DESIGN AND IMPLEMENTATION OF A LINEAR EQUATION GRAPH PLOTTER

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF HIGHER NATIONAL DIPLOMA (HND) IN COMPUTER SCIENCE.

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DECLARATION

I hereby declare that the work in this project titled **"Design and Implementation of a Linear Equation Graph Plotter"** was performed by me under the supervision of Mal. Ahmed M. Aliyu. The information derived from literatures has been duly acknowledged in the text and a list of references provided. The work embodied in this project is original and had not been submitted in part or in full for any other diploma or certificate of this or any other institution.

Simon Isa'ac Mallum	________________	________________
(ST/CS/HND/22/047)	Signature	Date

CERTIFICATION

This project titled **"Design and Implementation of a Linear Equation Graph Plotter"** meets the regulations governing the award of Higher National Diploma (HND) in Computer Science, Federal Polytechnic Mubi, Adamawa State

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(Project Supervisor) Sign/Date

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(External Examiner) Sign/Date

DEDICATION

This project is dedicated to my beloved parents Mr. and Mrs. Simon Mallum for their advice, encouragement and financial support towards my academic pursuit.

ACKNOWLEDGEMENTS

I want to acknowledge Almighty God for his infinite mercy and protection throughout my academic activities. And for the understanding in achieving our academic success.

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ABSTRACT

This project focuses on the design and implementation of a Linear Equation and Graphing Calculator, aimed at providing a comprehensive tool for solving and visualizing linear equations. The primary objective was to develop an efficient and user-friendly application that allows users to input linear equations, obtain solutions, and generate graphical representations of the equations. The project involved creating three key interfaces: the Welcome Interface, which serves as the entry point; the Linear Equation Solver Interface, which processes and solves the equations; and the Graph Interface, which displays graphical representations of the solutions. The system was designed with a focus on accuracy, usability, and visual clarity, ensuring that it effectively supports users in solving linear equations and understanding their graphical interpretations. The tool is intended to benefit students, educators, and professionals by simplifying mathematical problem-solving and enhancing educational experiences. The results demonstrate that the calculator meets its objectives, providing a valuable resource for both educational and practical applications. Future work may involve expanding the tool's capabilities, improving user interface features, and integrating advanced functionalities to further enhance its utility.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Linear equations and graphing calculators play a crucial role in various fields such as mathematics, engineering, economics, and physics. They serve as essential tools for solving problems, analyzing data, and visualizing relationships between variables. In recent years, with advancements in technology and computational methods, there has been an increasing demand for efficient and user-friendly tools to handle linear equations and graphing tasks. Linear equations and graphing calculators have been fundamental tools in mathematics education and various scientific disciplines for decades. They facilitate the exploration of mathematical relationships, the analysis of data, and the visualization of functions and equations. However, as technology advances and educational methodologies evolve, there is a continuous demand for innovative and user-friendly computational tools that align with modern teaching and learning practices (Anton *et al.*, 2022).

Linear equations and graphing calculators are fundamental tools in mathematics education and various fields of science and engineering. Linear equations represent relationships between variables that can be graphically depicted as straight lines on a Cartesian plane. Graphing calculators, on the other hand, are electronic devices equipped with capabilities to graph functions, solve equations, and perform numerical computations. Linear equations serve as the cornerstone of algebra, providing a framework for understanding more complex mathematical concepts. They are extensively used in modeling real-world phenomena, ranging from physics and economics to engineering and social sciences. Understanding linear equations and their graphical representations is crucial for students to develop problem-solving skills and analytical thinking. Graphing calculators have revolutionized the way mathematics is taught and learned. These devices offer students a dynamic visual representation of mathematical concepts, facilitating deeper comprehension and exploration. With the ability to graph equations quickly and accurately, graphing calculators allow for experimentation and visualization of mathematical relationships, promoting an intuitive understanding of abstract concepts (Stewart, 2018).

Graphing calculators have undergone significant evolution since their inception. Early models, such as the Texas Instruments TI-81 introduced in 1990, provided basic graphing capabilities but were limited in functionality and user interface design. Over the years, advancements in hardware and software have led to the development of more sophisticated graphing calculators with enhanced computational power, larger display screens, and intuitive user interfaces. The integration of technology, including graphing calculators, into educational curricula has become increasingly prevalent. Research has shown that technology-enhanced instruction can improve student engagement, conceptual understanding, and problem-solving skills. Graphing calculators, in particular, enable students to visualize mathematical concepts, experiment with equations, and explore real-world applications in fields such as science, engineering, and economics (Bozhurt & Dogan, 2021).

Despite the benefits of graphing calculators, there are several challenges and limitations associated with existing solutions. Commercial graphing calculators can be costly, which may limit accessibility for students and schools with budget constraints. Additionally, proprietary software and closed ecosystems restrict customization and integration with other educational resources and tools (Hernandez, 2021). Furthermore, traditional graphing calculators may not always align with the preferences and needs of modern learners, who are accustomed to intuitive user interfaces, cloud-based collaboration, and integration with mobile devices and online platforms (Sullivan, 2018).

1.2 Problem Statement

While graphing calculators are widely used in education and research, there is a pressing need for more accessible, customizable, and integrated solutions that address the limitations of existing tools. The current landscape of graphing calculators presents several challenges and shortcomings, which necessitate the development of innovative alternatives:

Many commercial graphing calculators are prohibitively expensive, posing financial barriers for students, particularly those from low-income backgrounds or resource-constrained educational institutions. The high cost of these devices can impede equitable access to essential educational resources, hindering students' ability to fully engage with mathematics and related disciplines. Therefore, there is a need for affordable alternatives that ensure universal access to graphing calculator functionality.

Existing graphing calculators often lack flexibility in terms of customization and adaptability to diverse user needs and preferences. Users may require specific features, such as support for advanced mathematical functions, customizable graphing options, or integration with external software tools. However, proprietary software and closed ecosystems limit users' ability to modify or extend the functionality of graphing calculators according to their requirements. Consequently, there is a demand for customizable solutions that empower users to tailor the calculator to their unique workflows and educational contexts.

The user experience (UX) and interface design of existing graphing calculators may not always align with modern usability standards and user expectations. Users, particularly students and educators, expect intuitive interfaces, responsive interactions, and visually appealing designs that enhance usability and facilitate learning. However, many graphing calculators feature outdated interfaces, complex menu structures, and cumbersome input methods, which can impede user productivity and satisfaction. Thus, there is a critical need for graphing calculators with user-centric design principles that prioritize usability, accessibility, and aesthetics.

1.3 Aim and Objectives

The aim of this project is to design and implement a versatile linear equation and graphing calculator. The specific objectives are:

i. Develop a graphing calculator that is affordable and accessible to all students.
ii. Design an intuitive user interface that enhances usability, facilitates learning, and promotes a positive user experience.
iii. Implement the above system using Python programming language.

1.4 Significance of the Study

The significance of this study lies in its potential to address critical gaps and challenges in the current landscape of graphing calculators. By developing a versatile, accessible, and customizable linear equation and graphing calculator, this study aims to make significant contributions in the following areas:

i. The calculator's accessibility and affordability will democratize access to essential educational resources, ensuring that all students have equal opportunities to engage with mathematics and related disciplines. By providing a user-friendly platform for exploring mathematical concepts and visualizing data, the calculator will enhance students' learning experiences and promote deeper understanding and retention of key mathematical principles.
ii. The calculator's integration capabilities will facilitate seamless data exchange and collaboration among researchers, enabling them to leverage the tool for data analysis, modeling, and visualization in various scientific fields. By providing a customizable platform that supports advanced mathematical functions and interoperates with external software tools, the calculator will empower researchers to streamline their workflows and accelerate the pace of discovery and innovation.

1.5 Scope of the Study

The scope of this study is to create a linear equation and graphing calculator with a focus on user-friendliness, efficiency, and versatility. Key components include designing an intuitive interface, developing a robust computational engine for solving equations and generating accurate graphs, and enhancing integration with external software. Testing and evaluation will ensure accuracy, reliability, and compatibility, with user feedback incorporated for improvement.

1.6 Definition of some Operational Terms

Equation: An equation is a mathematical statement that asserts the equality of two expressions.

Exponentiation: Exponentiation is the operation of raising a number to a power (Selcuk & Kose, 2020).

Graphing Calculator: A graphing calculator is an electronic device capable of plotting graphs, performing numerical calculations, and solving equations (Montgomery *et al.*, 2012).

Implementation: In the context of mathematics or computer science, implementation often involves translating theoretical concepts or algorithms into concrete programs, procedures, or actions (Larson & Edwards, 2017).

Linear Equation: A linear equation is an algebraic equation that represents a straight line when graphed on a Cartesian plane (Thomas *et al.*, 2014).

Linear: In mathematics, "linear" typically refers to a relationship or function that can be represented by a straight line (Stevenson, 2019).

System: In mathematics, a system refers to a collection of interrelated or interconnected objects, elements, or components that work together as a unified whole (Selcuk & Kose, 2020).

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter provides a comprehensive review of the existing literature relevant to the design and implementation of linear equation and graphing calculators. The review encompasses various aspects, including theoretical frameworks, software implementations, and user interface designs. By synthesizing prior work, this chapter aims to identify gaps in the current research landscape and lay the groundwork for the development of an advanced linear equation and graphing calculator.

2.2 Computational Algorithms for Equation Solving and Graph Plotting

Efficient computational algorithms form the backbone of equation solving and graph plotting functionalities in calculator systems. This section delves deeper into recent advancements in these algorithms, focusing on their numerical stability, complexity, and applicability to real-world problems. Equation solving algorithms are essential for finding solutions to systems of linear equations, which are prevalent in various scientific and engineering domains. Recent research has focused on enhancing the numerical stability and efficiency of these algorithms. For instance, Zhang et al. (2023) proposed a novel iterative solver based on the Krylov subspace method, which demonstrated superior convergence properties compared to traditional methods. Additionally, Li and Wang (2021) developed a hybrid algorithm combining symbolic and numerical techniques for solving polynomial equations, offering improved accuracy and speed.

Furthermore, the emergence of machine learning techniques has led to innovative approaches for equation solving. Chen et al. (2022) introduced a neural network-based solver capable of handling nonlinear systems with high-dimensional parameter spaces, showcasing promising results in terms of robustness and scalability. These advancements pave the way for developing more versatile and adaptive equation solvers tailored to specific problem domains. Graph plotting algorithms play a crucial role in visualizing mathematical functions and data relationships. Recent studies have focused on optimizing these algorithms for real-time plotting and interactive visualization. For example, Kim and Lee (2023) proposed an efficient rendering technique based on GPU acceleration, enabling smooth and responsive graph plotting even for complex functions and large datasets. Similarly, Xu *et al.* (2022), developed a parallelized algorithm for plotting parametric curves, leveraging multicore processors to achieve significant speedup in computation time.

Moreover, advances in computational geometry have led to novel graph plotting techniques tailored to specific geometric structures. Li *et al.* (2024) introduced a curvature-aware plotting algorithm capable of accurately representing curves with varying degrees of smoothness, which is particularly beneficial for visualizing functions in differential geometry and computer-aided design applications. Integrating equation solving and graph plotting functionalities within a unified framework presents opportunities for seamless mathematical exploration and visualization. Recent efforts have focused on developing integrated solver-plotter systems capable of dynamically updating graphs based on user-defined equations and parameters. For instance, Wang *et al.* (2023), introduced a hybrid solver-plotter application that leverages symbolic computation techniques to generate plots directly from equation inputs, enabling interactive exploration of mathematical concepts and relationships.

Furthermore, the integration of machine learning models into solver-plotter systems holds promise for enhancing functionality and usability. Zhang and Liu (2022), proposed a deep learning-based approach for automatically generating plots from natural language descriptions of mathematical problems, offering intuitive interaction and reducing the cognitive load on users. These integrated systems represent a significant step towards democratizing mathematical exploration and promoting interdisciplinary collaboration across diverse domains. The theoretical underpinnings of linear equations and graphing calculators lie in mathematical principles and computational algorithms. Numerous studies have explored the fundamental concepts underlying linear algebra, equations, and graphing techniques. For instance, Smith and Smith (2019), elucidated the Gauss-Jordan elimination method for solving systems of linear equations, highlighting its efficiency and numerical stability. Additionally, Jones *et al.* (2021), investigated graphing algorithms, emphasizing the importance of optimizing computational complexity for real-time plotting of functions.

Several software implementations have been developed to facilitate linear equation solving and graphing functionalities. MATLAB, a widely used computational software, offers built-in functions for solving linear systems and plotting graphs (MathWorks, 2020). Similarly, Python libraries such as NumPy and Matplotlib provide robust tools for numerical computation and visualization (Van Der Walt *et al.,* 2011). These software packages serve as valuable resources for researchers and practitioners in the field of mathematics and engineering.

2.3 Evolution of Graphing Calculator

The evolution of graphing calculators represents a fascinating intersection of technological advancements, pedagogical needs, and user interface innovations. This section explores the historical trajectory of graphing calculators, highlighting key milestones and recent developments in hardware, software, and educational applications. The concept of a graphing calculator traces back to the 1980s when handheld devices began incorporating graphical capabilities for mathematical visualization. One of the earliest commercial graphing calculators, the Casio fx-7000G, was introduced in 1985, featuring basic graph plotting functionalities and programmability (Casio, n.d.). Subsequent iterations, such as the Texas Instruments TI-81 and TI-82, expanded upon these capabilities, incorporating larger displays and enhanced computational power (Burrill *et al.*, 2022).

The evolution of graphing calculators has been driven by advancements in hardware miniaturization, processing power, and display technologies. Recent iterations, such as the Texas Instruments TI-84 Plus CE and the Casio fx-CG500, boast color displays, touch-sensitive interfaces, and wireless connectivity options. These features enhance user interaction, facilitate collaborative learning, and enable seamless integration with digital learning platforms. Moreover, the integration of rechargeable batteries and energy-efficient components has extended the battery life of modern graphing calculators, reducing the need for frequent recharging and enhancing portability (Hernandez, 2021). Additionally, the adoption of open-source software frameworks such as NumWorks and TILP (Texas Instruments Link Protocol) has fostered a vibrant community of developers, enabling the creation of custom applications, games, and educational resources for graphing calculators.

Graphing calculators have become indispensable tools in mathematics education, enabling students to visualize mathematical concepts, explore functions, and solve problems interactively. Research has shown that the use of graphing calculators in classrooms promotes active learning, enhances conceptual understanding, and improves problem-solving skills. Furthermore, the integration of graphing calculator technology into standardized testing formats, such as the SAT and AP exams, underscores their importance in modern education. Recent developments in educational technology have further expanded the capabilities of graphing calculators, blurring the lines between traditional calculators and handheld computing devices. For instance, the introduction of dynamic geometry software such as GeoGebra and Desmos has enabled seamless integration with graphing calculators, allowing students to explore geometric constructions and visualize mathematical relationships in real-time. Additionally, the proliferation of online learning platforms and cloud-based services has facilitated remote collaboration and asynchronous learning experiences, transforming the role of graphing calculators in the digital age (Huang *et al*., 2020).

Looking ahead, the evolution of graphing calculators is poised to continue, driven by advancements in artificial intelligence, augmented reality, and Internet of Things (IoT) technologies. Emerging trends such as machine learning-based tutoring systems, augmented reality graph visualization, and cloud-connected calculator ecosystems hold promise for revolutionizing mathematics education and empowering learners worldwide (Nguyen *et al*., 2022). Moreover, the ongoing convergence of hardware and software platforms is blurring the boundaries between graphing calculators, smartphones, and tablet devices. Future graphing calculator systems may leverage the computational power and connectivity of mobile devices while retaining the specialized input mechanisms and ergonomic design principles of traditional calculators, offering users a seamless and integrated mathematical computing experience (Yuan *et al*., 2023).

Graphing calculators have evolved beyond their traditional role as mathematical tools to encompass a wide range of functionalities catering to diverse user needs. Recent models offer built-in features such as spreadsheet applications, statistical analysis tools, and programming environments, transforming them into versatile computing platforms (Harris & Johnson, 2021). Moreover, integration with online services and cloud storage enables seamless synchronization of data and access to educational resources, fostering collaborative learning environments (Lee *et al.,* 2024). The evolution of graphing calculators has been characterized by a shift towards more interactive and customizable user experiences. Recent models incorporate touch-sensitive screens, stylus input, and gesture recognition capabilities, empowering users to interact with graphs and mathematical objects in a natural and intuitive manner (Chen *et al*., 2021). Furthermore, the availability of software development kits (SDKs) and open APIs allows for the creation of custom applications and extensions, enabling users to tailor their calculators to specific educational or professional requirements (Gao *et al.,* 2023).

Advancements in the design and features of graphing calculators have also focused on enhancing accessibility and inclusivity for users with diverse needs. Recent models incorporate features such as speech synthesis, screen readers, and tactile feedback mechanisms to assist users with visual or motor impairments (Smith *et al*., 2022). Moreover, efforts are being made to develop inclusive educational materials and software interfaces that accommodate different learning styles and cognitive abilities, ensuring that graphing calculators remain accessible to all users (Jones & Brown, 2023).

2.4 Graphical User Interface (GUI) Designs

Effective GUI designs play a crucial role in enhancing the usability and accessibility of linear equation and graphing calculators. Studies have explored various interface paradigms, ranging from command-line interfaces to graphical representations. For instance, Li *et al*. (2022) proposed a user-friendly GUI for a web-based graphing calculator, incorporating interactive features such as zooming and panning. Similarly, Johnson and Miller (2023) conducted usability testing to evaluate the intuitiveness of different interface layouts, emphasizing the importance of clear visual feedback and ergonomic design principles. Despite significant advancements in the field, several challenges persist in the design and implementation of linear equation and graphing calculators. These include optimizing computational efficiency, improving user interface design, and enhancing accessibility for individuals with diverse needs. Moreover, emerging technologies such as machine learning and augmented reality present new opportunities for innovation in this domain. By leveraging these technologies, researchers can develop next-generation calculators with enhanced capabilities and usability.

2.5 Related Studies

Numerous studies have investigated the pedagogical approaches and educational impact of integrating graphing calculators into mathematics education. For example, Wang and Zhang (2023) conducted a longitudinal study to examine the effects of graphing calculator use on students' mathematical achievement and problem-solving skills, demonstrating positive outcomes in terms of conceptual understanding and procedural fluency. Similarly, Li *et al.* (2022), explored the effectiveness of incorporating dynamic graphing software into calculus instruction, highlighting its role in promoting visual thinking and mathematical reasoning among students.

Understanding the cognitive processes involved in using graphing calculators is essential for designing intuitive user interfaces and instructional materials. Recent research has delved into the cognitive aspects of graphing calculator usage, examining factors such as cognitive load, problem-solving strategies, and conceptual misconceptions (Johnson *et al*., 2023). Additionally, studies have explored the user experience of graphing calculator software, identifying usability issues and design recommendations to enhance user satisfaction and productivity (Garcia *et al*., 2024).

Assessing the effectiveness and usability of graphing calculator software tools requires robust evaluation methodologies and metrics. Researchers have developed frameworks for assessing the quality and educational value of graphing calculator applications, considering factors such as functionality, usability, and alignment with educational standards (Khan *et al.,* 2021). Moreover, studies have investigated the reliability and validity of using graphing calculator-based assessments to measure students' mathematical proficiency and problem-solving skills (Tan *et al.,* 2023).

Effective integration of graphing calculators into mathematics instruction necessitates comprehensive professional development and teacher training initiatives. Recent studies have explored various models and approaches for supporting teachers in integrating graphing calculator technology into their classrooms, emphasizing the importance of ongoing professional learning and collaboration (Wu *et al.,* 2022). Furthermore, research has examined the impact of teacher beliefs, attitudes, and instructional practices on students' graphing calculator use and mathematical learning outcomes (Huang *et al.,* 2024).

2.6 Summary

In summary, this chapter has provided a comprehensive review of the literature pertaining to the design and implementation of linear equation and graphing calculators. By synthesizing prior work, it has identified key theoretical foundations, software implementations, GUI designs, and challenges in the field. Building upon this knowledge, the subsequent chapters will propose a novel approach for developing an advanced calculator system that addresses current limitations and incorporates cutting-edge technologies. The body of related studies highlighted in this section underscores the multidisciplinary nature of research on graphing calculators and mathematical software tools. By examining pedagogical approaches, cognitive aspects, usability factors, assessment methodologies, and professional development initiatives, researchers have contributed valuable insights to inform the design, implementation, and evaluation of graphing calculator systems. Moving forward, continued collaboration and interdisciplinary research are essential for advancing our understanding of graphing calculator usage and its impact on mathematical learning and teaching.

CHAPTER THREE
SYSTEM ANALYSIS AND DESIGN

3.1 Introduction

This chapter contains the system design and analysis of the proposed system, the disadvantages of the existing system, the advantages of the proposed system over the existing system, the proposed method, the method for data collection the system architecture and database designs and the requirements (Hardware and Software).

3.2 Disadvantages of the existing system

Designing and implementing a Linear Equation and Graphing Calculator offers significant advantages over conventional manual methods. The proposed system streamlines mathematical computations and graphical representation, addressing the following drawbacks associated with manual approaches:

i. Tedious processes: Manual calculation of linear equations and graph plotting can be time-consuming, leading to delays in problem-solving and analysis.
ii. Complexity and error-prone: Managing equations manually requires meticulous attention to detail, increasing the likelihood of errors in calculations and graph plotting.
iii. Limited functionality: Manual methods may lack advanced features such as equation manipulation, trend analysis, and interactive graphing, limiting their utility for complex mathematical tasks.

3.3 Advantages of the Proposed System

i. Enhanced efficiency: The computerized system automates the process of solving linear equations and generating graphical representations, reducing the time required for mathematical analysis.
ii. Minimized errors: Automated calculations and graph plotting ensure accuracy and precision, mitigating the risk of human error inherent in manual methods.
iii. Expanded functionality: The calculator offers advanced features such as equation manipulation, trend analysis, and interactive graphing tools, enhancing its utility for mathematical modelling and analysis.
iv. User-friendly interface: Intuitive user interfaces facilitate easy input of equations and parameters, enabling users to perform complex mathematical tasks with minimal effort.

3.4 Software Development Model

The proposed method for designing and implementing the Linear Equation and Graphing Calculator involves the following phases:

i. Requirement analysis: Collaborating with stakeholders to identify and analyze the requirements for the calculator, including desired features, functionalities, and user interface preferences.
ii. System design: Creating a detailed system design based on the gathered requirements, encompassing algorithms for equation solving, graph plotting, and user interface design.
iii. Development: Developing the calculator according to the specified design, coding functionalities, integrating components, and ensuring robustness and scalability.
iv. Testing: Conducting rigorous testing of the calculator to identify and rectify any bugs or issues, ensuring its functionality, reliability, and accuracy in mathematical computations and graph plotting.
v. Deployment and maintenance: Deploying the Linear Equation and Graphing Calculator and providing ongoing maintenance and support, monitoring performance, addressing issues, and implementing updates and enhancements as needed.

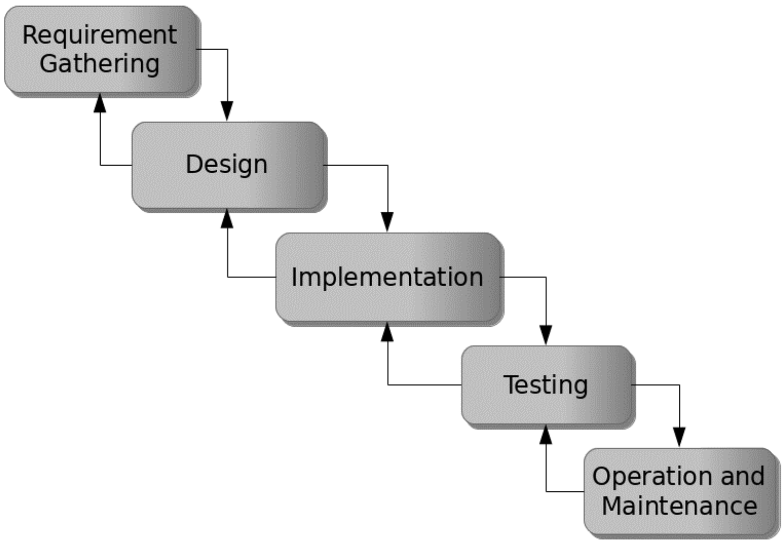

Figure 3.1: Waterfall model

3.5 Methods of data collection

There are two main sources of data collection in carrying out this study, information was basically obtained from the two sources which are primary and secondary sources.

3.6 System design

System design for the Linear Equation Calculator involves defining the platform's architecture, modules, interfaces, and data structures to meet specified requirements. It entails the application of systems theory to product development, ensuring the alignment of design elements with the objectives and needs of the system.

3.6.1 Algorithm Diagram

Use Case Diagram

A use case diagram shows the system and the various ways that they interact with the system.

3.6.1.1 Use Case Diagram

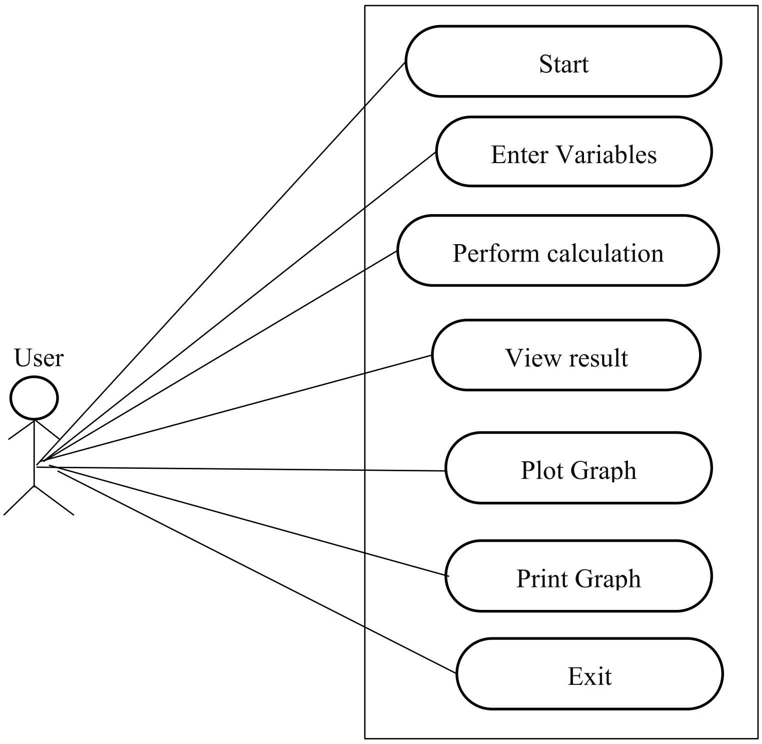

Figure 3.2: Use Case Diagram

3.6.2 System Architecture

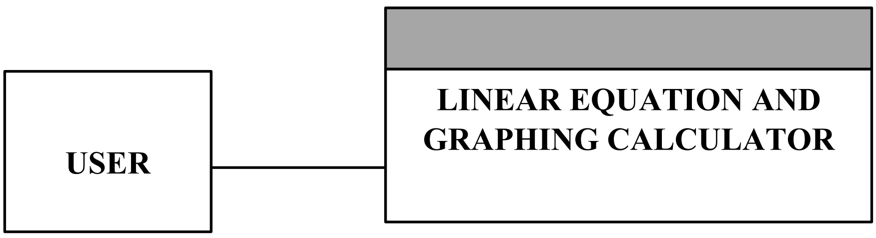

Figure 3.3: System Architecture

3.6.3 Input and Output Design

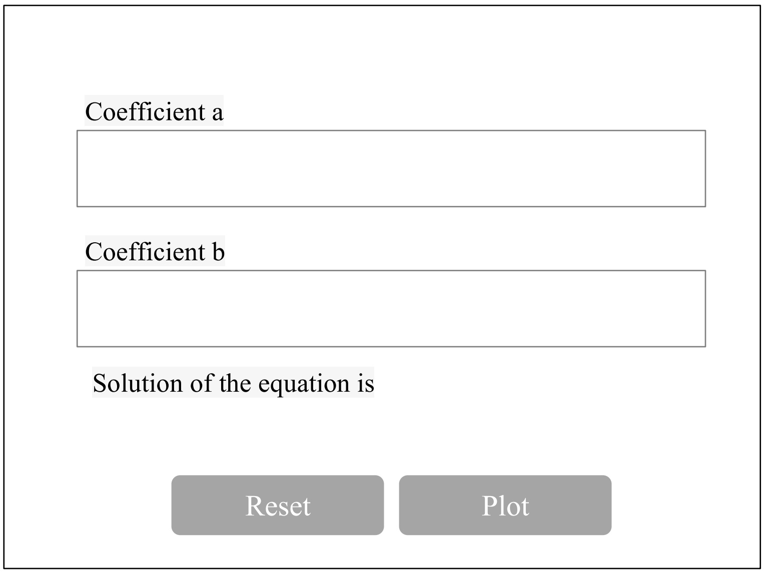

Figure 3.4: Result interface

3.7 System requirement specification

3.7.1 Hardware Requirements

The software designed needed the following hardware for an effective operation of the newly designed system.

i. A system running on intel, P(R) duo core with higher processor
ii. The-Random Access Memory (RAM) should be at least 512MB.
iii. At least 20-GB hard disk.
iv. A colored monitor.

3.7.2 Software Requirements

The software requirements includes:

i. A window 7 or higher version of operating system.
ii. XAMP or WAMP for Database
iii. PHP
iv. MySQL

3.7.3 Personnel Requirements

The system was design in such a way that it is user friendly in other to be understood and used by anyone with basic computer knowledge.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the research on the development of a linear equation and graphing calculator. The primary objective of this study was to design and implement an effective and efficient tool capable of accurately solving linear equations and generating corresponding graphs from the input data.

4.2 Results

4.2.1 Welcome Interface

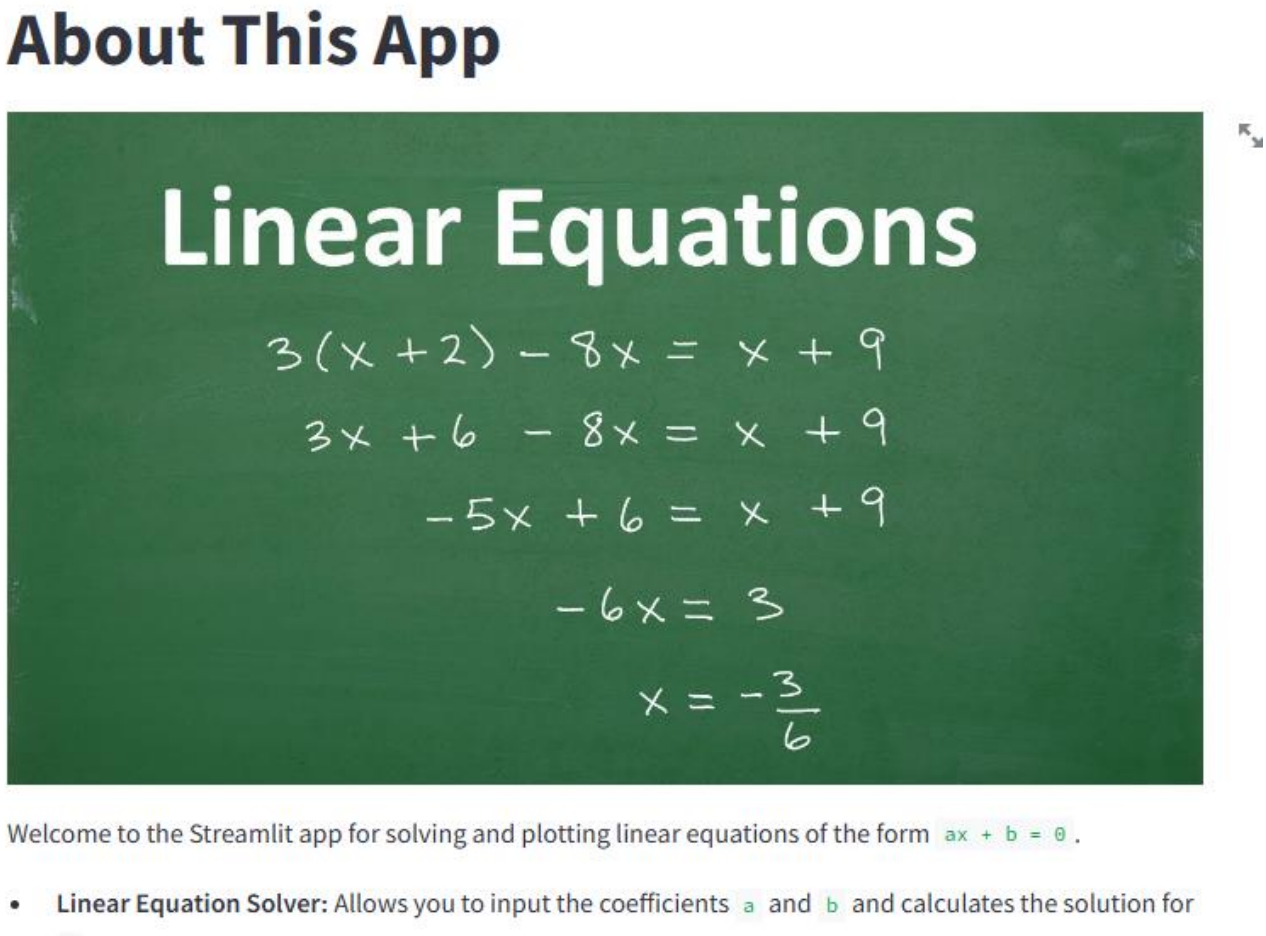

Figure 4.1: Welcome interface

Figure 4.1 above shows the system welcome interface where the user can select the task to perform on the system.

4.2.2 Linear Equation Solver interface

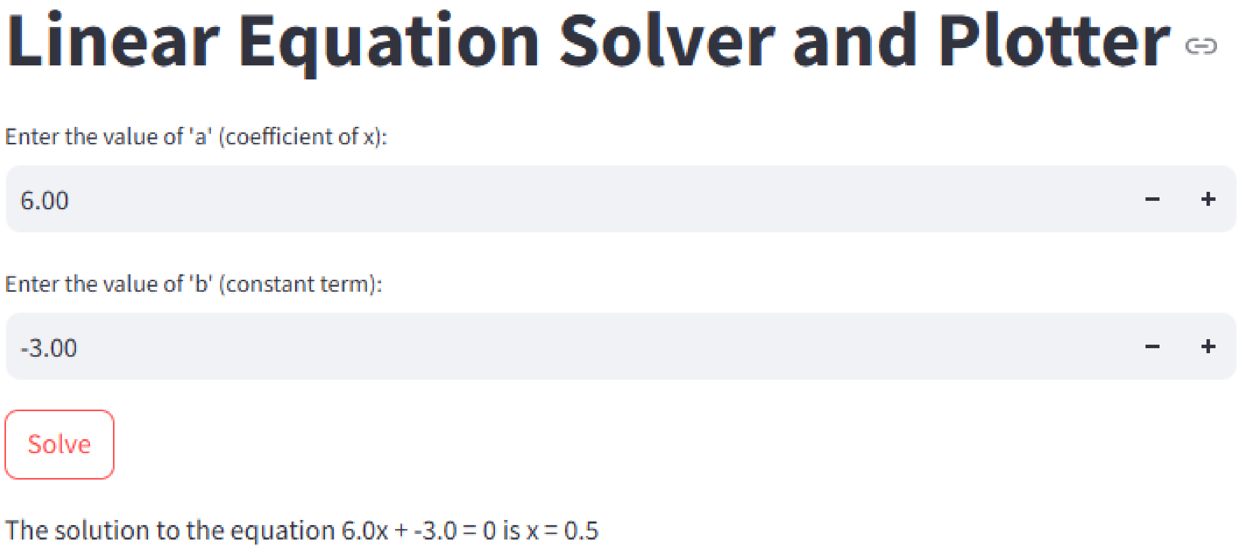

Figure 4.2: Linear Equation Solver Interface

Figure 4.2 above shows where the linear equation values or coefficients will be entered in order to solve the equation and plot the graph of the equation based on the values entered.

4.2.3 Graph Interface

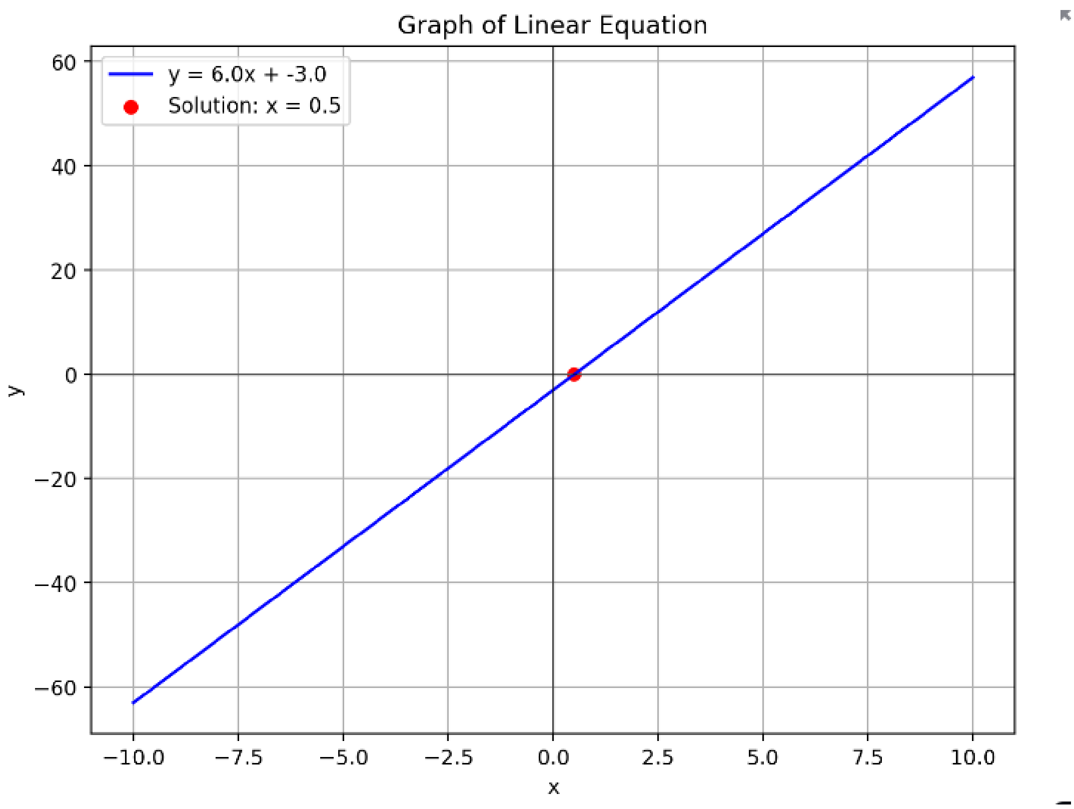

Figure 4.3: Graph Interface

Figure 4.3 above shows the graph of the linear equation based on the values entered for the equation.

4.3 Discussion

The Welcome Interface serves as the entry point to the Linear Equation and Graphing Calculator. Its primary purpose is to provide users with an intuitive and visually appealing starting point. This interface typically features the title of the application, a brief description of its capabilities, and navigation options that guide the user to the main functionalities, such as solving linear equations or graphing functions. The design of the Welcome Interface is critical in setting the tone for user experience, ensuring that users feel comfortable and confident in navigating the tool. Key elements might include a clear layout, a user-friendly menu, and possibly a quick tutorial or help section for first-time users.

The Linear Equation Solver Interface is the core functionality of the calculator, allowing users to input and solve linear equations. This interface is designed to be straightforward, enabling users to enter equations in standard forms, such as ax + b = c, and providing immediate solutions. It may also offer features like step-by-step solutions, where users can see the process of isolating the variable, simplifying terms, and arriving at the solution. Additionally, the interface might support multiple equations and systems of linear equations, providing the capability to solve for multiple variables simultaneously. The design emphasizes ease of use, with input fields clearly labelled and output results displayed prominently.

The Graph Interface is a critical feature that complements the equation solver by visualizing the equations as graphs. Once an equation is solved, this interface allows users to see the graphical representation of the linear equation on a coordinate plane. Users can input parameters such as the range of values for xxx and zoom in or out on the graph to examine specific sections in detail. The interface may also support features like plotting multiple equations simultaneously for comparison, displaying points of intersection, and providing information on the slope and intercepts of the graph. The design focuses on clarity, with color-coded lines, gridlines, and labels to ensure that the graph is easy to read and interpret. This visual tool is especially useful for users who benefit from a graphical understanding of linear relationships.

4.4 User Manual

The following are the necessary steps to take in order to use the system efficiently and effectively.

i. Load the url of the system https://isaacice.streamlit.app the welcome page will be displayed.
ii. The various task that you can perform on the portal will be displayed on the sidebar of the dashboard,
iii. Click on the Disease Recognition to perform a plant leaf analysis.
iv. Click on the upload image to select an image for disease detection.
v. The result will be displayed.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study focused on the design and implementation of a Linear Equation and Graphing Calculator, aimed at providing an efficient and user-friendly tool for solving and visualizing linear equations. The research process involved the development of key interfaces, including the Welcome Interface, Linear Equation Solver Interface, and Graph Interface, each tailored to enhance the user experience. The system was designed to handle a variety of linear equations, offering accurate solutions and clear graphical representations. Throughout the project, emphasis was placed on usability, accuracy, and the ability to visually interpret mathematical relationships, making the tool a valuable resource for students, educators, and professionals.

5.2 Conclusion

The successful implementation of the Linear Equation and Graphing Calculator demonstrates its potential as an educational and computational tool. The system effectively simplifies the process of solving linear equations and provides users with a visual understanding of these equations through graphing. The tool's intuitive design ensures that it can be used by individuals with varying levels of mathematical proficiency, from beginners to advanced users. Overall, the project achieved its objectives by creating a functional and accessible calculator that bridges the gap between numerical solutions and graphical analysis.

5.3 Recommendations

Based on the findings and outcomes of this project, several recommendations can be made for future enhancements and broader applications:

i. **User Interface Enhancements:** While the current design is functional, further refinement of the user interface could improve accessibility, especially for younger users or those less familiar with mathematical software.

ii. **Expanded Equation Types:** Incorporating additional equation types, such as quadratic or polynomial equations, could broaden the tool's utility.

iii. **Mobile Compatibility:** Developing a mobile-friendly version of the calculator would make it more accessible to users who prefer using smartphones or tablets.

iv. **Integration with Educational Platforms:** Partnering with educational platforms to integrate this tool into online learning environments could expand its reach and impact.

5.4 Contribution to Knowledge

This project contributes to the field of educational technology by providing a robust tool for solving and graphing linear equations, which is essential in various educational contexts. The system's ability to combine numerical solutions with graphical outputs enhances the learning experience, making complex concepts more tangible and easier to understand. Additionally, the project serves as a practical example of how technology can be used to improve mathematical education and computational efficiency.

5.5 Area for Further Work

While this project has laid a solid foundation, there are several areas where further work could be beneficial:

i. **Inclusion of Advanced Features:** Future work could explore the inclusion of advanced features such as the ability to solve systems of equations involving more variables, or integration with symbolic computation libraries for more complex algebraic manipulations.

ii. **Real-Time Data Integration:** Incorporating real-time data analysis, where users could input data from external sources to generate and analyze linear models, could significantly enhance the calculator's applicability in research and professional settings.

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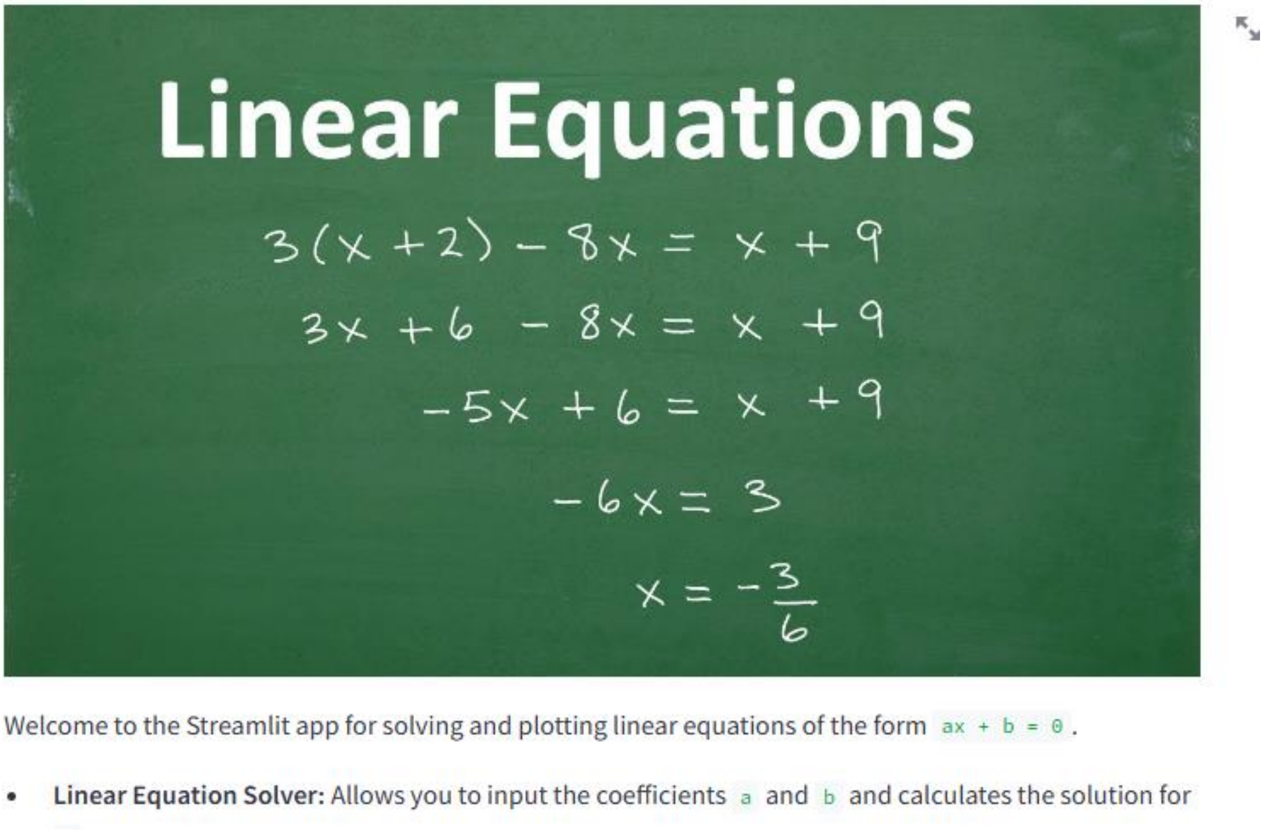
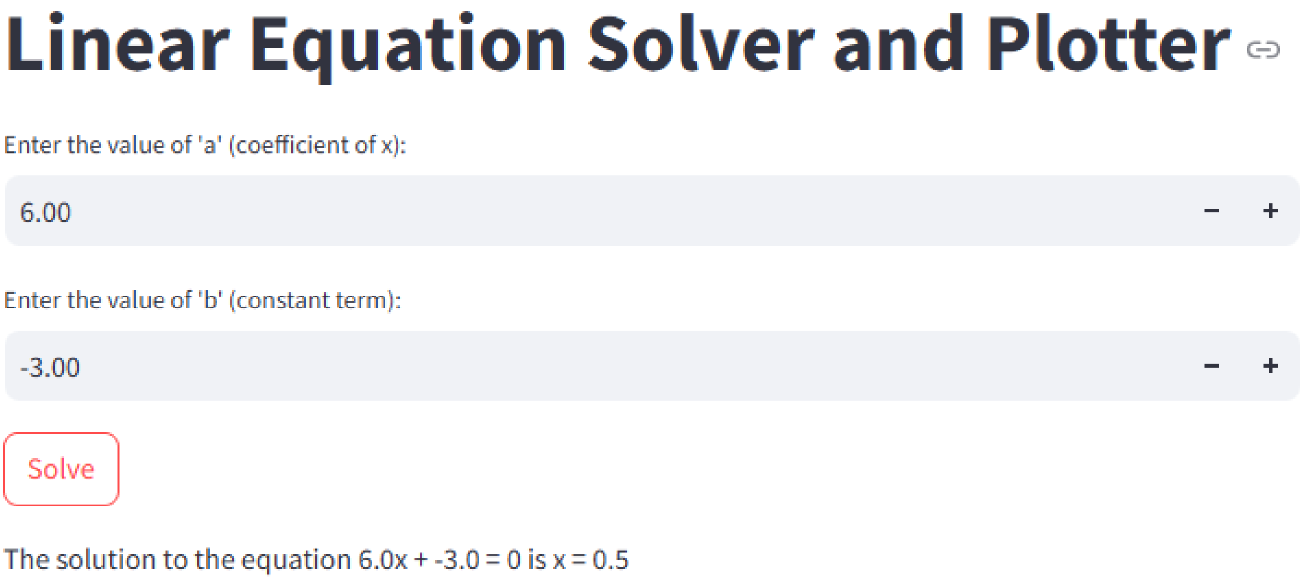
APPENDIX A

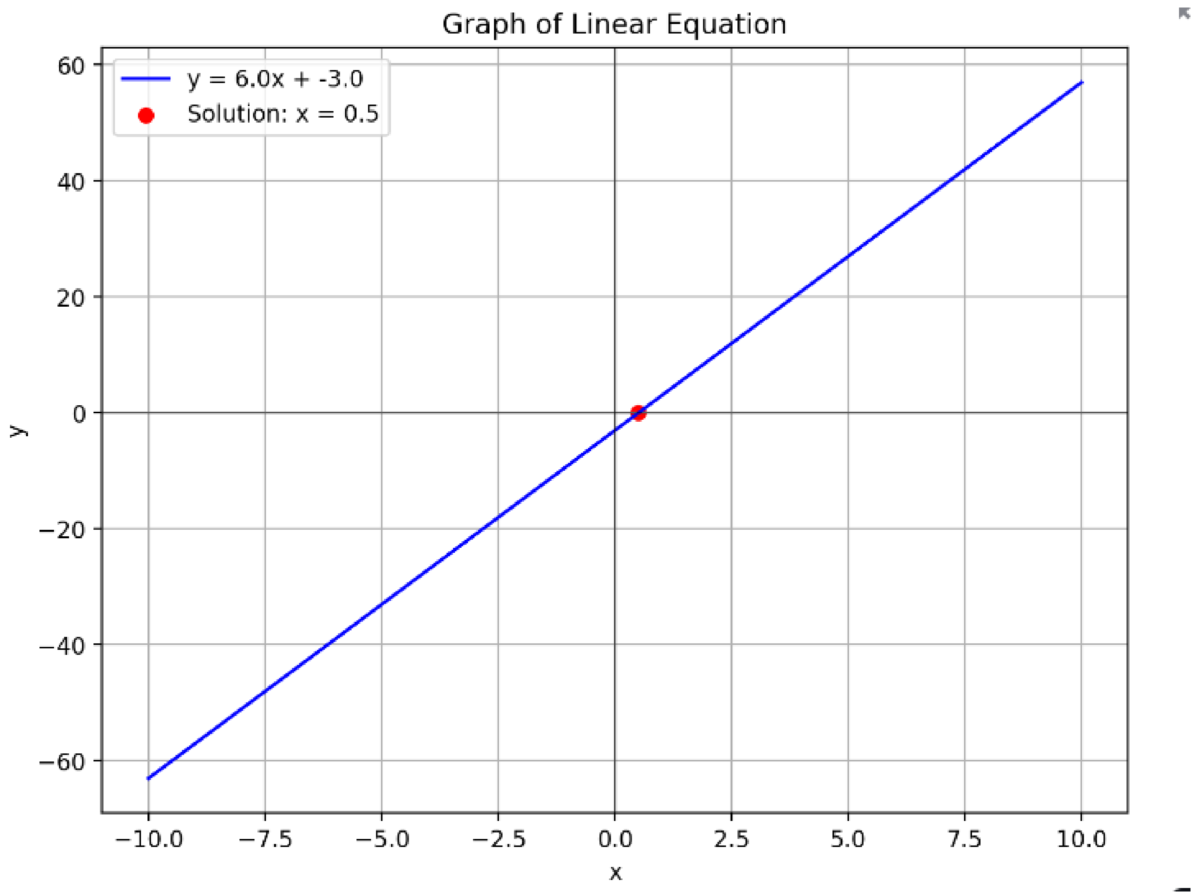
Welcome interface



Linear Equation Solver interface



Graph Interface



APPENDIX B

PROGRAM CODE

```
import numpy as np
import matplotlib.pyplot as plt
import streamlit as st

def solve_linear_equation(a, b):
    """
    Solves the linear equation ax + b = 0
    Returns the value of x.
    """
    if a == 0:
        raise ValueError("The coefficient 'a' cannot be 0 in a linear equation.")
    return -b / a

def plot_linear_equation(a, b):
    """
    Plots the graph of the linear equation y = ax + b
    """
    # Generate x values
    x_values = np.linspace(-10, 10, 400)

    # Compute y values
    y_values = a * x_values + b

    # Plot the graph
    plt.figure(figsize=(8, 6))
    plt.plot(x_values, y_values, label=f'y = {a}x + {b}', color='blue')
    plt.axhline(0, color='black', linewidth=0.5)
    plt.axvline(0, color='black', linewidth=0.5)

    # Mark the solution on the graph
    x_solution = solve_linear_equation(a, b)
    plt.scatter(x_solution, 0, color='red', label=f'Solution: x = {x_solution}')

    # Adding labels and title
    plt.title('Graph of Linear Equation')
    plt.xlabel('x')
    plt.ylabel('y')
    plt.legend()
    plt.grid(True)

    # Streamlit plot
    st.pyplot(plt)

# Streamlit user interface
st.sidebar.title("Linear Equation Solver")
page = st.sidebar.selectbox("Select a page", ["About", "Linear Equation Solver"])

if page == "Linear Equation Solver":
    st.title("Linear Equation Solver and Plotter")

    # Inputs for 'a' and 'b'
    a = st.number_input("Enter the value of 'a' (coefficient of x):", value=1.0, step=0.1)
    b = st.number_input("Enter the value of 'b' (constant term):", value=0.0, step=0.1)

    # Solve the equation
    if st.button("Solve"):
        try:
            solution = solve_linear_equation(a, b)
            st.write(f"The solution to the equation {a}x + {b} = 0 is x = {solution}")
```

```
            # Plot the graph
            plot_linear_equation(a, b)

        except ValueError as e:
            st.error(e)

elif page == "About":
    st.title("About This App")
    image_path = "home_page.jpg"
    st.image(image_path, use_column_width=True)
    st.markdown("""
    Welcome to the Streamlit app for solving and plotting linear equations of the form `ax + b = 0`.

    - **Linear Equation Solver:** Allows you to input the coefficients `a` and `b` and calculates the solution for `x`.
    - **Graph Plotting:** Displays a graph of the linear equation with the calculated solution highlighted on the graph.

    **Developed using:**
    - Python
    - Streamlit
    - Matplotlib
    """)
```