UNDERGRADUATE THESIS

IMPLEMENTATION OF HYBRID DETECTION WITH CASCADE MECHANISM FOR DDOS MITIGATION ON IOT NETWORKS USING RASPBERRY-PI

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ABSTRACT

Student Name / NPM	:	Muchammad Basroil Billah / 22081010260
Thesis Title	:	Implementation of Hybrid Detection with Cascade Mechanism for DDoS Mitigation on IoT Networks using Raspberry-Pi
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Internet of Things (IoT) devices typically operate with limited computational resources, leaving them highly vulnerable to Distributed Denial of Service (DDoS) attacks. Existing approaches present a fundamental trade-off: rule-based detection offers low latency but struggles with ambiguous attack patterns, while machine learning achieves higher accuracy at the cost of substantial computational overhead unsuitable for edge devices. This research develops a hybrid DDoS detection system with a cascade mechanism on a Raspberry Pi 4B acting as a security gateway. The architecture consists of three sequential layers: Tier 1 rule-based detection for immediate blocking using three high-precision rules (R1: rate > 456.08 pps; R2: ICMP flag; R3: SYN-only flag), Tier 2 weighted scoring with five rules (R4–R8, maximum score 160, blocking threshold 70%) for ambiguous traffic, and a Random Forest model trained on the CICIoT2023 dataset (46 features, 1,154,684 samples) as the final layer. Threshold values were derived from percentile-based statistical distribution analysis, with mitigation enforced through iptables and real-time alerts delivered via Telegram Bot API. Evaluation results demonstrate 99.84% accuracy, 99.99% recall, and 99.92% F1-score, with 94.76% of traffic resolved directly by the rule-based layer. Stress testing up to 50,000 pps recorded maximum CPU usage of 26.2%, confirming sufficient headroom on the Raspberry Pi 4B. Scenario testing and independent pentester validation confirmed a 100% detection rate across volumetric, protocol, and application-layer attacks with detection latency below one second, while MQTT-based IoT communication remained unaffected with zero false positives. The proposed cascade-based hybrid detection system effectively combines rule-based responsiveness with machine learning accuracy on resource-constrained devices.

Keywords: DDoS, Hybrid Detection, Cascade, Rule-Based, Random Forest, IoT, Raspberry Pi, Security Gateway

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The author humbly welcomes constructive criticism on this thesis, in the hope that it may continue to grow and bring something of value to its readers and to the field.

Surabaya, April 10th 2026

Author

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE