Indian Journal of Computer Science and Technology
https://www.doi.org/10.59256/indjcst.20250401026
Volume 4, Issue1 (January-April 2025), PP: 171-175.
www.indjcst.com
ISSN No: 2583-5300

Rootkit Detecting Application

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To Cite this Article: *Sethulakshmi[1], Raja Dhurai S[2], "Rootkit Detecting Application", Indian Journal of Computer Science and Technology, Volume 04, Issue 01 (January-April 2025), PP: 171-175.*

Abstract: *Rootkits are malicious software designed to conceal the presence of unauthorized access to a computer system. Detecting rootkits is challenging due to their ability to evade traditional security mechanisms. This project proposes a novel rootkit detection technique based on behavioural analysis, security log analysis and anomaly detection. The approach Uses such an algorithm that baselines system behaviour and identify deviations indicative of rootkit activity. Key features include dynamic analysis of system calls, file system interactions, and network traffic patterns. Evaluation results demonstrate the effectiveness of the proposed method in detecting both known and novel rootkits with high accuracy and low false positives.*

Keywords: *Cyber Security, Rootkit Detection, Malware analysis, Kernel-level Security, Registry Monitoring, File System Analysis, Anti-rootkit Software.*

I.INTRODUCTION

Rootkits are malicious software designed to conceal the presence of unauthorized access to a computer system. Detecting rootkits is challenging due to their ability to evade traditional security mechanisms. [1]

The Rootkit Detector Application is designed to provide a robust solution for identifying and mitigating the risks posed by rootkits. This application scans computer systems for signs of rootkit infections, leveraging a variety of detection techniques such as signature-based analysis, behaviour monitoring, and integrity checks. By detecting anomalies in system behaviour, file structures, and registry entries, the Rootkit Detector Application helps users ensure the security and integrity of their systems.[2]

This paper proposes a novel rootkit detection technique based on behavioural analysis and anomaly detection. The approach leverages machine learning algorithms to establish baseline system behaviour and identify deviations indicative of rootkit activity. Key features include dynamic analysis of system calls, file system interactions, and network traffic patterns. [3]

Evaluation results demonstrate the effectiveness of the proposed method in detecting both known and novel rootkits with high accuracy and low false positives. Future research directions include enhancing detection capabilities against sophisticated rootkit variants and optimizing performance in real-time deployment scenarios. [4] The remainder of this paper is organized as follows: Section II presents a literature review of related work. Section III details the proposed methodology, including the system architecture. Section IV discusses the experimental results, findings and performance evaluation of the proposed framework. Finally, Section V concludes the page.

II.LITERATURE REVIEW

Mohammad Nadim, Wonjun Lee, David Akopian [5] had proposed the comprehensive survey presents a structured taxonomy of kernel-level rootkit detection mechanisms. It discusses the strengths and challenges of various detection approaches, explores prevention techniques, and examines literature on profiling rootkit behaviours. The paper concludes with suggestions for future research directions in kernel-level rootkit detection. The survey by Mohammad Nadim, Wonjun Lee, and David Akopian provides an in-depth analysis of the different types of kernel-level rootkits and their detection mechanisms. It categorizes various detection methods into static, dynamic, and hybrid approaches, highlighting the pros and cons of each. The authors also emphasize the importance of combining multiple detection techniques to enhance the accuracy and reliability of rootkit detection systems. Additionally, they stress the need for developing real-time detection systems that can efficiently monitor and identify rootkit activities without compromising system performance.

Basirah Noor, Sana Qadir [6] had proposed the study introduces an effective technique that leverages memory analysis to detect concealed rootkits. It develops models and tools to automate the analysis of memory dumps for efficient rootkit detection and investigates a novel set of features extracted from memory images, including DLLs, handles, privileges, network connections, modules, injections, and services. The study by Basirah Noor and Sana Qadir focuses on enhancing rootkit detection through memory analysis, a technique often overlooked in traditional methods. By automating the analysis of memory dumps, their approach significantly reduces the manual effort and time required for rootkit detection. They introduce a unique set of features derived from memory images that provide deeper insights into potential rootkit behaviors, such as suspicious DLLs, hidden network connections, and altered privileges. The study also explores how memory forensics can reveal hidden processes and

injected code, which are critical indicators of rootkit activity. Furthermore, the authors propose an integrated system that can analyze these features in real-time, improving the overall detection efficiency and making it a promising approach for proactive security measures.

Suresh Kumar Srinivasan, SudalaiMuthu Thalavaipillai [7] had proposed the study proposes the Kernel Rootkit Detection Multi- Class Deep Learning Techniques (KRDMCDLT). It utilizes deep learning algorithms to recognize kernel rootkits from data batches by selecting essential properties for learning tracking models. The detection approach was tested in a Google Cloud Platform (GCP) computing system. The study by Suresh Kumar Srinivasan and SudalaiMuthu Thalavaipillai introduces a novel approach for detecting kernel rootkits using multiclass deep learning techniques, offering an advanced method for automated detection. By leveraging deep learning algorithms, their approach is able to effectively distinguish between normal system behavior and malicious kernel activities, enhancing detection accuracy. The KRDMCDLT model was trained on carefully selected system properties, enabling it to track and recognize the subtle patterns associated with kernel rootkits. The authors also evaluate the performance of their detection technique in a cloud computing environment, specifically the Google Cloud Platform (GCP), showing its scalability and effectiveness in real-world, large-scale systems.

Kovacs [8] had Proposed the integrity checking methods for detecting file system tampering that is characteristic of rootkit activity. Checks for alterations in system files, configurations, and memory, comparing current system states with known good baselines. Kovacs' proposed integrity checking methods focus on identifying unauthorized changes in critical system files, which are often a hallmark of rootkit activity. The approach involves periodic scanning of the file system to detect discrepancies between the current system state and a trusted baseline, making it difficult for rootkits to remain undetected. By verifying the integrity of system configurations and memory, the method can uncover subtle tampering that might otherwise go unnoticed by traditional detection tools. Kovacs emphasizes the importance of maintaining an up-to-date baseline, which can help identify new forms of rootkits as they evolve. Additionally, the proposed method is designed to be lightweight and efficient, ensuring minimal impact on system performance while providing robust protection against rootkit induced file system tampering.

Kaufman, C., & McAllister, G. [9] had proposed the Advanced integrity checking systems that monitor critical system files and configurations to detect rootkits. Kaufman and McAllister's proposed advanced integrity checking systems aim to provide a comprehensive defense against rootkits by continuously monitoring critical system files and configurations. Their system operates by comparing the current state of these files with secure, predefined baselines, ensuring that any unauthorized modifications are quickly detected. In addition to monitoring static files, their approach also tracks dynamic system changes, such as runtime memory and active processes, which can be manipulated by sophisticated rootkits. The system is designed to adapt to emerging threats, using heuristic analysis to detect suspicious patterns and behaviors that may indicate rootkit presence. By implementing this proactive monitoring, the proposed system can detect rootkits before they gain full control over the system. Furthermore, Kaufman and McAllister emphasize the importance of integrating this integrity checking system with other security mechanisms, such as intrusion detection and prevention systems, to provide layered defense against rootkit attacks.

Gandotra, A., & Gupta, A. [10] had proposed a cloud-based rootkit detection system that uses centralized monitoring tools and anomaly detection algorithms to identify suspicious activity across virtual machines in the cloud. The authors also discussed challenges unique to cloud environments, such as the multi-tenancy model and the difficulty of memory forensics in a virtualized cloud setup. Gandotra and Gupta's proposed cloud-based rootkit detection system leverages centralized monitoring tools to track and analyze activity across multiple virtual machines, allowing for more efficient detection of rootkits in cloud environments.Their use of anomaly detection algorithms helps identify deviations from normal behavior, making it possible to spot hidden rootkit activity that might otherwise be missed by traditional detection methods. The authors highlight the challenges of working in a cloud environment, especially in terms of the multi-tenancy model, where multiple users share the same physical resources, complicating the identification of malicious activity. They also address the difficulty of performing memory forensics in virtualized cloud setups, as rootkits can hide within virtual machine images or hypervisors, making traditional memory analysis tools less effective. To overcome these challenges, the system integrates advanced techniques for monitoring network traffic, file integrity, and system calls, enabling better detection of rootkit activities across virtualized infrastructures. Additionally, the authors propose strategies for enhancing the scalability of their detection system, ensuring it can handle the dynamic nature of cloud environments without sacrificing detection performance.

Sriram, S., & Bansal, A. [11] had proposed the techniques for detecting rootkits in cloud computing, including leveraging cloud- native anomaly detection systems, behaviour analysis, and forensic investigation tools. The authors emphasize the importance of cloud-specific solutions for rootkit detection. Sriram and Bansal's techniques for detecting rootkits in cloud computing focus on integrating cloud-native anomaly detection systems, which are specifically designed to work within the unique architecture of cloud environments. Their approach emphasizes the importance of behavior analysis, where deviations from typical system operations are used to identify potential rootkit infections. The authors also propose the use of forensic investigation tools tailored to cloud environments, enabling the collection and analysis of data from virtual machines and cloud infrastructure without disrupting service. Recognizing the dynamic and scalable nature of cloud platforms, they advocate for adaptive detection mechanisms that can scale with the evolving complexity of cloud resources. Additionally, the authors stress that traditional rootkit detection methods may not be effective in cloud settings, urging the development of specialized cloud-specific solutions that can address issues such as multi-tenancy, virtualization, and the ephemeral nature of cloud instances.

III.PROPOSED METHODOLOGY

Our project makes use of the vast libraries in python to scan for any hidden processes and inappropriate system behaviours by taking syscall (system call) address as input. Because no matter how undetectable Rootkits are they still need to make some sort of system calls to perform their actions.In Windows, a system call (syscall) is a way for user-mode applications to interact with the operating system kernel. When a user-mode application needs to perform a low-level operation, such as accessing hardware,

managing memory, or interacting with the file system, it makes a syscall. The syscall serves as an interface between user-mode applications and the kernel.

Fetches all Running Processes

The program scans all running processes on the system using the psutil library, saves the process information to a text file named process_list.txt, and displays the scanned processes in a Listbox.

Fig 3.1

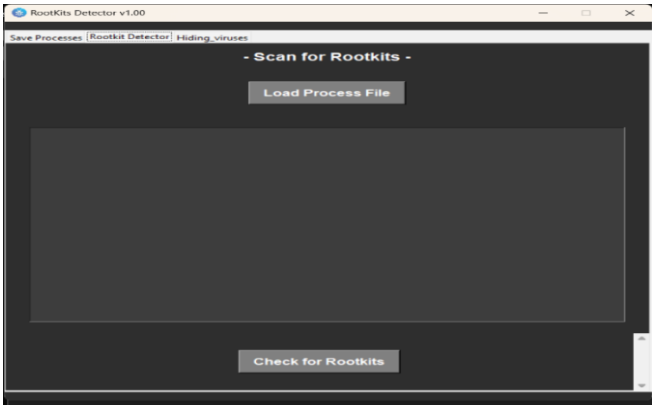


Fig 3.2

Fig 3.3

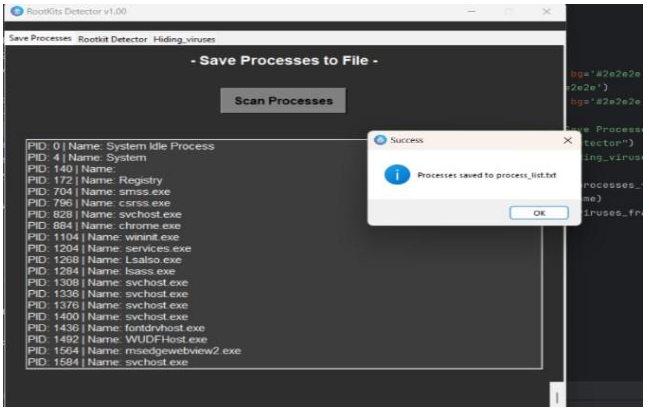


Fig 3.4

Checks for Rootkits

The program allows the user to load a file containing process IDs. It checks the loaded processes for suspicious behavior that might indicate rootkits, such as unusual names, paths, network activity, or command line arguments. The results are displayed in a Text widget with a scrollbar, and feedback is provided through message boxes.

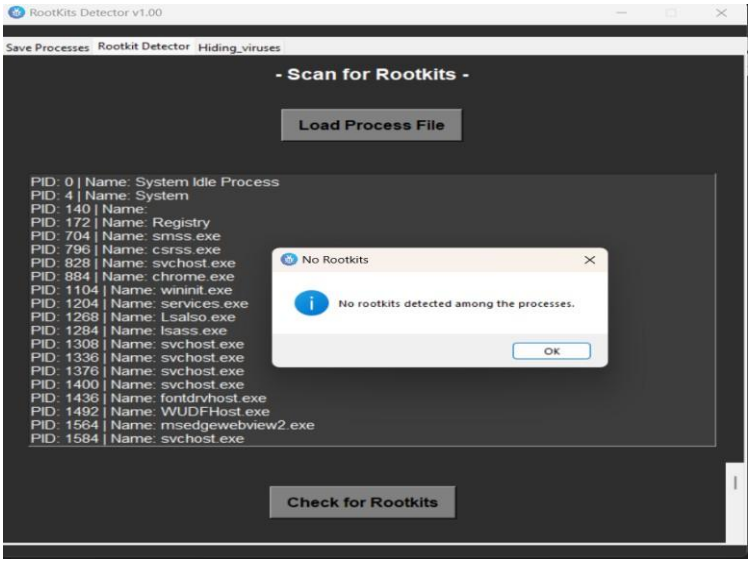
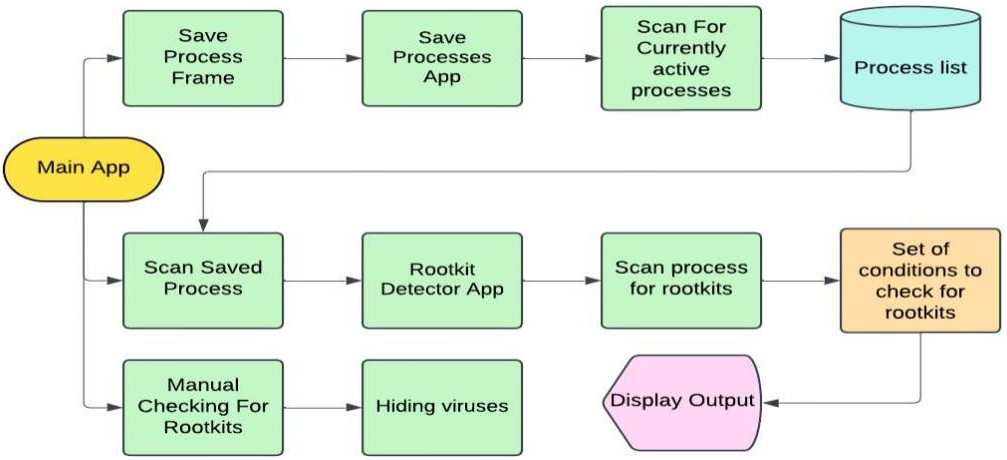


Fig 3.5

IV.SYSTEM ARCHITECTURE



V.FINDINGS

Rootkit detection highlights both the strengths and limitations of various detection methods in combating sophisticated threats posed by rootkits. Rootkits, due to their ability to hide their presence and operate at the kernel or hardware level, present significant challenges to traditional security mechanisms. The project found that while signature-based detection remains effective for identifying known rootkits, its reliance on previously recognized signatures limits its ability to detect new, unknown rootkits, which are often polymorphic or zero-day. Behavioural (heuristic) detection methods showed promise in identifying abnormal patterns in system behaviour, even for unknown rootkits, by monitoring system calls, file activities, and process behaviours. However, these methods were found to produce a higher rate of false positives, especially in environments with high variability in system behaviour. Integrity checking, when used to monitor critical files and system configurations, proved to be a reliable tool in detecting unauthorized modifications that could signal rootkit presence. However, this method requires frequent updates and careful monitoring to avoid overlooking subtle changes that could indicate rootkit activity. Memory forensics emerged as a powerful tool in detecting rootkits, particularly those that manipulate memory to evade detection. Memory dumps allowed the project to uncover hidden processes and injected malicious code that was not visible through traditional disk-based analysis. Machine learning-based approaches demonstrated the potential to detect even novel and evasive rootkits by learning from system behaviours, although they required large datasets for effective training and could still suffer from high computational overhead. Despite the effectiveness of these methods, the project identified several challenges in rootkit detection. Moreover, the integration of multiple detection techniques into a hybrid model showed promise in improving accuracy and minimizing the trade-off between false positives and detection rates, although the complexity of such systems increased. Lastly, cloud-based detection and hardware-based solutions added another layer of security but often require specialized infrastructure and were not universally applicable to all environments.

VI.CONCLUSION

The Rootkit Detector Application is a robust and essential security tool designed to detect, quarantine, and remove rootkits from computer systems. Rootkits pose a significant threat by hiding malicious activities and compromising system integrity. This application addresses these challenges by combining advanced detection techniques, including signature-based detection, behavioural analysis, and memory forensics. Through real-time monitoring and detailed reporting, it provides users with an effective solution to identify and mitigate both known and zero-day threats.

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