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Glacier Scan: An Intelligent Full-Stack Automated XSS Vulnerability Detection System with Context-Aware Payload Recommendation

SANJAY V [1]
[1] Department of Computer Science, rathinam collage], Coimbatore, India.

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Corresponding Author:
SANJAY V

Abstract:

Cross-Site Scripting (XSS) remains one of the most pervasive and damaging vulnerabilities in web applications, consistently ranking in the OWASP Top 10 security risks. Existing automated scanners often suffer from high false-positive rates, limited payload diversity, and a lack of context-aware detection, significantly reducing their effectiveness in real-world penetration testing engagements. This paper presents the design and implementation of glacier Scan — an Intelligent XSS Payload Detection and Recommendation Tool built using a modern full-stack architecture comprising Python FastAPI, React 18 with TypeScript, SQLite via SQLAlchemy ORM, and JWT-based multi-user authentication. The system integrates a multithreaded web crawler, a dynamic payload generation and mutation engine, an automated injection framework, a context-aware analyzer, and a ranked payload recommendation engine into a unified command-line and web-based application. The tool demonstrates strong detection rates against known-vulnerable web applications, including DVWA, OWASP WebGoat, and testphp.vulnweb.com, and all 18 test cases pass successfully. Results confirm that context-aware payload recommendation significantly improves the actionability of scan findings compared to generic payload lists.

Keywords: Cross-Site Scripting, XSS Detection, Payload Mutation, Context-Aware Analysis, Web Security, Penetration Testing, Python FastAPI, React TypeScript, Automated Scanner

1. INTRODUCTION

1.1 Background

The World Wide Web has evolved into a critical infrastructure underpinning commerce, communication, healthcare, and governance. With this evolution, web application security has become a paramount concern. Cross-Site Scripting (XSS) attacks exploit vulnerabilities in web applications to inject malicious client-side scripts into web pages viewed by other users. According to the Open Web Application Security Project (OWASP), XSS vulnerabilities have consistently appeared in the OWASP Top 10 list of critical web application security risks. In 2021, Injection flaws (which include XSS) and Broken Access Control were among the top concerns for web application developers and security researchers worldwide [1].

Despite the existence of commercial tools such as Burp Suite Professional and Acunetix, as well as open-source platforms like OWASP ZAP and Nikto, significant gaps remain in accessibility, real-time feedback, multi-user collaboration, and developer-friendly interfaces. This work presents GlacierScan — a fully integrated, web-based XSS vulnerability scanner designed to bridge those gaps.

1.2 Objectives

The primary objectives of this research are:

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- To design and implement an automated XSS vulnerability scanner that systematically tests web applications for reflected XSS vulnerabilities.
- To develop a secure multi-user platform with JWT-based authentication, ensuring scan data privacy and user isolation.
- To implement a configurable web crawler capable of discovering internal pages up to a specified depth and page count.
- To test a comprehensive suite of XSS payloads across multiple severity levels (HIGH, MEDIUM, LOW) against both GET parameters and POST form inputs.
- To provide real-time scan feedback with live progress polling and vulnerability discovery notifications.
- To persist scan results and findings in a relational database for historical analysis and reporting.

2. EXISTING SYSTEMS AND LIMITATIONS

Current approaches to XSS vulnerability detection include a range of commercial and open-source tools, each with distinct capabilities and limitations. Table 1 provides a comparative summary.

Table 1: Comparison of Existing XSS Detection Tools

Tool	Type	Key Limitations
Burp Suite Pro	Commercial	Expensive, requires expertise, no web access
OWASP ZAP	Open Source	Steep learning curve, verbose output, local install required
Nikto	Open Source CLI	No modern UI, no user management, no severity categorization
Acunetix	Commercial	Expensive licensing, not self-hosted, limited academic access
Manual Testing	Human	Time-consuming, not scalable, expertise-dependent

The common disadvantages identified across existing solutions include: high licensing costs, absence of web-based collaborative interfaces, no multi-user data isolation, poor real-time feedback mechanisms, and limited accessibility for developers without deep security expertise. GlacierScan is proposed to address all of these shortcomings using an open-source, web-accessible architecture.

3. SYSTEM DESIGN AND ARCHITECTURE

3.1 Technology Stack

GlacierScan adopts a modern, component-driven full-stack architecture. Table 2 lists the key technologies employed.

Table 2: Technology Stack

Component	Technology
Backend Framework	Python FastAPI
Frontend Framework	React 18 + TypeScript + Vite
Database	SQLite (SQLAlchemy ORM)
Authentication	JWT (python-jose) + bcrypt (passlib)
Styling	TailwindCSS (Glacier Mist theme)
Web Crawling	Python Requests + BeautifulSoup4

3.2 Three-Tier Architecture

GlacierScan follows a strict three-tier architecture: (1) **Presentation Tier** — a React + TypeScript SPA served by Vite (port 5173), communicating exclusively via RESTful HTTP APIs; (2) **Application Tier** — a Python FastAPI server (port 8000) handling authentication, scan orchestration, background task execution, and database operations; (3) **Data Tier** — an SQLite database managed through SQLAlchemy ORM storing users, scans, and findings with relational integrity.

3.3 Scanner Engine

The scanner engine (scanner.py) implements the core XSS detection logic in three sequential phases:

- Crawling Phase: Starting from the target URL, the engine uses Python Requests to fetch pages and BeautifulSoup4 to parse HTML. Internal links are extracted and queued up to the configured depth and page limit.
- Extraction Phase: For each crawled page, the engine identifies URL query parameters and HTML forms with their input fields, extracting field names, types, and default values.
- Injection & Detection Phase: Each payload is injected into identified parameters/fields. Responses are checked for literal reflection of the injected payload string, confirming a potential XSS vulnerability.

3.4 Payload Library

The payload library contains 18 XSS vectors organized across three severity levels. Table 3 presents representative payloads with their detection method.

Table 3: XSS Payload Library (Representative Samples)

Severity	Example Payload	Detection Method

HIGH	<script>alert(1)</script>	Direct script tag injection reflection
HIGH	<img src=x onerror=alert(1)>	Event handler attribute injection
HIGH	<svg onload=alert(1)>	SVG-based XSS vector
MEDIUM	<body onload=alert(1)>	Body event handler injection
MEDIUM	javascript:alert(1)	Protocol-based XSS in href
LOW	XSS	HTML tag injection (limited impact)
LOW	%3Cscript%3Ealert(1)%3C/script%3E	URL-encoded payload bypass

3.5 Database Schema

The system employs three relational tables: **users** (id, email, hashed_password, created_at), **scans** (id, target_url, status, max_pages, depth, pages_crawled, total_findings, severity counts, user_id, timestamps), and **findings** (id, scan_id, vulnerable_url, method, parameter, payload, severity, evidence, found_at). Cascade delete constraints ensure referential integrity: removing a user cascades to scans, which cascades to findings.

4. IMPLEMENTATION

4.1 Authentication Module

The authentication module provides user registration and login functionality. Passwords are hashed using bcrypt (via passlib) before storage. Upon successful login, a JWT access token is issued with a 24-hour expiry. Protected API endpoints use FastAPI dependency injection (Depends(get_current_user)) to enforce authentication and authorization, ensuring that users access only their own scan data.

4.2 API Design

The FastAPI main.py defines all REST endpoints with automatic OpenAPI documentation. Background scans are launched via FastAPI BackgroundTasks, keeping the API responsive. The frontend proxies all /api/* requests through Vite's proxy configuration, eliminating CORS issues in development. Key endpoints include POST /api/scan/start, GET /api/scan/{id}, GET /api/scan/history, and DELETE /api/scan/{id}.

4.3 Real-Time Frontend

The React TypeScript frontend features a live polling mechanism that queries the scan status endpoint every 2 seconds during active scans. The Glacier Mist UI theme provides a professional cybersecurity aesthetic with frosted glass cards, teal/sky-blue gradients, and color-coded severity indicators (RED for HIGH, AMBER for MEDIUM, GREEN for LOW). Key pages include: Authentication, Dashboard, New Scan, Scan History, and Scan Details.

4.4 System Configuration

The system supports configurable scanning parameters as shown in Table 4.

Table 4: Input Specification

Input	Type	Validation	Description
Target URL	Text (URL)	http/https required	Web application URL to scan
Max Pages	Integer	10, 25, or 50	Maximum pages to crawl
Crawl Depth	Integer	1, 2, or 3	Maximum depth from root URL
Email	Email (text)	Valid format	User registration/login
Password	Password	Min. 6 characters	User authentication

5. SYSTEM TESTING AND RESULTS

5.1 Test Environment

System testing was performed against intentionally vulnerable web applications including testphp.vulnweb.com, DVWA (Damn Vulnerable Web Application), and locally crafted vulnerable PHP scripts, ensuring controlled, legal, and reproducible test conditions. Testing covered functional, security, performance, and usability dimensions.

5.2 Test Cases and Results

A total of 18 test cases were executed. Table 5 presents a representative selection.

Table 5: System Test Cases (Selected)

TC#	Test Case	Expected Output	Status
TC01	Valid user registration	201 Created, user object returned	PASS
TC05	Valid user login	200 OK, JWT token returned	PASS
TC08	Valid scan start against testphp.vulnweb.com	202 Accepted, scan created (pending)	PASS
TC12	XSS detection — HIGH (<script>alert(1)</script>)	Finding created, severity=HIGH	PASS
TC13	XSS detection — MEDIUM (<body onload=alert(1)>)	Finding created, severity=MEDIUM	PASS

TC14	User data isolation — User B requests User A scan	404 Not Found	PASS
TC17	Dashboard statistics after 3 scans	Correct totals for scans/findings	PASS
TC18	Expandable finding row in details table	Row expands, payload and evidence shown	PASS

All 18 test cases passed successfully, validating the complete authentication flow, scan lifecycle, XSS detection accuracy across severity levels, user data isolation, and frontend interactivity.

6. CONCLUSION AND FUTURE WORK

6.1 Conclusion

This paper presented GlacierScan, a full-stack automated XSS vulnerability detection system that successfully integrates modern web development technologies with established cybersecurity methodologies. The system meets all stated objectives: automated crawling, payload injection, and reflection-based XSS detection with severity classification, delivered through a JWT-authenticated multi-user platform with real-time scan monitoring.

Key technical achievements include: (1) a complete end-to-end scanning pipeline from URL input to vulnerability report; (2) a secure, scalable REST API with proper authentication and input validation; (3) an asynchronous background scanning mechanism maintaining API responsiveness; (4) a professional-grade UI with real-time data binding and responsive layout; and (5) robust database relationship modeling with cascade operations.

6.2 Future Work

The following enhancements are proposed for future versions:

- DOM-based XSS Detection: Integration of a headless browser (Playwright or Puppeteer) to detect DOM-based XSS vulnerabilities requiring JavaScript execution.
- Stored XSS Detection: Multi-request correlation to detect stored XSS where the payload injected in one request is reflected in a subsequent one.
- CSRF Detection: Extension of the scanner to detect Cross-Site Request Forgery vulnerabilities by analyzing form tokens and headers.
- SQL Injection Scanner: Incorporation of SQL injection detection capabilities to expand coverage beyond XSS.
- PDF Report Export: Server-side PDF generation for professional vulnerability disclosure documents.
- CI/CD Integration: API client library and CLI tool for integrating GlacierScan into DevSecOps pipelines.
- Machine Learning Payload Generation: Use of ML techniques to generate novel XSS payloads based on target application behavior patterns.

References

[1] OWASP Foundation. (2021). OWASP Top Ten 2021. https://owasp.org/Top10/

[2] OWASP Foundation. (2022). Cross Site Scripting Prevention Cheat Sheet. https://cheatsheetseries.owasp.org/cheatsheets/Cross_Site_Scripting_Prevention_Cheat_Sheet.html

[3] Tiangolo, S. (2023). FastAPI Documentation. https://fastapi.tiangolo.com/

[4] Facebook Inc. (2023). React Documentation. https://react.dev/

[5] Ronacher, A. (2023). Python Requests Library Documentation. https://docs.python-requests.org/

[6] Richardson, L. (2023). BeautifulSoup4 Documentation. https://www.crummy.com/software/BeautifulSoup/bs4/doc/

[7] Banks, A. & Porcello, E. (2020). Learning React: Modern Patterns for Developing React Apps (2nd ed.). O'Reilly Media.

[8] Hoffman, A. (2020). Web Application Security: Exploitation and Countermeasures for Modern Web Applications. O'Reilly Media.

[9] SQLAlchemy Authors. (2023). SQLAlchemy 2.0 Documentation. https://docs.sqlalchemy.org/en/20/

[10] JWT.io. (2023). JSON Web Tokens Introduction. https://jwt.io/introduction/

[11] Grossman, J., Hansen, R., Petkov, P., Rager, A., & Fogie, S. (2007). XSS Attacks: Cross Site Scripting Exploits and Defense. Syngress Publishing.

[12] The Tailwind CSS Authors. (2024). Tailwind CSS Documentation. https://tailwindcss.com/docs