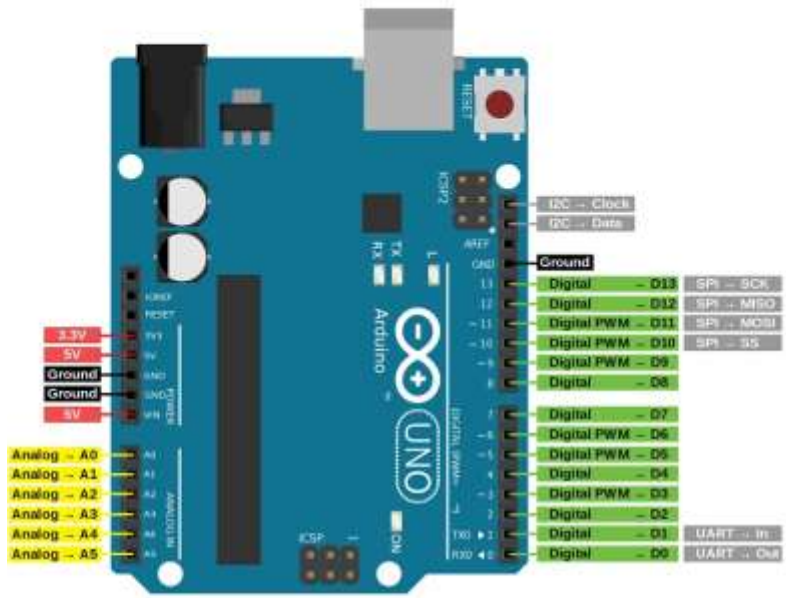

Fig.no.5.1 Arduino UNO Board

ARDUINO-UNO-BOARD

- ATmega328P Microcontroller is from 8-bit AVR family
- Operating voltage is 5V
- Input voltage (Vin) is 7V to 12V
- Input/Output Pins are 22
- Analog i/p pins are 6 from A0 to A5
- Digital pins are 14
- Power consumption is 19 mA
- I/O pins DC Current is 40 mA
- Flash memory is 32 KB
- SRAM is 2 KB
- EEPROM is 1 KB

COLORIMETRIC SENSOR:

Colorimetry is widely used to detect pesticide pollutants because of its application in food and environment. Its advantages include easy preparation, low cost and clear observation of results with naked eyes. AuNPs and silver nanoparticles are the most common probes for colorimetric sensing analysis in the detection of pesticide residues by colorimetry.

Therefore, in order to improve the sensitivity of colorimetric sensor based on gold and silver nanoparticles, it is a common method to modify AuNPs. For example, silk fibroin was used to modify AuNPs, and a kind of AuNPs -silk fibroin (SF-AuNPs) was developed, and a colorimetric biosensor with high sensitivity to CLPF was successfully constructed. After degumming, dissolving and enzymolysis, silk protein solution was extracted and dialyzed, this FB Roin solution was used for synthesis of AuNPs *in-situ* without using any external reducing and capping agent. Moreover, this sensor can detect CLPF with a concentration of 10ppb.

In addition to modifying AuNPs particles, a colorimetric sensor sequence was designed based on potassium permanganate assisted by sulfuric acid. H_2SO_4 can help $KMnO_4$ fade in the presence of pesticides, and it can be observed with naked eyes. At the same time, the red, green and blue values of different pesticide $KMnO_4$-H_2SO_4 systems will change. Based on this, a variety of pesticides, such as CLPF, α-666, 2-methyl-4-chlorophenoxyacetic acid sodium salt monohydrate, etc., can be distinguished and identified only by using different concentrations of potassium permanganate and sulfuric acid.

This method can be applied to the detection of a large number of pesticide residues, and has a good development prospect

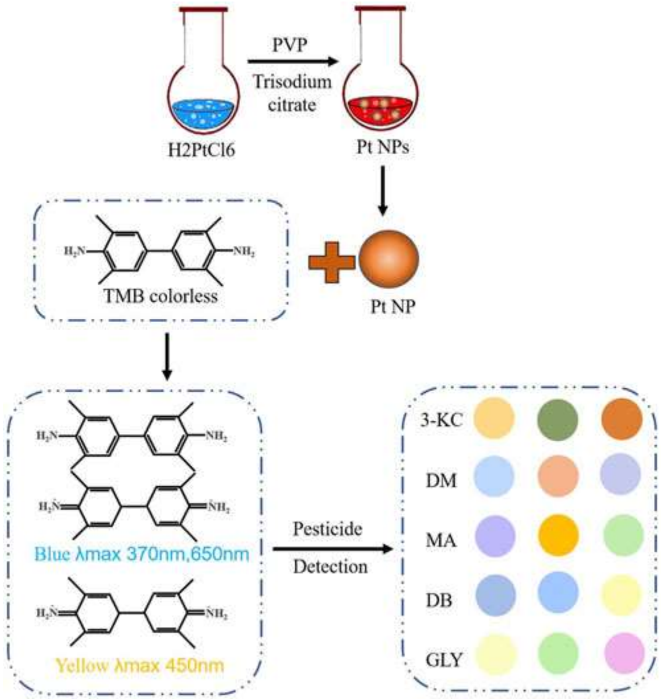

Fig.no.5.2 Schematically illustration for construction of TMB-Pt NPs multichannel colorimetric sensor array.

Biosensor Type	**LOD**	**Cost**	**Reproducibility**	**Characteristic**	**Reference**
Electrochemical sensor	0.88 p.m. – 1.2 nM	350	Relatively poor	On-site; detection; Complex; pretreatment	Li et al. (2016), Patella et al. (2021)
Fluorescence sensor	0.13 nM – 10 nM	500 – 5,000	Affected by the lifetime and background of fluorescent substances	High sensitivity detection; Influenced by the lifetime and background of substance	(Li et al., 2018; Arvand and Mirroshandel, 2019)
Colorimetric sensor	5 nM	100 – 300	Strong	Simple; Practical; Visible to the naked eye; Unable to achieve multiple detection and quantitative detection	Shi et al. (2013)
Surface enhanced Raman sensor	1 nM – 0.1 μM	1,000	Relatively poor	Trace detection	(Zhang et al., 2013; Hu et al., 2016)

Table.1 Bio-sensor Type and Characteristics

LIQUID CRYSTAL DISPLAY

LCD is used to display the results of the system operation such as sensed values, motor status etc…. A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. The LCD standard requires 3 control lines and 8 I/O lines for the data bus. The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. In this tutorial, we will discuss about character based LCDs, their interfacing with various microcontrollers, various interfaces (8-bit/4-bit), programming, special stuff and tricks you can do with these simple looking LCDs which can give a new look to your application.

PIN DESCRIPTION

The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780controllers.

Pin description is shown in the table below.

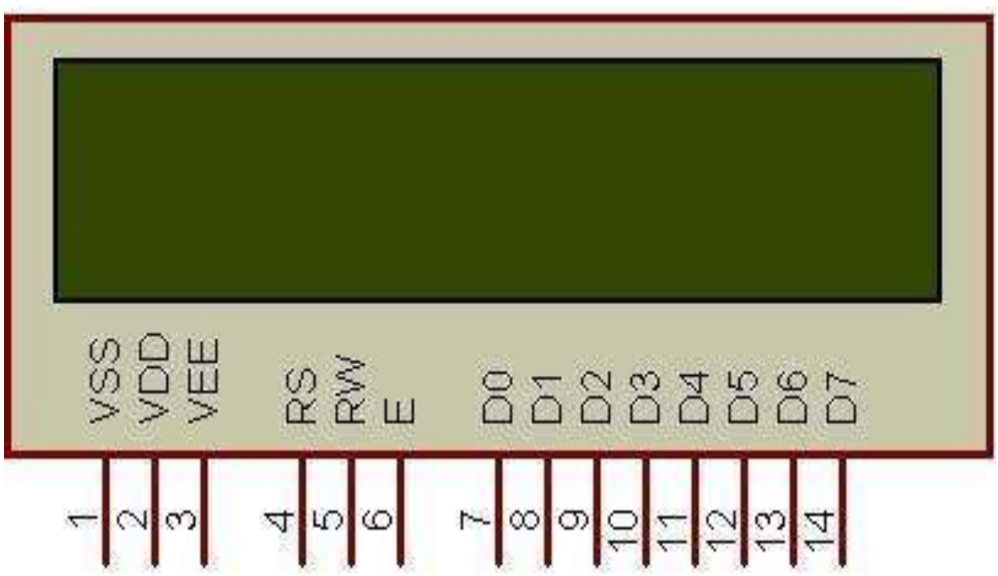

Fig.no.5.3 LCD Pinout

Pin No.	Name	Description
Pin no. 1	D7	Data bus line 7 (MSB)
Pin no. 2	D6	Data bus line 6
Pin no. 3	D5	Data bus line 5
Pin no. 4	D4	Data bus line 4
Pin no. 5	D3	Data bus line 3
Pin no. 6	D2	Data bus line 2
Pin no. 7	D1	Data bus line 1
Pin no. 8	D0	Data bus line 0 (LSB)
Pin no. 9	EN1	Enable signal for row 0 and 1 (1^{st}controller)
Pin no. 10	R/W	0 = Write to LCD module 1 = Read from LCD module
Pin no. 11	RS	0 = Instruction input 1 = Data input
Pin no. 12	VEE	Contrast adjust
Pin no. 13	VSS	Power supply (GND)
Pin no. 14	VCC	Power supply (+5V)
Pin no. 15	EN2	Enable signal for row 2 and 3 (2^{nd}controller)
Pin no. 16	NC	Not Connected

Table.2 Character LCD pins with 2 Controller

8 data pins D7:D0

Bi-directional data/command pins.

Alphanumeric characters are sent in ASCII

format.

• **RS: Register Select**

RS = 0 -> Command Register is selected

RS = 1 -> Data Register is selected

• **R/W: Read or Write**

0 -> Write, 1 -> Read

BF - Busy Flag:

Busy Flag is an status indicator flag for LCD. When we send a command or data to the LCD for processing, this flag is set (ie., BF =1) and as soon as the instruction is executed successfully this flag is cleared (BF = 0). This is helpful in producing and exact amount of delay. for the LCD processing. To read Busy Flag, the condition RS = 0 and R/W = 1 must be met and The MSB of the LCD data bus (D7) act as busy flag. When BF = 1 means LCD is busy and will not accept next command or data and BF = 0 means LCD is ready for the next command or data to process.

Instruction Register (IR) and Data Register (DR)

There are two 8-bit registers in HD44780 controller Instruction and Data register. Instruction register corresponds to the register where you send commands to LCD e.g LCD shift command, LCD clear, LCD address etc. and Data register is used for storing data which is to be displayed on LCD. when send the enable signal of the LCD is asserted, the data on the pins is latched in to the data register and data is then moved automatically to the DDRAM and hence is displayed on the LCD. Data Register is not only used for sending data to DDRAM but also for CGRAM, the address where you want to send the data, is decided by the instruction you send to LCD. We will discuss more on LCD instruction set further in this tutorial.

Commands and Instruction set

Only the instruction register (IR) and the data register (DR) of the LCD can be controlled by the MCU. Before starting the internal operation of the LCD, control information is temporarily stored into these registers to allow interfacing with various MCUs, which operate at different speeds, or various peripheral control devices. The internal operation of the LCD is determined by signals sent from the MCU. These signals, which include register selection signal (RS), read/write signal (R/W), and the data bus (DB0 to DB7), make up the LCD instructions in table.

There are four categories of instructions that:

- Designate LCD functions, such as display format, data length, etc.
- Set internal RAM addresses
- Perform data transfer with internal RAM

Command	Code										Description	Execution Time
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82μs~1.64ms
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40μs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40μs
Cursor & Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40μs
Function Set	0	0	0	0	1	DL	N$	F	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40μs
Set CG RAM Address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40μs
Set DD RAM Address	0	0	1	A_{DD}							Sets the DD RAM address. Data may be written or read after making this setting.	40μs
Read Busy Flag & Address	0	1	BF	AC							Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.	1μs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	46μs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	46μs
	I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C= 1: Display shift S/C = 0: cursor move R/L= 1: Shift to the right. R/L= 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5x10 dots F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data *# Set to 1 on 24x4 modules* *$ With KS0072 is Address Mode.*										DD RAM: Display data RAM CG RAM: Character generator RAM A_{CG}: CG RAM Address A_{DD}: DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.

Table.3 Command and Instruction

CHAPTER 6

RESULT AND DISCUSSION

The proposed software-based simulation model successfully achieves its objective of monitoring pesticide contamination in fruits and vegetables without the use of physical hardware. The mobile application developed using Flutter provides an intuitive and user-friendly interface that allows users to simulate pesticide levels in various produce types and instantly assess their safety.

The app generates random pesticide contamination levels (from 0% to 100%) and applies a threshold-based classification system. If the level is below 30%, the produce is labeled as “Safe to Eat,” while levels equal to or above 30% trigger a warning as “Unsafe!” This simple decision-making mechanism has been effective in demonstrating how software can replicate basic environmental monitoring concepts.

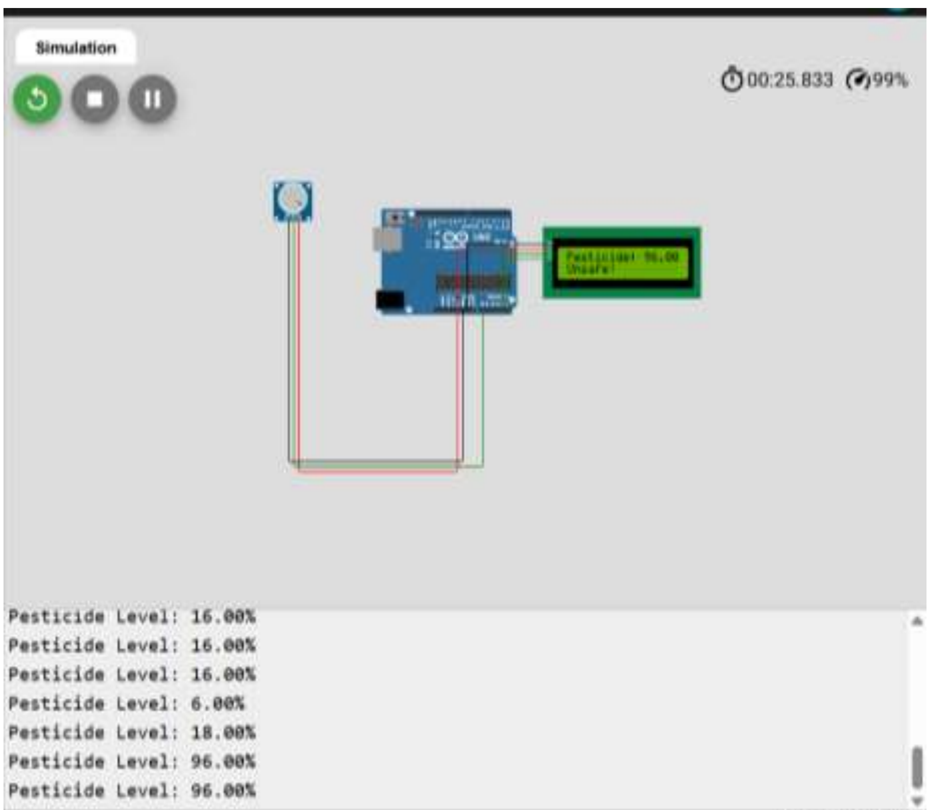

Fig.no.6.1 Simulation Setup

Through testing on Android devices and emulators, the app was found to be responsive, accurate in displaying simulated values, and clear in its visual representation of data. Color-coded indicators and graphs enhanced the overall user experience, making it easier for users to interpret pesticide levels at a glance.

The integration of the Wokwi platform allowed for simulation of the sensor input environment, which helped in visualizing how a real-time sensor system would behave. Though the project is purely software-based, this addition strengthened the conceptual bridge between physical sensing and virtual modeling.

In discussion, it’s important to note that while the simulation provides educational value and raises awareness, it does not replace actual pesticide detection methods used in laboratories or through sensors. However, its accessibility, cost-effectiveness, and simplicity make it a useful tool for everyday users to understand the importance of pesticide monitoring. Future improvements such as machine learning integration, real data support, and user history tracking could make the app more robust and closer to real-world application.

CHAPTER 7

CONCLUSION AND FUTUREWORK

This project successfully demonstrates a software-based simulation model for monitoring pesticide pollution in fruits and vegetables using a mobile application. By eliminating the dependency on hardware sensors or expensive laboratory procedures, the solution offers a cost-effective, accessible, and user-friendly tool for everyday consumers. The app developed using Flutter generates simulated pesticide levels and classifies the safety of produce through a simple decision- making algorithm. Visual features such as color indicators, graphs, and alerts make the system easy to understand and interactive.

To further improve the effectiveness and functionality of the system, the following enhancements are proposed:

Integration of AI/ML Models: Incorporate machine learning algorithms to predict pesticide levels based on various factors like crop type, season, and location.

Database Connectivity: Store user data, historical contamination records, and trends for analysis and reference.

Sensor Integration: In future versions, physical sensors can be connected to validate simulated results and enhance accuracy.

User Customization: Allow users to set their own pesticide safety thresholds and monitor specific fruits or vegetables.

Awareness Modules: Add more educational content, health tips, and links to food safety guidelines to improve user knowledge.

Cloud-Based Data Syncing: Enable real-time syncing and access of data across devices using cloud services like Firebase.

REFERENCES

1.Narasimha, H. B., & Varsha, D. K. (2020). IoT based smart agriculture monitoring system. International Journal of Engineering Research & Technology (IJERT), 9(6), 1-4. https://www.ijert.org/iot-based-smart-agriculture-monitoring-system

2.Sharma, A., & Arya, R. (2018). Pesticide detection techniques: A review. International Journal of Scientific Research and Review, 7(3), 99–107.

3.Ghosh, S., & **Majumdar, D.** (2016). A low-cost wireless sensor network for real-time monitoring of pesticide contamination in fruits and vegetables. International Conference on IoT and Applications (ICIOT), 112–117.

4.Espressif Systems. (2022). ESP32 Series Datasheet. https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf

5.Blynk IoT Platform Documentation. (2023). https://docs.blynk.io

6.Wokwi ESP32 Simulator Documentation. (2023). https://docs.wokwi.com/parts/wokwi-esp32-devkit

7.Random Nerd Tutorials. (2022). ESP32 with I2C LCD using Arduino IDE. https://randomnerdtutorials.com/esp32-i2c-lcd-arduino-ide/

8.IFTTT Documentation – Webhooks Service. (2023). https://help.ifttt.com/hc/en-us/articles/115010230347

9.Kaur, H., & Kaur, K. (2021). A review on applications of IoT in agriculture. Materials Today: Proceedings, 51(1), 21–25.

10.Mishra, P., & Soni, P. (2020). Pesticide residue monitoring in food products using biosensors: A brief review. Journal of Environmental Science and Health, Part B, 55(9), 797–808.

OUTCOME


AIP Publishing
School of Computing
SRM
Springer
CONFERENCE ON
ADVANCES IN COMMUNICATION NETWORKS & SYSTEMS
(COACONS 2025)
Conference on COACONS 2025
CERTIFICATE OF MERIT
This is to certify that
Dr./Mr./Mrs. Subhika D
of M. Kumarasamy College of Engineering has presented a paper entitled
Enhancing Body Detection in CSSR Operation Using Advanced Technology
in the Conference on "Advances in Communication Networks & Systems (COACONS 2025)" Organized by Department of Networking and Communications, School of Computing, SRM Institute of Science and Technology, Kattankulathur held between 26th and 27th March, 2025.
Dr. A. Suresh
Convenor (COACONS 2025), Associate Professor, NWC, SRMIST.
Dr. M. Lakshmi
Professor & Head, Networking and Communications, SRMIST.
Dr. M. Pushpalatha
Associate Chairperson, School of Computing, SRMIST.
Dr. Revathi Venkataraman
Chairperson, School of Computing, SRMIST.


AIP Publishing
School of Computing
SRM
Springer
CONFERENCE ON
ADVANCES IN COMMUNICATION NETWORKS & SYSTEMS
(COACONS 2025)
Conference on COACONS 2025
CERTIFICATE OF MERIT
This is to certify that
Dr./Mr./Mrs. Swetha M
of M. Kumarasamy College of Engineering has presented a paper entitled
Enhancing Body Detection in CSSR Operation Using Advanced Technology
in the Conference on "Advances in Communication Networks & Systems (COACONS 2025)" Organized by Department of Networking and Communications, School of Computing, SRM Institute of Science and Technology, Kattankulathur held between 26th and 27th March, 2025.
Dr. A. Suresh
Convenor (COACONS 2025), Associate Professor, NWC, SRMIST.
Dr. M. Lakshmi
Professor & Head, Networking and Communications, SRMIST.
Dr. M. Pushpalatha
Associate Chairperson, School of Computing, SRMIST.
Dr. Revathi Venkataraman
Chairperson, School of Computing, SRMIST.

AIP Publishing | Springer | School of Computing | SRM

Conference on COACONS 2025

CONFERENCE ON

ADVANCES IN COMMUNICATION NETWORKS & SYSTEMS

(COACONS 2025)

CERTIFICATE OF MERIT

This is to certify that

Dr./Mr./Mrs. Swetha M

of M. Kumarasamy College of Engineering has presented a paper entitled Enhancing Body Detection in CSSR Operation Using Advanced Technology

in the Conference on **"Advances in Communication Networks & Systems (COACONS 2025)"** Organized by Department of Networking and Communications, School of Computing, SRM Institute of Science and Technology, Kattankulathur held between 26th and 27th March, 2025.

Dr. A. Suresh	Dr. M. Lakshmi	Dr. M. Pushpalatha	Dr. Revathi Venkataraman
Convenor (COACONS 2025), Associate Professor, NWC, SRMIST.	Professor & Head, Networking and Communications, SRMIST.	Associate Chairperson, School of Computing, SRMIST.	Chairperson, School of Computing, SRMIST.

AIP Publishing | Springer | School of Computing | SRM

Conference on COACONS 2025

CONFERENCE ON

ADVANCES IN COMMUNICATION NETWORKS & SYSTEMS

(COACONS 2025)

CERTIFICATE OF MERIT

This is to certify that

Dr./Mr./Mrs. Thanishka K

of M. Kumarasamy College of Engineering has presented a paper entitled Enhancing Body Detection in CSSR Operation Using Advanced Technology

in the Conference on **"Advances in Communication Networks & Systems (COACONS 2025)"** Organized by Department of Networking and Communications, School of Computing, SRM Institute of Science and Technology, Kattankulathur held between 26th and 27th March, 2025.

Dr. A. Suresh	Dr. M. Lakshmi	Dr. M. Pushpalatha	Dr. Revathi Venkataraman
Convenor (COACONS 2025), Associate Professor, NWC, SRMIST.	Professor & Head, Networking and Communications, SRMIST.	Associate Chairperson, School of Computing, SRMIST.	Chairperson, School of Computing, SRMIST.