بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

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Anomaly Detection in Crowded Scene

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Abstract

Monitoring abnormal events in a crowded scenes is essential these days, especially with the increase in surveillance cameras in most, if not all, places. This has made the field of computer vision an active field of research in recent periods. Identifying abnormal events in a crowded scene as soon as possible is essential, especially from the security side. It is a cumbersome and challenging task for humans because there are many surveillance cameras and overcrowding these days. Computer vision can be used to solve this problem and get accurate and high results. In this thesis, a convolutional autoencoder neural network architecture for anomaly detection in videos has been proposed. The proposed convolutional neural network model has been trained to recognize anomaly frames. The performance of the proposed network has been evaluated using Avenue [1] and UCSD [2] standard datasets designed to identify anomalous events in crowded scenes. Experimental results showed that the proposed model outperforms state-of-the-art methods achieving an accuracy of 71.96% and 89.52% on Avenue [1] and UCSD Peds2 [2] datasets respectively. A detailed analysis of the experiments used to choose the parameters is presented along with a comparison with other methods that used machine learning methods with an average accuracy of 69.31% and 63.90% on Avenue [1] and UCSD Peds2 [2] datasets respectively.

List of Publications

1. M. Ali, M. Al-Berry, & Z. T. Fayed (2021). Convolutional Autoencoder for Anomaly Detection in Crowded Scenes. In A. E. Hassanien, A. Haqiq, P. J. Tonellato, L. Bellatreche, S. Goundar, A. T. Azar, E. Sabir, & D. Bouzidi (Eds.), *Proceedings of the International Conference on Artificial Intelligence and Computer Vision (AICV2021)* (pp. 626–633). Springer International Publishing. https://doi.org/10.1007/978-3-030-76346-6_55
2. M. Ali, M. Al-Berry, & Z. T. Fayed (2021). Comparative Study for Anomaly Detection in Crowded Scenes. *International Journal of Intelligent Computing and Information Sciences*, *21*(3), 84–94. https://doi.org/10.21608/ijicis.2021.84588.1112
3. M. Ali, M. Al-Berry, & Z. T. Fayed (2021). CONVOLUTIONAL AUTOENCODER FOR ANOMALY DETECTION IN CROWDED SCENES. *Journal of Southwest Jiaotong University*, *56*(6). https://doi.org/10.35741/issn.0258-2724.56.6.67

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List of Abbreviations

Abbreviation		**Stands for**
AUC		Area Under the Curve
BiGRU		Bi-directional Gated Recurrent Unit
BSO		Bird Swarm Optimization
CAE		Convolutional Autoencoder
CBE		Crowds By Examples
CCTVs		Closed-Circuit Televisions
CNN		Convolutional Neural Network
ConvLSTM		Convolutional Long Short-Term Memory
EMD		Earth Mover Distance
FPR		False Positive Rate
GMM		Gaussian Mixture Model
IR		Information Retrieval
MAP		Maximum A Posteriori
MBSO		Monarch Bird Swarm Optimization
MHOF		Multi Histogram Optical Flow
MRF		Markov Random Field
MSE		Mean Squared Error
OF		Optical Flow
OSVM		Optimal Support Vector Machine
PCA		Principal Component Analysis
PCANet		Principal Component Analysis Network
PPN		Position Projection Network
QMUL		Queen Mary University of London
ROC		Receiver Operator Characteristic
SI		Saliency Information
STIPs		Spatio-Temporal Interest Points
SVM		Support Vector Machines
TM		Trademark
TPR		True Positive Rate
UCSD		University of California, San Diego
UMN		University of Minnesota

Chapter 1

Introduction

Chapter 1. Introduction

1.1 Thesis Motivation

Now, Closed-Circuit Televisions (CCTVs) are everywhere, especially in crowded places. So, it is essential to use machine learning to help in detecting anomalies in those places. Without the help of artificial intelligence, this task will require a lot of human efforts to monitor many screens and discover these cases, knowing that they are rare.

There is no fixed definition of anomalous events because the event varies according to the event's location. For example, running in parks is normal, but running in a restaurant is strange. The event, which is traction, changes its evaluation according to the place in which it occurred. Those differences add more challenges for machine learning to discover these events in applications in the daily life. Other challenges include environmental conditions (presence of shadow, different lighting, the appearance of obstructions, background problems, etc.), crowd density, and the complex nature of human behavior. These things add further challenges to machine learning to discover anomalies.

In literature, some recent researches deal with the problem of discovering anomalies as a binary classification problem (normal and anomaly), and some other works focus on classifying each event separately, as each moving object is tracked and the behavior is studied to determine if it is normal or not.

Fixed surveillance cameras can be used, such as surveillance cameras in the streets or front of stores, or mobile surveillance cameras such as front car cameras or police cameras. However, to the best of our knowledge, there is little research devoted to detecting video anomalies using mobile cameras, so this research will focus on machine learning methods to detect anomalies using fixed cameras.

1.2 Thesis Objectives

This research aims to propose a fast and accurate method that can detect anomaly events in crowded scenes without any human interaction. The objectives of this research can be summarized in the following points:

1. Studying different anomaly detection methods.
2. Analyzing the already existing related studies to get the crucial problems to be considered.
3. Implementing relevant techniques and comparing the performance of implemented techniques using a benchmark dataset to choose an appropriate technique.
4. Enhancing the chosen technique and analyzing the performance after enhancement.
5. Comparing the proposed method against similar studies in the literature regarding the overall and average accuracy and reliability.

1.3 Thesis Achievements

The contributions of the work can be summarized as follows:

1. Providing a comprehensive survey on the existing anomaly detection techniques in crowded scenes and introducing a

comparative analysis for the crucial issues to be considered in this thesis.

2. Modifying existing preprocessing steps by using a better way for background removal.
3. Modifying an existing method by using better models for autoencoders.
4. Providing evidence on the robustness of the proposed method by evaluating it using three datasets.

1.4 Thesis Organization

This thesis is organized into six chapters, including this one. Their contents are described briefly as follows:

Chapter 2 (Titled: Anomaly Detection) is divided into two sections. Section one is info about Anomaly Detection Systems, training and learning frameworks and approaches for video anomaly detection. The second section is the literature review of some previous work. It presents a survey on different datasets and a comparative analysis.

Chapter 3 (Titled: Autoencoder) provides the explanation and details for machine learning method "Autoencoder".

Chapter 4 (Titled: Proposed Method) describes the algorithms used for the proposed anomaly detection in crowded scenes in detail.

Chapter 5 (Titled: Results and Discussion) provides the used datasets and the experimental results for the proposed anomaly detection method in detail.

Chapter 6 (Titled: Conclusions and Future Work) presents the conclusions and future work.