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Detection Of SQL Injection Attacks With Real-Time Alert System

Real time monitoring and alert generation for database security

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Abstract : SQL Injection (SQLi) is one of the most common and serious security problems in web applications. It allows attackers to access or manipulate backend databases by entering malicious input through application forms or URLs. Even today, many applications are vulnerable because of weak input validation and the absence of real-time monitoring systems. This project focuses on detecting and preventing SQL injection attacks as they occur, rather than responding after damage has already been done. The proposed system is a real-time SQL Injection Detection and Alert System developed using FastAPI and SQLite. It uses pattern-based analysis to identify suspicious queries and classifies attacks based on their severity. The system can automatically block malicious IP addresses and instantly send alerts through Telegram to notify administrators. An admin dashboard is also provided for monitoring attack logs and system activity. This approach improves web application security by providing quick alerts and active protection while keeping system performance efficient.

Index Terms **- Pattern-Based Analysis, FastAPI Framework, Automated IP Blocking, Telegram Alert System, Database Security, Intrusion Prevention.**

I. INTRODUCTION

Web applications play an important role in storing and managing sensitive data such as user details, financial records, and organizational information. These applications interact with databases using Structured Query Language (SQL). Improper handling of user inputs can lead to serious security vulnerabilities. One of the most dangerous and commonly exploited vulnerabilities is SQL Injection, attackers insert malicious SQL queries through input fields to gain unauthorized access to the database. Such attacks can result in data leakage, data manipulation, service disruption, and even complete system compromise. This highlights the need for an efficient real-time detection and response system that can identify malicious patterns, prevent further damage, and notify administrators instantly.

The SQL Injection Detection and Real-Time Alert **System** using pattern-based analysis. The system monitors user inputs, detects SQL injection attempts based on predefined patterns, classifies attacks by severity, and takes automated actions such as logging the attack, blocking malicious IP addresses, and sending instant alerts through Telegram. By providing real-time detection and active prevention, the proposed system significantly enhances the security of web applications while maintaining efficient performance.

II. PROBLEM STATEMENT

Web applications depend heavily on databases to store and manage sensitive information such as user data, financial details, and organizational records. This makes them major targets for SQL Injection attacks, attackers exploit weak input validation to insert malicious SQL queries into the system. Such attacks can lead to unauthorized data access, data modification, deletion of records, and even complete system compromise.

Although security measures like firewalls and authentication systems are used, many applications fail to detect SQL injection attacks at the application level in real time. Existing solutions often lack continuous monitoring, severity-based classification, automatic blocking of repeated attackers, and instant alert mechanisms. This delay in detection and response increases the risk of data breaches and service disruption.

The need for an efficient real-time SQL Injection Detection System that can analyse user inputs, detect malicious query patterns, log attack details, automatically block suspicious IP addresses, and immediately notify administrators. Such a system will strengthen web application security and reduce the impact of SQL injection attacks.

III. OBJECTIVES

The primary objectives of the proposed system are outlined as follows:

1. **Real-Time SQL Injection Detection:** To develop a system that can detect SQL injection attacks instantly before the query is executed in the database.
2. **Pattern-Based Input Analysis**: To use regular expression (regex) techniques to analyse user inputs and identify malicious SQL patterns.
3. **Severity Classification:** To categorize detected SQL injection attacks into different levels such as LOW, MEDIUM, HIGH, and CRITICAL based on their impact.
4. **Automated Attack Prevention:** To automatically block malicious requests and prevent harmful SQL commands from affecting the database.
5. **Automatic IP Blocking:** To monitor repeated attack attempts from the same IP address and block it after a defined number of malicious activities.
6. **Real-Time Alert Notification:** To send instant alerts to administrators using the Telegram Bot API with complete attack details.
7. **Admin Dashboard Development:** To provide a secure dashboard for administrators to monitor attack statistics, blocked IPs, and system status.
8. **Secure Authentication Mechanism:** To implement secure login and password protection using encryption techniques such as SHA-256.

IV. LITERATURE SURVEY

SQL Injection Detection and Prevention using Pattern Matching Algorithm [1] The SQL Injection (SQLI) is a serious web security problem caused by poor input validation. Researchers proposed methods like pattern matching, encryption, and query validation to detect and prevent different SQLI attacks.

Detecting Data Leaks Via SQL Injection Prevention [2] The SQL Injection (SQLI) is a major security threat to web applications, mainly caused by improper validation of user input. Previous studies have proposed techniques such as dynamic taint analysis, trusted data identification, and automated query validation to detect and prevent malicious SQL queries. These methods enhance database security and protect confidentiality, integrity, and authentication.

Prevention of Data Leakage via SQL Injection [3] The SQL Injection Attacks are a serious security threat to web applications. Researchers have proposed prevention methods such as input validation, static and dynamic analysis, machine learning techniques, and encryption algorithms like AES. Combining detection techniques with strong encryption is considered an effective way to prevent SQL injection and protect sensitive data.

A Review Study on SQL Injection Attacks, Prevention, and Detection [4] SQL Injection (SQLi) attacks are a major web security threat. Detection methods include pattern matching, static and dynamic analysis, and machine learning models like MLP, LSTM, and SVM. Although these techniques improve accuracy, challenges such as false positives, high cost, and zero-day attack detection remain, requiring more efficient real-time solutions.

A systematic review of detection and prevention techniques of SQL injection attacks [5] SQL Injection (SQLi) attacks are a serious threat to web applications, and researchers have developed detection methods such as static and dynamic analysis, pattern-based techniques, firewall protection, and machine learning models like MLP, LSTM, and SVM. While these approaches improve detection accuracy, issues like false positives, high computational cost, and difficulty in detecting zero-day attacks remain, emphasizing the need for efficient real-time solutions.

Detecting Data Leaks due to SQL Injection [6] The SQL Injection (SQLi) that can lead to data breaches and unauthorized access. Existing methods like signature-based detection, machine learning, and parameterized queries help prevent attacks but have limitations such as false positives and performance issues. The efficient and real-time SQL injection detection system is needed.

Detecting Data Leaks Using SQL Injection [7] The SQL Injection (SQLi) attacks are a serious threat to web applications. Detection methods include static and dynamic analysis, runtime monitoring, pattern matching, and machine learning, while prevention techniques like parameterized queries and input validation strengthen security. The issues such as false positives and performance overhead highlight the need for efficient real-time detection systems.

SQL injection attack: Detection, prioritization & prevention [8] SQL Injection a major web security risk identified by OWASP. Traditional detection methods used pattern matching, while modern approaches apply machine learning and deep learning for better accuracy. The most systems only detect attacks and lack proper classification, risk prioritization, and prevention, showing the need for a more complete security solution.

Identifying Data Leaks via SQL Injection [9] Researchers propose methods like input validation, parameterized queries, static and dynamic analysis, and machine learning for detection and prevention. However, issues such as false positives and performance overhead still require better real-time solutions.

Detecting Data Leaks via SQL Injection [10] The SQL Injection is a major web security threat. Researchers use techniques like static analysis, web application firewalls, and machine learning models such as SVM and KNN for detection. Although results show high accuracy, improved real-time and adaptive solutions are still needed.

V. PROPOSED SYSTEM

An application of a web-based security framework, the SQL Injection Detection and Real-Time Alert System technique can be used to enhance the security and reliability of web applications. The proposed approach is presented as an integrated system with functional modules that support continuous input monitoring, attack detection, automated prevention, and instant administrator notification. By combining pattern-based analysis, severity classification, IP blocking, and real-time alert mechanisms, the system ensures efficient threat identification and rapid response to potential database attacks.

Step 1: User Request Submission
The process begins when a user submits input data through a web application form. This input may include login details, search queries, or any form data that interacts with the database.

Step 2: Input Monitoring and Validation
Before the input reaches the database, the system intercepts and analyzes it. This ensures that every request is examined for suspicious patterns.

Step 3: SQL Injection Detection
The Detection Engine compares the user input with predefined SQL injection patterns using regular expressions. If the input contains malicious keywords such as DROP, UNION SELECT, or OR 1=1, it is flagged as an attack.

Step 4: Severity Classification
Once detected, the attack is categorized into severity levels such as Low, Medium, High, or Critical. This helps in understanding the seriousness of the attack and deciding the appropriate response.

Step 5: Attack Logging
The system records important details including IP address, attack payload, accessed endpoint, severity level, and timestamp. This data is stored in the database for future analysis and investigation.

Step 6: Automated IP Blocking
If repeated malicious attempts are detected from the same IP address, the system automatically blocks that IP to prevent further attacks.

Step 7: Real-Time Alert Generation
After detection, an instant alert message containing attack details is sent to the administrator via Telegram. This ensures quick awareness and response.

Step 8: Admin Dashboard Monitoring
The administrator can view real-time attack logs, blocked IP addresses, and overall security statistics through a secure dashboard. This helps in monitoring and managing system security effectively.

VI. SYSTEM DESIGN

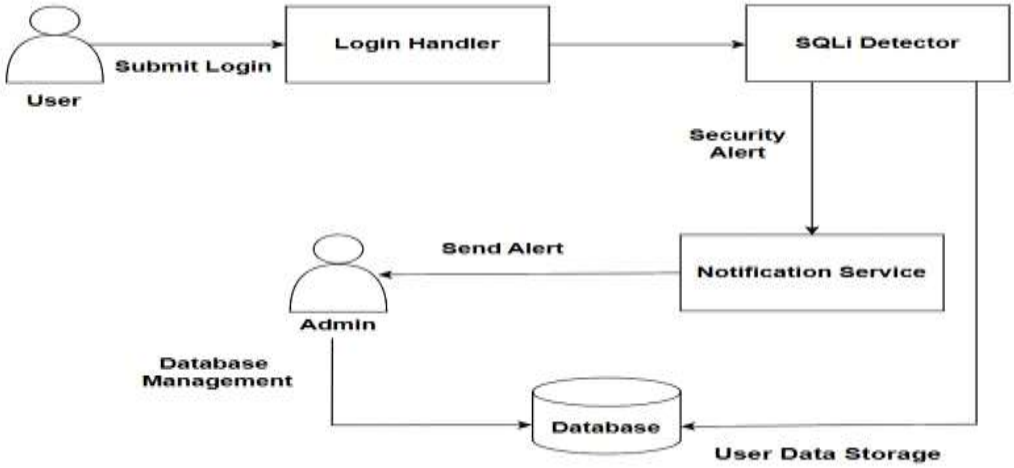

Figure 1: System Architecture

The major components of the system are described below:

1. **User Layer:** Represents the client interface where users submit login credentials or input data through web forms. It sends HTTP requests to the backend server and receives responses after processing. This layer has no direct access to the database, ensuring secure backend handling.
2. **Login Handler:** The entry point of the system within the FastAPI backend. It receives user requests, performs basic validation, and forwards the input to the SQL Injection Detection Engine before any database interaction. It ensures controlled routing and structured request handling.
3. **SQL Injection Detection Engine:** The core security component responsible for analyzing user input using predefined regex-based patterns. It classifies detected threats into severity levels (LOW, MEDIUM, HIGH, CRITICAL). If the input is safe, the request proceeds to the database; if malicious, it blocks the request, logs the attack, updates IP status, and triggers alerts.
4. **Notification Service:** Handles real-time alert generation and delivery. When an attack is detected, it compiles details such as IP address, payload, endpoint, timestamp, and severity level, and sends instant alerts to the administrator via Telegram Bot API. This ensures rapid incident awareness and response.
5. **Database Layer:** Responsible for secure data storage using SQLite. It stores user credentials (hashed passwords), attack logs, blocked IP addresses, and attempt counters. All database interactions occur only after security validation to maintain data integrity and prevent unauthorized access.
6. **IP Blocking Mechanism:** Monitors repeated malicious attempts from specific IP addresses. If the number of detected attacks exceeds a defined threshold, the IP is automatically blocked for a certain duration. This prevents continuous exploitation attempts.
7. **Admin Dashboard:** Provides centralized monitoring and control functionality. It allows administrators to view real-time attack logs, analyze severity levels, monitor blocked IP addresses, and manually block or unblock users. Secure session-based authentication ensures restricted access.

VII. METHODOLOGY

The system detects and prevents SQL Injection attacks in real time using a structured and efficient approach. All user inputs from web forms and API requests are intercepted by the FastAPI backend and analyzed using predefined regular expression patterns to identify malicious behaviour. Detected attacks are classified into severity levels (Low, Medium, High, Critical) to determine appropriate responses.

Malicious requests are immediately blocked and logged with details such as IP address, payload, endpoint, severity, and timestamp in an SQLite database. The system continuously monitors repeated attacks, automatically blocking IP addresses and defined threshold is exceeded. Real-time alerts are sent to the administrator via Telegram, and an administrative dashboard provides log analysis, IP management, and system monitoring. Secure database practices such as input validation, prepared statements, password hashing, and session-based authentication ensure robust protection and data security

VIII. CONCLUSION

This project presents an effective real-time SQL Injection Detection and Alert System designed to protect web applications from one of the most common security threats. By analyzing user inputs at the application layer, the system successfully detects and blocks SQL injection attempts before they reach the database. The integration of severity-based classification, automated IP blocking, and real-time alerts enables quick incident response and minimizes potential damage. Experimental results demonstrate accurate detection with minimal performance overhead. The proposed system is lightweight, scalable, and easy to deploy, making it suitable for practical web security applications. Overall, the system enhances application security and provides a proactive approach to intrusion prevention.

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