A PARADIGM SHIFT IN XSS-DOM MITIGATION VIA DYNAMIC CONTENT SECURITY POLICY

REPORT
IT5712 - PROJECT I

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INTRODUCTION:

Cross-Site Scripting (XSS) and Document Object Model (DOM) attacks are critical security concerns for web applications. XSS vulnerabilities allow attackers to inject malicious scripts into web pages viewed by other users, potentially compromising their data or session information. These attacks exploit the trust a user has in a website, enabling unauthorized access or data theft. DOM-based XSS attacks specifically manipulate a webpage's Document Object Model, which represents the structure of a web page in a hierarchical manner. In DOM-based XSS, malicious scripts manipulate the DOM of a web page dynamically, often targeting client-side scripts and affecting the behavior of web applications. Detecting and mitigating DOM-based XSS attacks is essential for safeguarding user data, maintaining application integrity, and preventing unauthorized access to sensitive information. Security measures involve input validation, output encoding, and monitoring for unusual script behavior to thwart these attacks and ensure a secure web environment.

Our focus is on using pattern matching techniques to detect XSS-DOM vulnerabilities, adding an extra layer of security to web applications. This proactive approach helps identify potential attacks early, enhancing overall security. We also explore preventive strategies, such as input validation and Content Security Policy (CSP), in detail. These strategies are effective in reducing the risks associated with XSS-DOM attacks, making web environments more secure against potential breaches.

OBJECTIVES:

Understanding Vulnerabilities: Gain insight into the nature and mechanics of Cross-Site Scripting (XSS) and DOM-based attacks.

Detection Techniques: Investigate methods (Pattern matching) for identifying XSS-DOM vulnerabilities, enabling proactive defense against potential attacks.

Preventive Strategies: Explore strategies such as input validation and Content Security Policy (CSP) to mitigate the risks of XSS-DOM attacks.

Real-world Insights: Analyze real-world cases of notable attacks to grasp the potential consequences and implications of these vulnerabilities.

PROBLEM STATEMENT:

Cross-Site Scripting (XSS) vulnerabilities persist in web applications, allowing malicious scripts to compromise user data and privacy. Existing Content Security Policy solutions struggle to effectively protect dynamic web pages where content changes based on user interactions.

Lack of adaptive security measures leaves dynamic pages exposed to XSS attacks, necessitating a novel solution.

TECH STACK:

- Python
- Flask
- Javascript
- Sqlite

System Requirements:

- Windows 10 and above
- VS Code
- Chrome Browser

IMPLEMENTATION MODULES:

Module 1: DETECTION

- In this module, we have implemented a set of regular expression patterns designed to enhance the security system's ability to identify potential XSS-DOM vulnerabilities.
- This pattern integration allows for more robust detection of security threats related to client-side scripting and DOM manipulation.

Module 2: MITIGATION

- Under this module, we explore the integration of Content Security Policy (CSP) as a proactive measure to mitigate the risks associated with client-side scripting and DOM manipulation.
- We employ a specific whitelist framework to ensure no scripts or resources are loaded from a source that we are unaware of.
- Additionally, we receive alerts when such an attack is detected and blocked.
- These alerts include detailed information about the detected threats and recommended actions for effective incident response.
- This combined approach ensures that not only are vulnerabilities identified, but also steps are taken to mitigate and respond to potential threats effectively.

NOVELTY:

Traditionally, detecting XSS DOM attacks involved manual inspection of source code for potential vulnerabilities. We've introduced a novel approach that automates this process using pattern matching techniques and dynamic pattern learning.

Pattern Matching Techniques: We use predefined patterns to identify known attack vectors within user inputs.

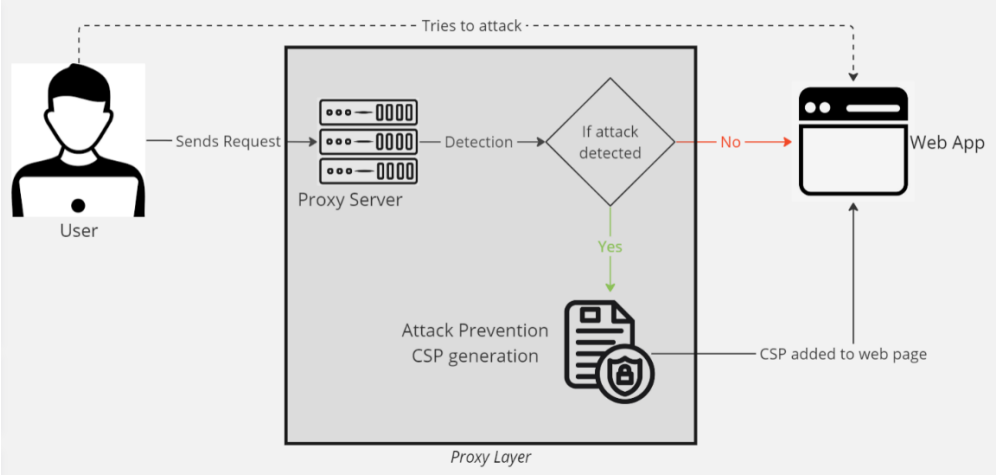
Dynamic Pattern Updation: Our innovation is a dynamic pattern updation algorithm that learns from the application's behavior. It employs taint analysis to track data flow and assesses inputs for suspicious keywords and context.

Risk Assessment: Inputs are assigned risk scores, and those exceeding a predefined threshold are considered potential new attack patterns.

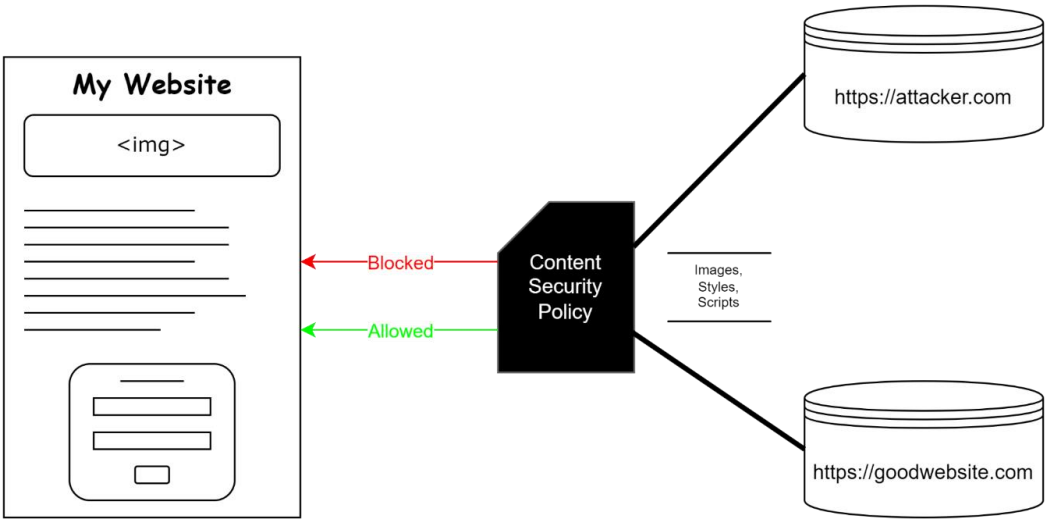
Pattern Addition: New patterns are added to the library, enabling real-time protection against emerging threats.

This approach streamlines XSS DOM attack detection, reducing manual effort and enhancing the application's security.

ARCHITECTURE DIAGRAM:

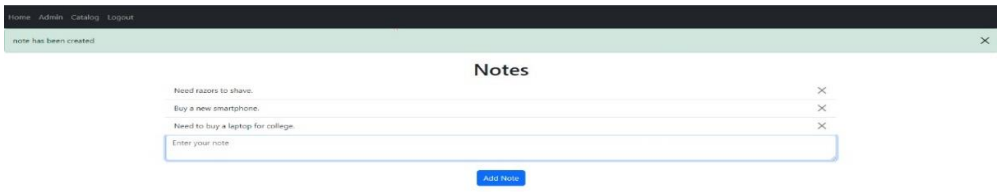


Project Architecture Diagram

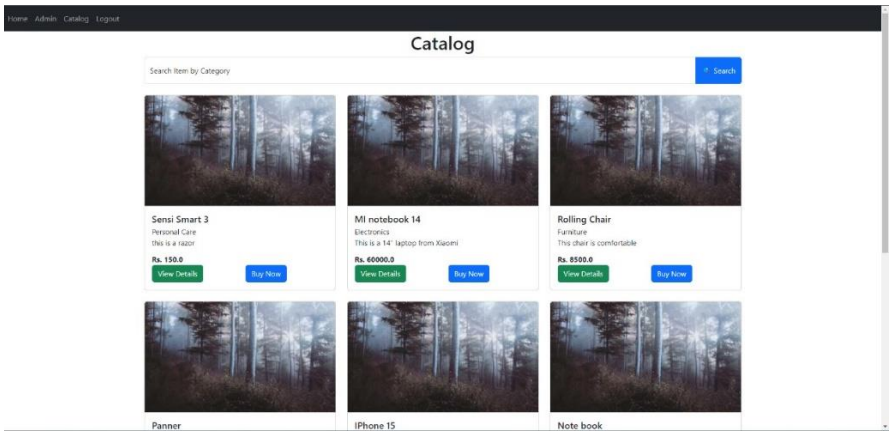


Content Security Policy working

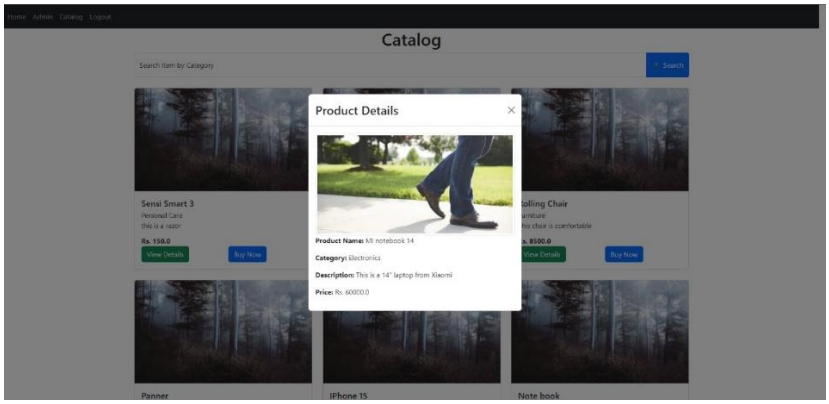
OUTPUT SCREENSHOTS:



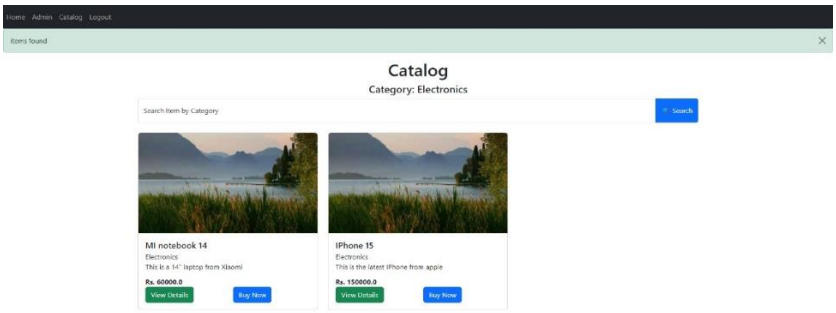
Notes page



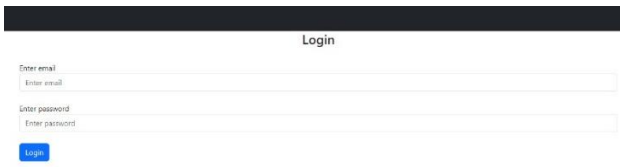
Catalog Page



Product details

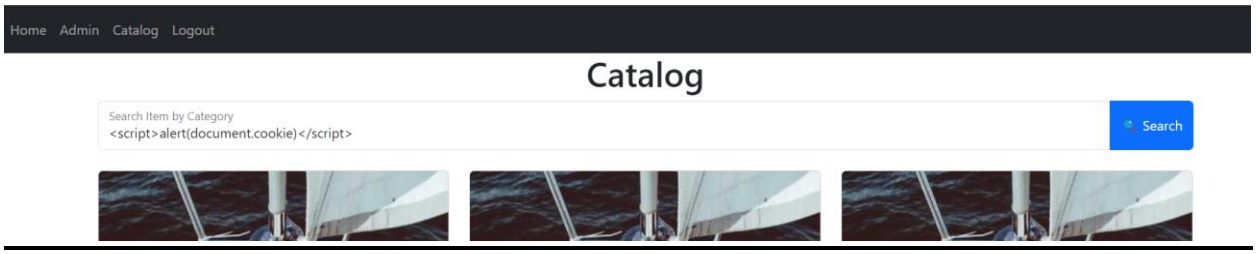


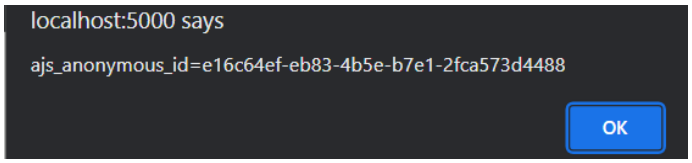
Product filtering based on category



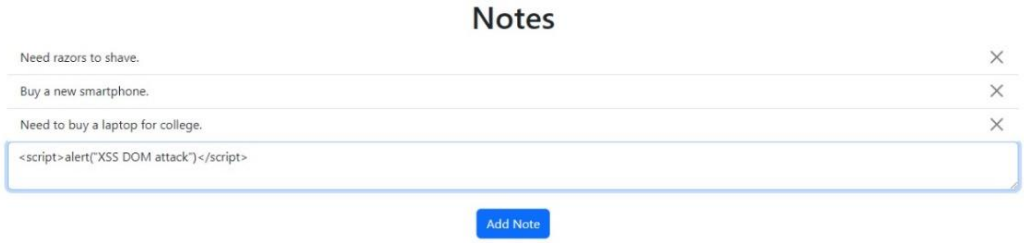
Admin, Login and Signup Pages

Injecting Script in various ways:

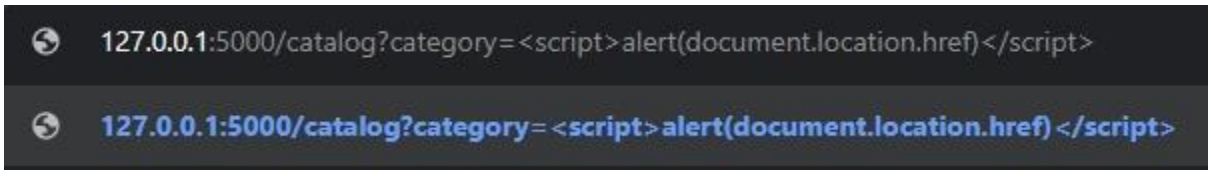


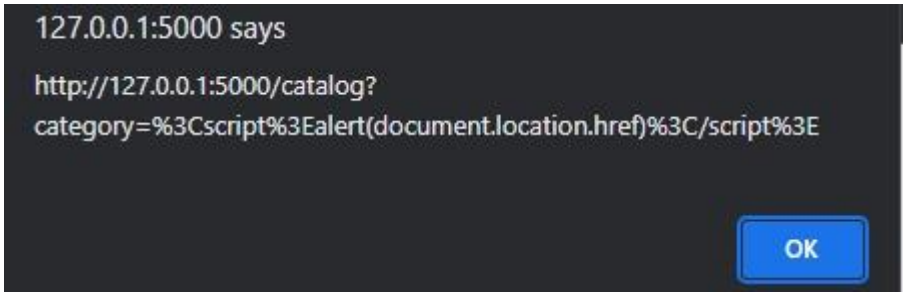


Via Search Bar



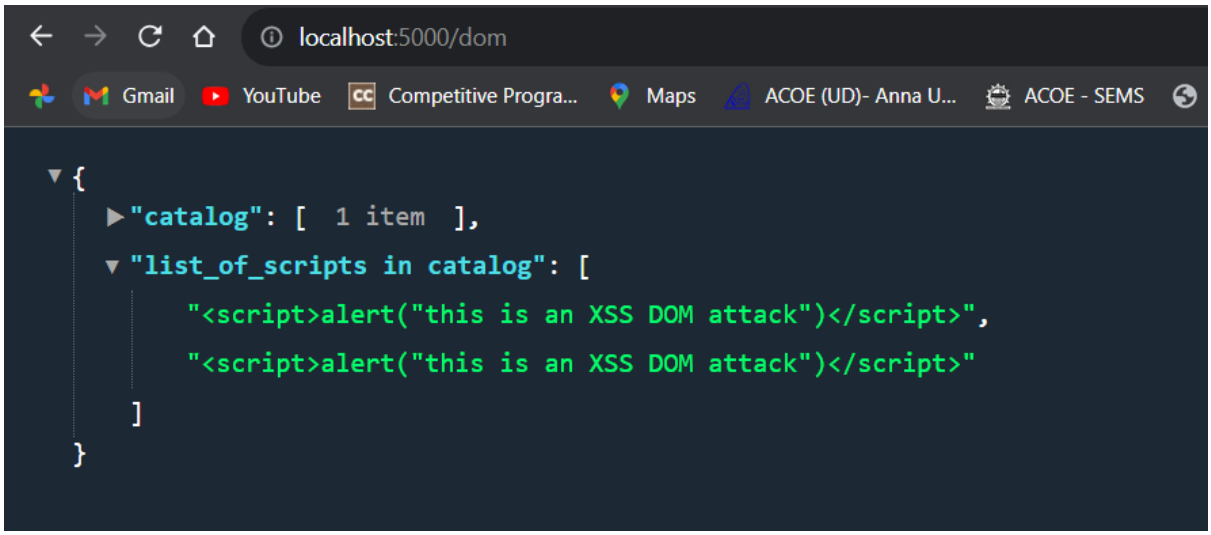
Via Notes Page





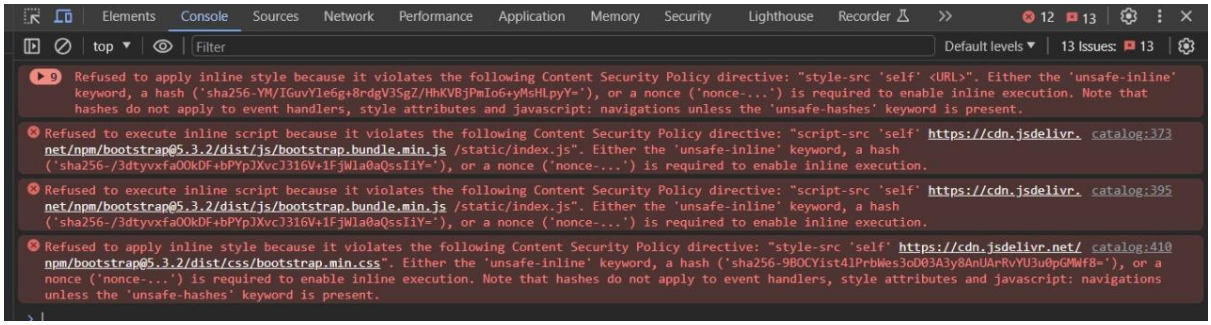
Via URL

Detection of XSS DOM attacks via RegEx (pattern matching):



Pattern Matching

Mitigation of XSS DOM attacks via CSP



Warning on prevention of XSS DOM Attack

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