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Approved for defense

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„___” _____ 2025

APPLICATION OF COMPUTER VISION IN MODERN AUTOMATED VIDEO SURVEILLANCE SYSTEMS

Master's project

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Chisinau, 2025

ABSTRACT

This master's thesis focuses on the development and analysis of an automated video surveillance system powered by computer vision, aimed at enhancing security and monitoring capabilities. The project integrates state-of-the-art artificial intelligence technologies, including real-time person detection, facial recognition, behavioral analysis, and rapid identification of emergency situations such as fires and floods. The system architecture is designed to be modular, with AI models for object classification and detection, such as a cat classifier and a fire detector, evaluated using advanced metrics like mAP@50 and mAP@50-95, ensuring high accuracy and efficient generalization. The proposed solution demonstrates significant improvements in reducing false alarms, enabling faster response times, and offering a scalable, reliable, and intelligent surveillance system for both security and home automation applications. Through its integration of modern hardware and software interfaces, the project presents a practical application of computer vision, contributing to advancements in automated surveillance and emergency response systems.

REZUMAT

Această lucrare de master se concentrează pe dezvoltarea și analiza unui sistem automatizat de supraveghere video bazat pe viziune computerizată, având ca scop îmbunătățirea capabilităților de securitate și monitorizare. Proiectul integrează tehnologii avansate de inteligență artificială, inclusiv detectarea în timp real a persoanelor, recunoașterea feței, analiza comportamentală și identificarea rapidă a situațiilor de urgență, cum ar fi incendiile și inundațiile. Arhitectura sistemului este concepută pentru a fi modulară, incluzând modele AI pentru clasificarea și detectarea obiectelor, cum ar fi un clasificator pentru pisici și un detector de incendii, evaluate folosind metrici avansați precum mAP@50 și mAP@50-95, asigurând o acuratețe ridicată și o generalizare eficientă. Soluția propusă demonstrează îmbunătățiri semnificative în reducerea alarmelor false, permitând timpi de răspuns mai rapizi și oferind un sistem de supraveghere scalabil, fiabil și inteligent pentru aplicații de securitate și automatizare a locuințelor. Prin integrarea interfețelor hardware și software moderne, proiectul prezintă o aplicație practică a viziunii computerizate, contribuind la avansarea sistemelor de supraveghere automatizată și răspuns la urgențe.

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INTRODUCTION

The field of video surveillance has undergone a dramatic transformation with the integration of computer vision technologies, offering far more than traditional passive monitoring. Automated surveillance systems now employ sophisticated algorithms that analyze visual data in real-time, allowing for intelligent detection, analysis, and response to events. This shift from simple recording to proactive monitoring represents a significant advancement, addressing both security needs and enhancing the overall functionality of surveillance systems in various environments, from homes to large-scale enterprises.

Computer vision-powered surveillance systems are revolutionizing crime prevention and home security by leveraging AI capabilities such as facial recognition, motion detection, and object tracking. These features enable systems to differentiate between normal and suspicious activities, providing more accurate detection and reducing false alarms. The ability to autonomously detect and react to potential threats has made modern surveillance systems an essential part of security infrastructure, particularly in an era where rapid response is crucial for preventing crimes or addressing emergencies.

In addition to security, automated surveillance systems are increasingly integrated with smart home technologies, providing homeowners with remote monitoring and control over their environments. By connecting surveillance cameras to mobile applications, users can access live video feeds and receive real-time alerts, regardless of their location. This capability not only improves convenience but also enhances safety by enabling the detection of unusual behaviors and triggering automated responses such as locking doors or turning on lights. This seamless integration with smart home ecosystems adds another layer of functionality, transforming surveillance systems into versatile tools for modern living.

Another significant contribution of computer vision to surveillance is in the area of emergency response. By integrating these systems with other safety devices, such as smoke detectors or medical alert systems, automated surveillance can play a critical role in ensuring timely intervention in case of fire, gas leaks, or health-related emergencies. The ability to detect and analyze safety risks in real-time provides homeowners and businesses with an invaluable tool for mitigating dangers before they escalate, ultimately saving lives and reducing damage.

As the market for video surveillance grows, a wide range of AI-powered solutions has emerged, each tailored to meet specific needs, from home security to enterprise-level monitoring. This paper aims to explore how computer vision enhances modern video surveillance systems by providing a detailed analysis of its applications, including crime prevention, smart home integration, and emergency response. Furthermore, it will examine existing market solutions and assess how these technologies are reshaping the future of security and surveillance, offering greater efficiency, accuracy, and adaptability to diverse environments.

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