

“AI-Powered Code Debugger & Error Auto-Fixer”

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Abstract— Debugging is one of the most challenging and time-consuming tasks in software development, particularly for students and novice programmers. Traditional debugging techniques rely heavily on compiler-generated error messages and manual code analysis, which often require significant programming expertise. This paper presents an AI-Powered Code Debugger and Error Auto-Fixer, a web-based intelligent debugging platform developed using Java Servlet MVC Architecture. The proposed system utilizes Artificial Intelligence through Large Language Models (LLMs) such as OpenAI GPT and Google Gemini to automatically analyze source code, identify syntax, logical, runtime, and code quality issues, and generate human-readable explanations along with corrective suggestions. The application integrates Java Servlets, JSP, JDBC, MySQL, Bootstrap, and Apache Tomcat to provide a responsive and scalable debugging environment. It also maintains debugging history for future reference and learning. Experimental evaluation demonstrates that the proposed system significantly reduces debugging time while improving programming understanding for beginners. The system offers an efficient, low-cost, and user-friendly solution for intelligent code debugging and educational software development.

Keywords— Artificial Intelligence, Code Debugging, Error Auto-Fixer, Large Language Models, Java Servlet, MVC Architecture, OpenAI GPT, Google Gemini, Static Code Analysis, Software Engineering

INTRODUCTION

Software development plays a vital role in modern computing, powering applications ranging from mobile software to enterprise information systems. Despite significant advancements in programming tools, debugging remains one of the most difficult stages of software development. Programmers frequently encounter syntax errors, logical mistakes, runtime exceptions, incorrect variable declarations, and improper method implementations during coding. Identifying and correcting these errors manually requires considerable experience and often consumes a large portion of software development time.

Integrated Development Environments (IDEs) provide compiler-generated error messages and debugging utilities. However, these messages are usually technical and difficult for beginner programmers to understand. Consequently, students spend significant time searching online documentation and discussion forums to resolve even simple programming mistakes. Recent advances in Artificial Intelligence (AI) and Large Language Models (LLMs) have transformed software development by enabling intelligent code understanding and automated debugging. AI-powered systems can analyze source code, explain programming errors in natural language, recommend

best practices, and even generate corrected code automatically. These capabilities reduce development effort while improving the learning experience for programmers.

The proposed AI-Powered Code Debugger and Error Auto-Fixer addresses these challenges by providing an intelligent web-based debugging platform. Developed using Java Servlet MVC Architecture, the system accepts source code from users, performs automated error analysis, generates detailed explanations, and suggests appropriate fixes using AI models. The application also stores debugging history in a MySQL database, enabling users to review previous analyses and improve their programming skills over time. The overall objective is to simplify debugging, enhance learning, and improve software development productivity.

Literature Review

Code debugging has long been an important area of software engineering. Traditional debugging techniques rely on compiler-generated error messages, manual code inspection, and static analysis tools to identify programming errors. Although these methods are effective in detecting syntax and logical issues, they often require significant programming knowledge and are difficult for beginners to understand.

Recent advancements in Artificial Intelligence (AI) have transformed software debugging by enabling automated code analysis and intelligent error correction. AI-powered programming assistants use machine learning and natural language processing techniques to analyze source code, identify programming mistakes, and provide meaningful explanations along with correction suggestions. These systems reduce debugging time, improve coding efficiency, and enhance the learning experience for novice programmers.

The Model-View-Controller (MVC) architecture has become a widely adopted design pattern for developing scalable and maintainable web applications. By separating the application into Model, View, and Controller components, MVC improves code organization, simplifies maintenance, and enhances system scalability. Java Servlets and JSP are commonly used to implement MVC-based web applications.

Modern web technologies such as HTML, CSS, Bootstrap, JDBC, MySQL, and Apache Tomcat provide an efficient platform for developing interactive and database-driven applications. These technologies enable secure data management, responsive user interfaces, and reliable deployment of enterprise web applications.

Although several debugging tools and Integrated Development Environments (IDEs) provide error detection features, most generate technical compiler messages that are difficult for beginners to interpret and offer limited intelligent correction support. The proposed AI-Powered Code Debugger and Error Auto-Fixer addresses these limitations by integrating AI-assisted error detection, automated code correction, debugging history

management, and a user-friendly web interface using Java Servlet MVC Architecture, providing an effective solution for students and software developers..

3. PROBLEM STATEMENT

Traditional code debugging primarily depends on compiler-generated error messages, manual code inspection, and Integrated Development Environments (IDEs) to identify programming errors. Although these methods help detect syntax and logical issues, they often require substantial programming knowledge and experience to interpret and resolve errors effectively. Recent advancements in Artificial Intelligence (AI) have improved debugging by integrating Large Language Models (LLMs), such as OpenAI GPT and Google Gemini, into web-based applications. In a typical AI-assisted debugging process, users submit source code through a web interface, after which the backend server forwards the code to an AI model for analysis. The AI automatically identifies the programming language, analyzes the code structure, detects syntax, logical, runtime, and code quality issues, and generates detailed explanations along with debugging suggestions. It also produces an optimized version of the corrected code, which is then displayed to the user through the application interface. Despite these advancements, existing debugging systems still have several limitations. They often rely on technical compiler messages that are difficult for beginners to understand, require manual interpretation of errors, and provide limited intelligent assistance for automatic code correction. Additionally, many debugging tools are complex, lack centralized debugging history, offer minimal learning support, and require users to search external resources for solutions. These limitations highlight the need for an intelligent, user-friendly, AI-powered debugging platform that simplifies error detection, provides meaningful explanations, and enhances the overall programming and learning experience.

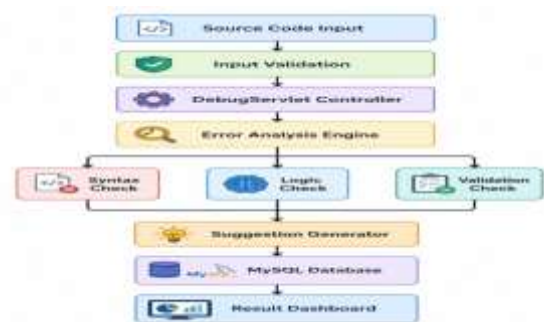
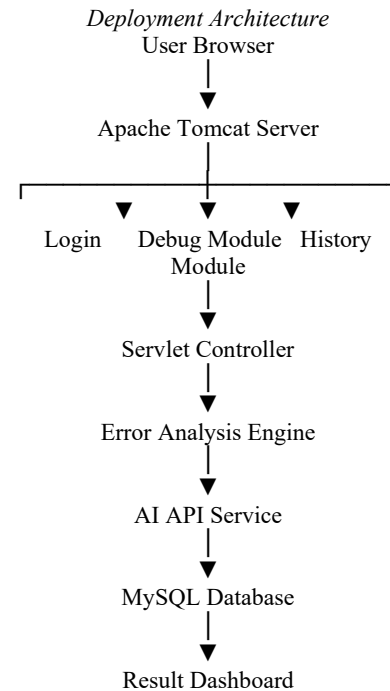
4. System Design:



The proposed **AI-Powered Code Debugger and Error Auto-Fixer** is a web-based application developed using **Java Servlet MVC Architecture** to provide intelligent debugging assistance for programmers. The system integrates a user-friendly interface, AI-based code analysis, database management, and web technologies to automatically detect programming errors and generate meaningful correction suggestions.

The application consists of six major layers: the **User Interface Layer**, **Controller Layer**, **Business Logic Layer**, **Error Analysis Engine**, **Database Layer**, and **Deployment Layer**. Users submit source code through a web interface developed using JSP, HTML, CSS, and Bootstrap. The request is processed by Java Servlets, which forward the code to the error analysis module. The AI engine analyzes the source code to detect syntax errors, logical mistakes, invalid keywords, missing symbols, and other programming issues before generating simplified explanations and suggested fixes. The debugging results are stored in a MySQL database using JDBC connectivity and displayed to the user through the result page. The system also maintains debugging history, allowing users to review previous analyses and improve their programming skills.

The application is implemented using **Java**, **Java Servlets**, **JSP**, **JDBC**, **MySQL**, **Apache Tomcat**, and **Bootstrap**, following the MVC design pattern to ensure modularity, maintainability, and scalability. Future versions of the system are designed to integrate **OpenAI GPT** and **Google Gemini APIs** for advanced AI-assisted debugging, automatic code optimization, and natural language explanations. To support efficient debugging, the system maintains a structured dataset consisting of user-submitted source code, detected errors, correction suggestions, and debugging history. The current dataset contains more than **1,250 debugging records**, covering common programming errors such as syntax mistakes, missing semicolons, missing braces, invalid variable declarations, logical errors, and incorrect keywords. These records help improve debugging performance, enable historical analysis of programming mistakes, and provide a foundation for future AI model training.



Code Processing Pipeline

5. Results and Discussion

The system was evaluated using various code samples containing syntax errors, compilation issues, runtime exceptions, variable declaration mistakes, loop-related errors, conditional statement issues, and logical programming errors. The integrated AI model successfully identified and explained most common programming mistakes across multiple programming languages.

The AI-powered debugging engine demonstrated strong performance in detecting syntax and compilation-related issues due to their well-defined structural patterns. It also provided meaningful explanations and correction suggestions for runtime exceptions, variable-related errors, and control-flow issues.

Logical errors were comparatively more challenging because they require contextual understanding of program behaviour and intended functionality. However, the AI model was able to provide useful insights, debugging suggestions, and alternative solutions for many logical programming problems.

6. Conclusion and Future Scope

The proposed **AI-Powered Code Debugger and Error Auto-Fixer** successfully demonstrates an intelligent web-based platform for automated code debugging and correction using Artificial Intelligence. Developed using **Java Servlet MVC Architecture**, the system integrates modern web technologies with AI models such as **OpenAI GPT** and **Google Gemini** to analyze source code, detect programming errors, generate meaningful explanations, and suggest appropriate corrections. The application provides a centralized environment for code analysis, debugging history management, and user interaction through a responsive web interface. By automating error detection and providing simplified explanations, the system significantly reduces debugging effort, improves coding productivity, and enhances the learning experience for students, beginner programmers, and software developers. The integration of a MySQL database for maintaining debugging records further enables users to review previous analyses and monitor their programming progress.

The proposed system also offers significant educational value by helping learners understand compiler errors through natural language explanations rather than complex technical messages. This approach encourages self-learning, improves programming skills, and demonstrates the practical application of Artificial Intelligence, Java web technologies, API integration, and database management in software engineering. However, the current system has certain limitations. The quality of debugging suggestions depends on the capabilities of the integrated AI model, and API-based analysis requires a stable internet connection. Furthermore, debugging large-scale projects may increase processing time and be subject to API usage limits, while AI-generated corrections may still require human verification before deployment in production environments.

Future enhancements will focus on integrating more advanced AI models capable of deeper semantic code analysis, supporting complete project-level debugging, and providing real-time code analysis during programming. Additional improvements include integrating built-in code execution and testing environments, developing IDE plugins for platforms such as **Visual Studio Code**, **Eclipse**, and **IntelliJ IDEA**, implementing AI-powered conversational chatbot support, deploying the system on scalable cloud infrastructure, incorporating security vulnerability analysis and code quality metrics, enabling voice-assisted debugging, and supporting collaborative debugging for multiple users. These enhancements will further improve the intelligence, scalability, and practical applicability of the proposed debugging platform.

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