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Math Manus

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ABSTRACT

MathManus is an advanced educational tool designed to transform how math is learned and practiced by leveraging the power of hand-drawn input and artificial intelligence (AI). This innovative system provides users with a unique way to interact with mathematics, allowing them to solve problems by drawing equations with their hands. A standard webcam captures these inputs, and AI algorithms process them in real time, converting the drawings into mathematical expressions. The system instantly interprets these expressions, solves the equations, and provides feedback, making the entire process intuitive and user-friendly. By eliminating the need for traditional input devices like keyboards or touchscreens, MathManus not only reduces the chance of input errors but also minimizes the physical effort required, reducing user fatigue and speeding up the overall process.

One of the key advantages of MathManus is its ability to create an engaging and interactive learning environment. Traditional methods of learning math can sometimes feel rigid and tedious, but MathManus makes the experience more dynamic and enjoyable, which helps foster curiosity and enthusiasm among learners. The system is designed to be highly accessible, catering to a wide range of users, from students exploring basic math concepts to educators seeking innovative teaching tools. It removes the barriers of setup time and physical tools, making it easier for anyone to dive into math problem-solving with minimal preparation.

Overall, MathManus represents a groundbreaking shift in educational technology by introducing a hands-on, efficient, and fun approach to learning mathematics. Its blend of cutting-edge AI and hand-drawn input technology not only enhances the learning process but also makes math more accessible and enjoyable for everyone involved, from beginners to advanced learners. This tool is poised to redefine traditional methods of math education, offering a modern, interactive, and highly effective alternative for both students and teachers.

1-INTRODUCTION

The project revolutionizes math learning through an innovative Math Trail interface. By capturing hand movements via webcam, users can draw math equations in the air, which are then interpreted and solved by AI in real time. This approach removes the need for traditional input methods, making learning more engaging and accessible.

Scope

- The project involves developing a Math Trail interface that leverages computer vision and AI technologies.
- The system will allow users to solve mathematical problems by drawing equations in the air, providing instant feedback and solutions.
- It aims to enhance educational experiences by making learning interactive and accessible.

Existing System

- Traditional educational tools rely on manual inputs like keyboards or touchscreens, which can be prone to errors, time-consuming, and less engaging.

- These systems often lack the interactive elements necessary to fully engage students, potentially leading to user fatigue.

Proposed System

This project uses a webcam and AI to recognise and solve Math problems drawn in air with your hand.It makes learning math easier and more fun, and interactive.This technology is especially helpful for students and teachers in schools, creating a new and exciting way to solve math problems without needing a pen or paper.

2-REQUIREMENT ANALYSIS

Functional Requirements

User Module

1. Register
   - Users can create an account by providing their username and password.
   - The registration process enables users to access the app, and after registration, they are automatically logged in.
2. Login
   - Registered users can log in using their credentials (username/password).
   - Session management using Streamlit's st.session_state ensures users stay logged in until they manually log out.
3. Provide Hand-Drawn Input
   - Users can draw math problems or equations using their mouse or touchscreen devices on a virtual canvas created via NumPy arrays.
   - The drawing is captured in real-time, with OpenCV handling the webcam input, and MediaPipe and CvZone enabling hand gesture recognition for drawing actions.

Non-Functional Requirements

- Security: Ensure user data, including passwords and hand-drawn inputs, is securely stored and transmitted. Use Hashlib for secure password hashing.
- Scalability: Design the application to handle an increasing number of users and larger datasets as the platform grows.
- Usability: Create a user-friendly interface using Streamlit, with intuitive navigation and gesture recognition.
- Maintainability: Ensure the code is well-structured and modular, making it easy for future updates or modifications.

3-DESIGN

Architectures

Design architecture refers to the overall structure and framework of a system, outlining how its components interact, communicate, and work together to meet functional and non-functional requirements. It serves as a blueprint for the system's development, ensuring it is scalable, maintainable, and efficient.

Software Architecture

The software architecture illustrates a hand gesture recognition system with three components: User, System, and Database. Users interact with the system for registration, login, submitting gestures, viewing results, and logout. The system processes inputs, performs gesture recognition, and provides results by communicating with the database, which stores user data and results. This architecture ensures efficient interaction and data management for gesture recognition.

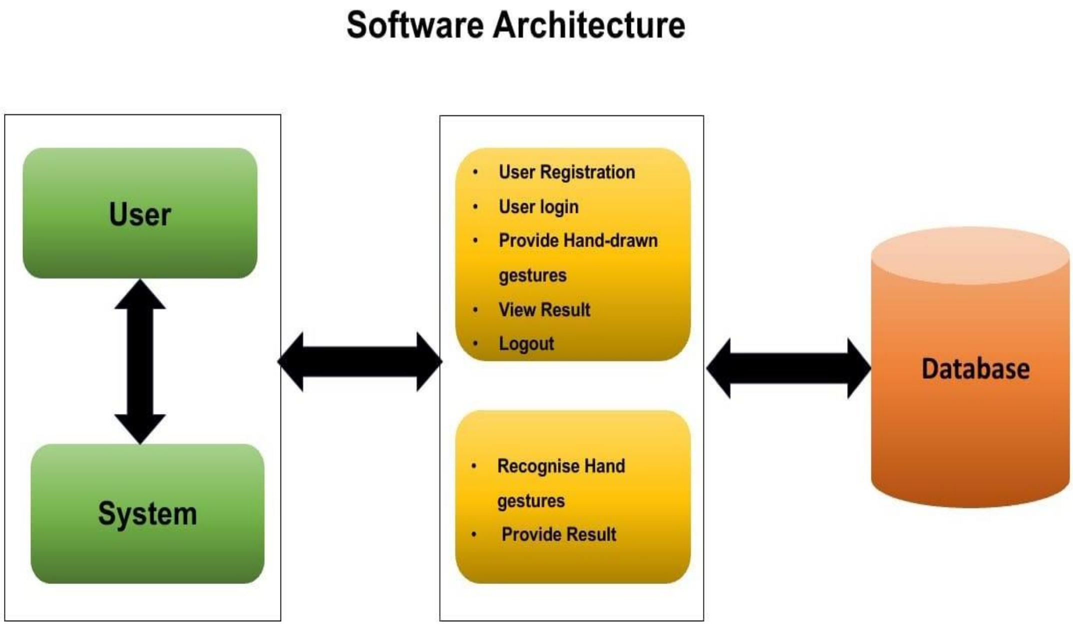


Fig. 3.1 Software Architecture

Technical Architecture

The technical architecture illustrates a system built using Streamlit, Python, and SQLite. Streamlit serves as the frontend, enabling user interaction through a web-based interface. Python acts as the core logic layer, processing inputs, executing functionality, and managing data flow. SQLite functions as the backend database, storing and retrieving data efficiently. The architecture ensures seamless integration between the user interface, processing logic, and data management.

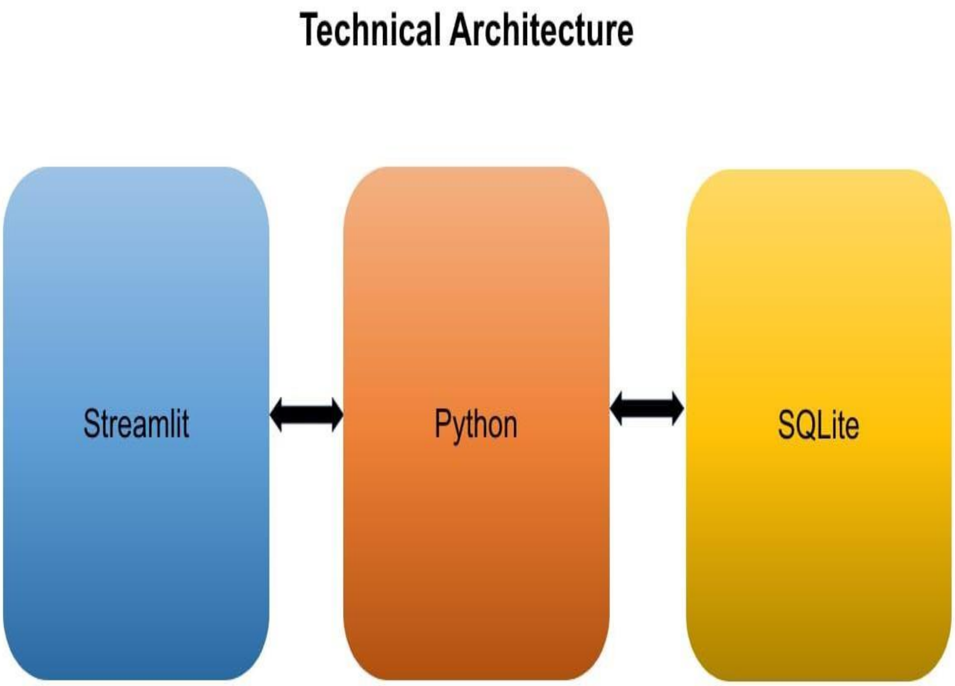


Fig. 3.2 Technical Architecture

4-IMPLEMENTATION

Technologies

Frontend:

- Streamlit:
  - A Python framework for creating interactive and data-driven web applications.
  - Used to create the user interface for login, registration, and gesture- based interactions.
  - Features: Simple UI, real-time updates, and Python integration.

Backend:

- Python:
  - Core programming language used for backend logic, integrating AI models, and processing data.
  - Libraries used:
    - OpenCV: For image processing and hand tracking.
    - cvzone: Simplifies hand gesture detection with OpenCV.
    - Google Generative AI: For solving math problems drawn by users

Database:

- SQLite:
  - Relational database management system used to store user login data securely.
  - Passwords are hashed before being stored for added security.

5-TESTING

Software testing is a process, to evaluate the functionality of a software application with an intent to find whether the developed software met the specified requirements or not and to identify the defects to ensure that the product is defect free in order to produce the quality product. As per the current trend, due to constant change and development in digitization, our lives are improving in all areas. The way we work is also changed. We access our bank online we do shop online; we order food online and many more. We rely on software's and systems. We all know that one small bug shows huge impact on business in terms of financial loss and goodwill. To deliver a quality product, we need to have Software Testing in the Software Development Process.

- Cost effectiveness
- Customer Satisfaction
- Security
- Product Quality

Unit Testing

During this first round of testing, the program is submitted to assessments that focus on specific units or components of the software to determine whether each one is fully functional. The main aim of this endeavour is to determine whether the application functions as designed.

Integration Testing

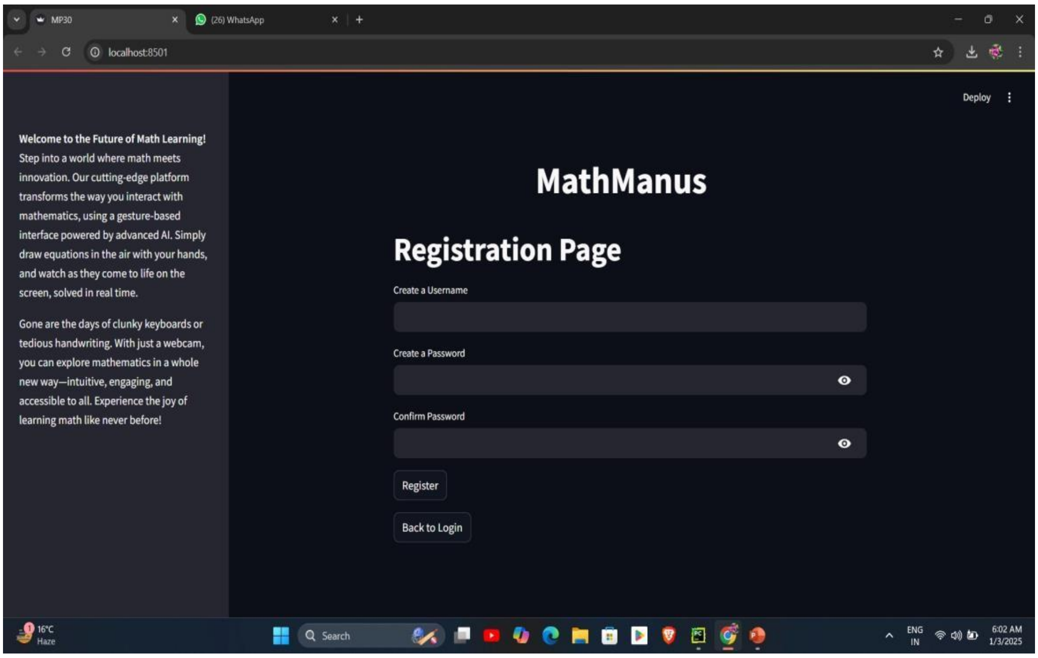
Integration testing allows individuals the opportunity to combine all of the units within a program and test them as a group. This testing level is designed to find interface defects between the modules/functions. This is particularly beneficial because it determines how efficiently the units are running together. Keep in mind that no matter how efficiently each unit is running, if they properly integrated, it will affect the functionality of the software program. In order to run these types of tests, individuals can make use of various testing methods, but the specific method that will be used to get the job done will depend greatly on the way in which the units are defined.

System Testing

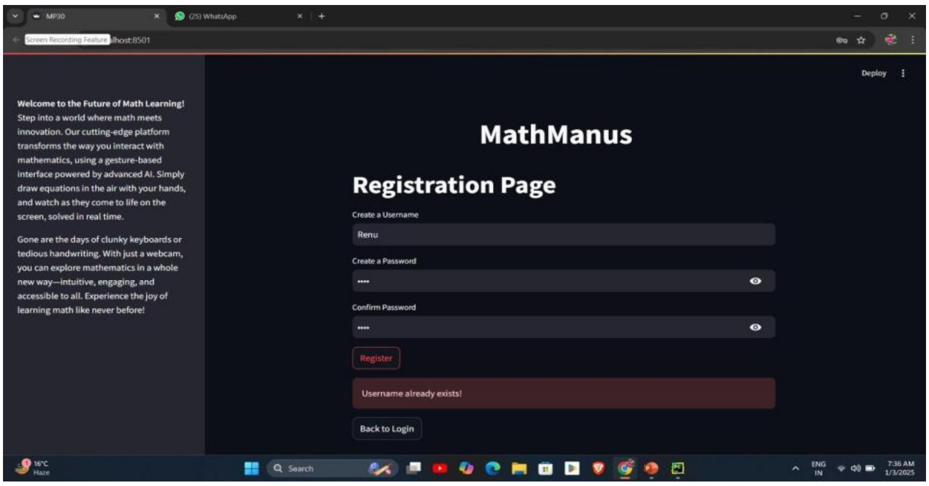
System testing is the first level in which the complete application is tested as a whole. The goal at this level is to evaluate whether the system has complied with all of the outlined requirements and to see that it meets Quality Standards. System testing is undertaken by independent testers who haven't played a role in developing the program. This testing is performed in an environment that closely mirrors production. System Testing is very important because it verifies that the application meets the technical, functional, and business requirements that were set by the customer.

6-SCREENSHOTS

Registration Page

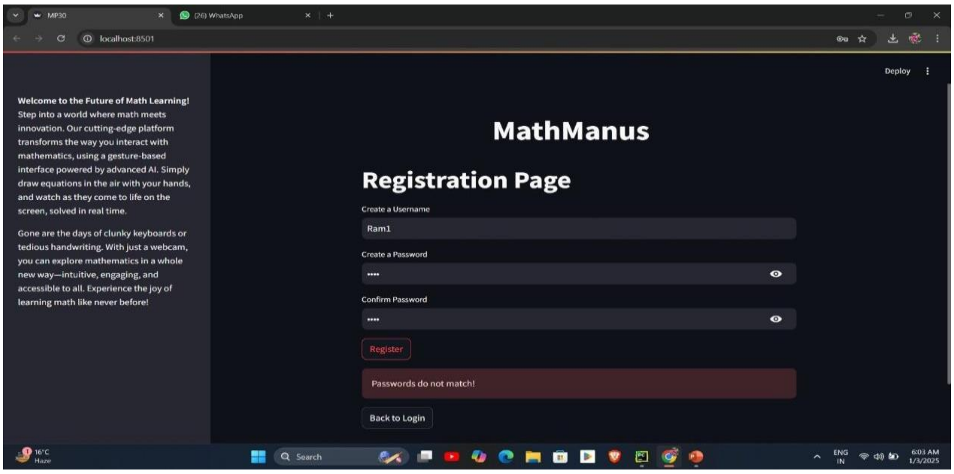


Screenshot 6.1 Registration Page



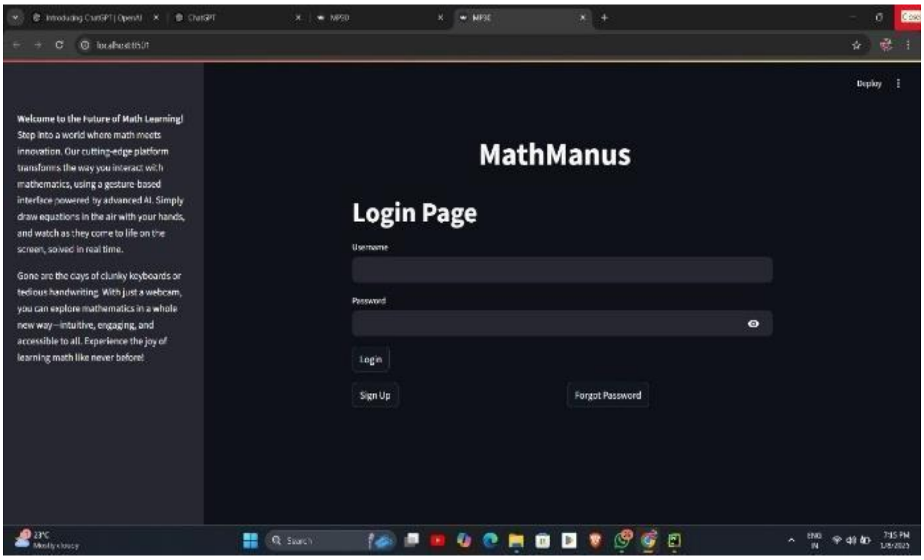
Registration Page with existing Username

Registration page with Validation Error



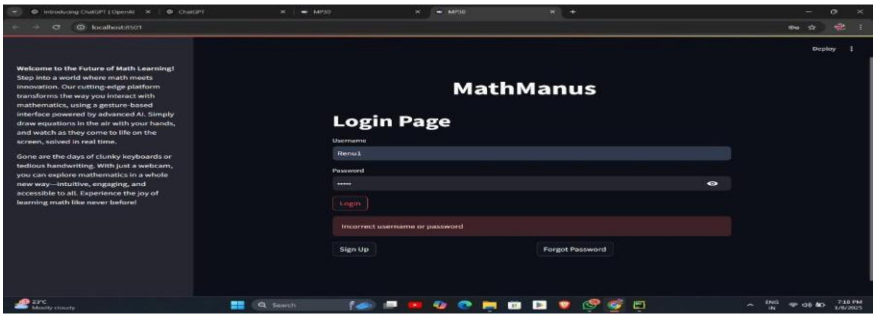
Screenshot 6.3 Registration page with Validation Error

Login Page



Screenshot 6.4 Login Page

Login Page with Validation Error



Screenshot 6.5 Login Page with Validation Error

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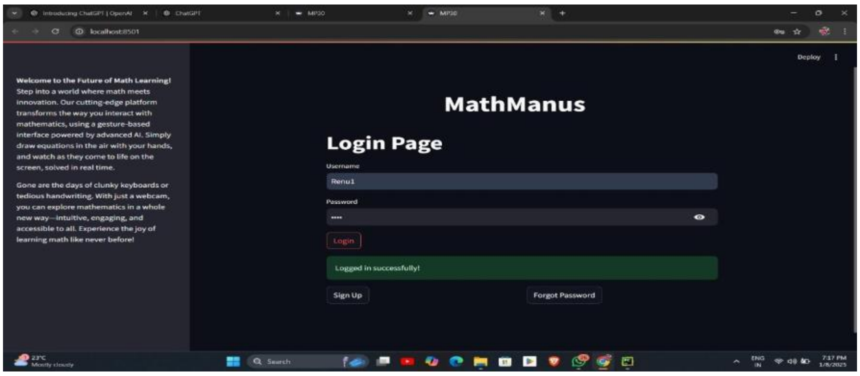
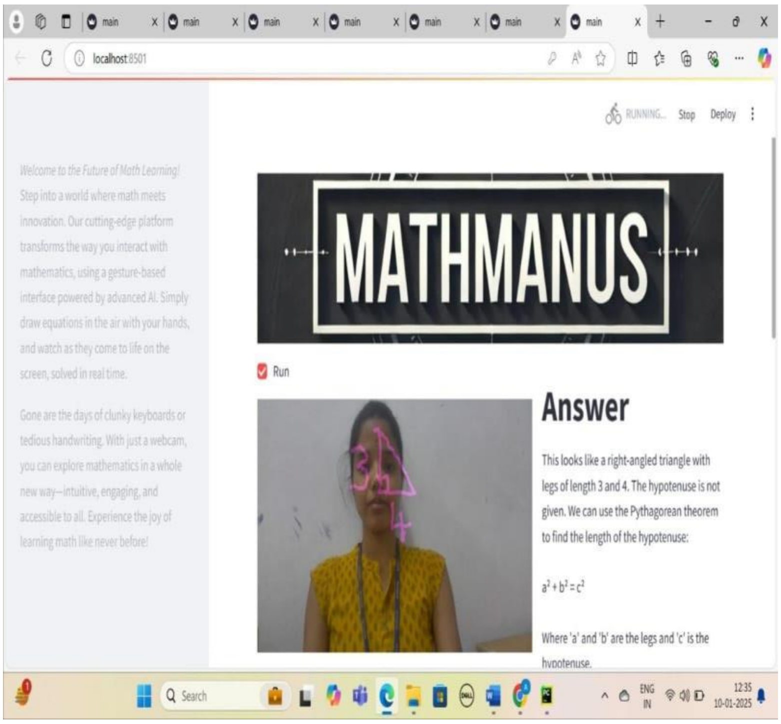
Login Page with Successful Login



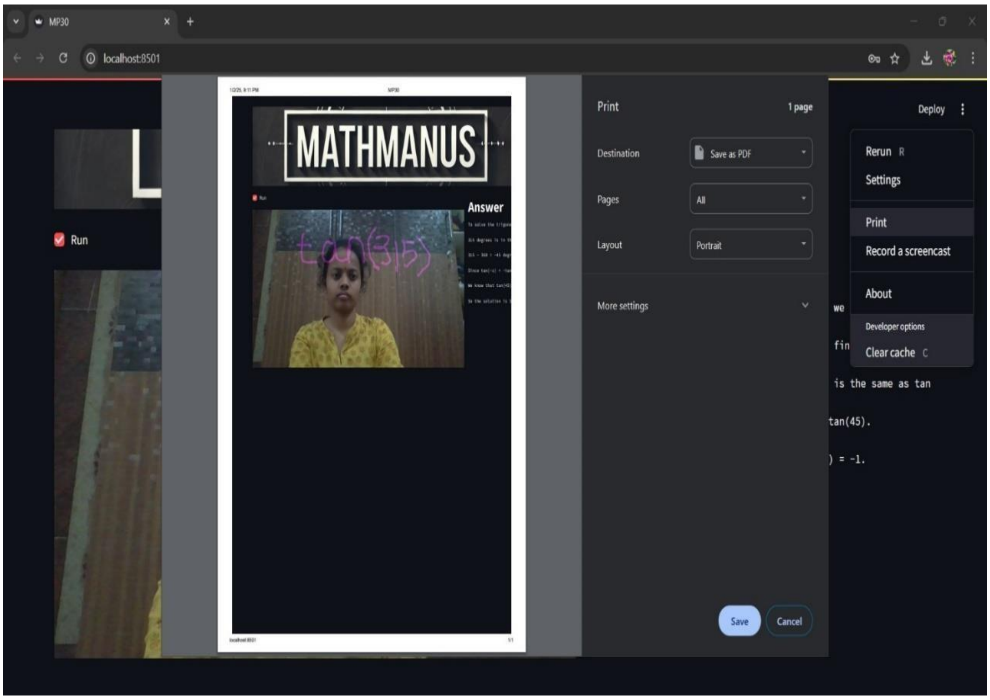
Screenshot 6.6 Login Page with Successful Login

MathManus Main interface (Answer Page)



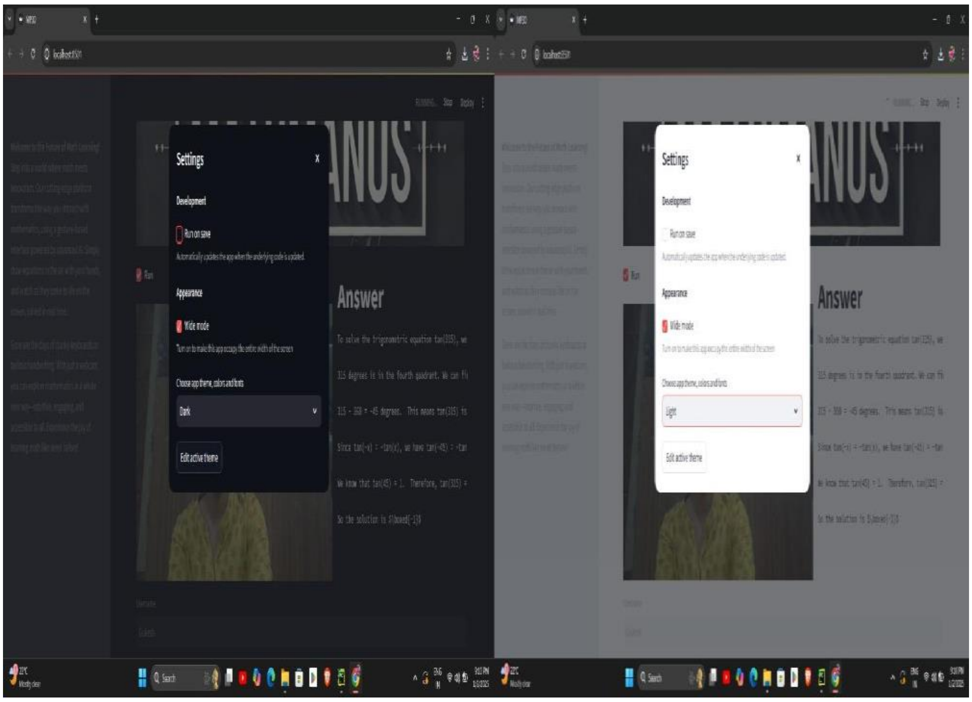
Screenshot 6.7 MathManus Main interface (Answer Page)

Print Preview



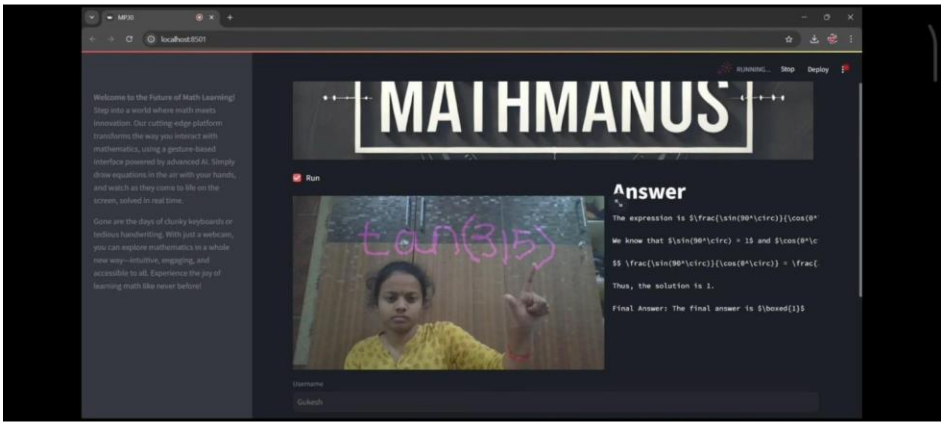
Screenshot 6.8 Print Preview

Dark and Light Mode



Screenshot 6.9 Dark and Light Mode

Screen Recording Feature



Screenshot 6.10 Screen Recording Feature

7-CONCLUSION AND FUTURE SCOPE

Conclusion

"MathManus" revolutionizes math education by leveraging computer vision and AI to deliver an engaging, interactive, and personalized learning experience. By making mathematics more accessible and enjoyable, it aims to bridge the gap between traditional learning methods and modern technology.

Future Scope

The project holds immense potential for future development. Enhancements could include advanced AI capabilities for solving more complex mathematical problems, optimization for mobile platforms to ensure accessibility, and features such as user progress tracking and collaborative tools.

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