Model Engineering College Ernakulam
Department of Computer Engineering
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CSQ415 Project Phase 1
Literature Survey Report

MULTI-LAYERED ARCHITECTURE FOR ANOMALY DETECTION IN SURVEILLANCE NETWORKS USING DISTRIBUTED COMPUTING

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November 29, 2022

Keywords: Anomaly detection, LSTM, CNN, RestNet, Distributed Computing

Abstract

An optimized and feature-based, intelligent framework which operates in CCTV surveillance networks using Convolutional Neural Networks(CNN) with bi-directional Long-Short-Term Memory(LSTM) and Resnet50 Model can be used for efficient anomaly detection. The project aims to create a multi-layered architecture consisting of a distributed system for processing multiple live feeds on a cloud computing platform by dividing work among nodes and achieving parallelisation of anomaly detection.

1 Introduction

Over 464,000 international homicides has been reported in the past 3 years. Due to limited performance of manual monitoring, law enforcement agencies are having difficulty in capturing or preventing anomalous incidents. An optimized and feature-based, intelligent, anomaly detection framework which operates in CCTV surveillance networks can help mitigate this problem. Convolutional Neural Networks(CNN) with bi-directional Long-Short-Term Memory(LSTM) and Resnet50 Models with reduced time complexity using distributed systems can be used to make it more efficient and accurate. The project aims to create a multi-layered architecture consisting of a distributed system for processing multiple live feeds on a cloud computing platform by dividing work among nodes and achieving parallelisation of anomaly detection. It incorporates ideas of a shared log and state machine for asynchronous process creation, distributed process management, data sharing, and enabling the distribution of load in video processing computations onto a cluster of nodes running in parallel with mutual consensus.

2 Literature Survey

1. **CNN features with bi-directional LSTM for real-time anomaly detection in surveillance networks :** In this paper, an efficient deep features-based intelligent anomaly detection framework that can operate in surveillance networks with reduced time complexity is presented. In the proposed frame- work, we first extract spatiotemporal features from a series of frames by passing each one to a pre-trained Convolutional Neural Network (CNN) model. The features extracted from the sequence of frames are valuable in

capturing anomalous events. We then pass the extracted deep features to multi-layer Bi-directional Long Short-term Memory (BD- LSTM) model, which can accurately classify ongoing anomalous/normal events in complex surveillance scenes of smart cities.Extensive experiments on various anomaly detection benchmark datasets were performed to validate the functionality of the proposed framework within complex surveillance scenarios.The accuracy of the model was 85.3% on the UCF crime dataset and 89% on the UCFCrime2Local Dataset.There was a reported 3.41% and 8.09% increase in accuracy on UCF-Crime and UCFCrime2Local datasets compared to state-of-the-art methods. %

2. **Unsupervised Anomaly Detection and Localization Based on Deep Spatiotemporal Translation Network :** In this paper, a Deep Spatiotemporal Translation Network (DSTN), novel unsupervised anomaly detection and localization method based on Generative Adversarial Network (GAN) and Edge Wrapping (EW) is presented. In training, only the frames of normal events are used in order to generate their corresponding dense optical flow as temporal features. During testing, since all the video sequences are input into the system, unknown events are considered as anomalous events due to the fact that the model knows only the normal patterns. To benefit from the information provided by both appearance and motion features, a novel fusion of background removal and real optical flow frames with a concatenation of the original and background removal frames were used. The performance of anomaly localization is improved in the pixel- level evaluation by proposing the Edge Wrapping framework to reduce the noise and suppress non-related edges of abnormal objects. The DSTN model has been tested on publicly available anomaly datasets, including UCSD pedestrian, UMN, and CUHK Avenue. The results show that it outperforms other state-of-the-art algorithms with respect to the frame-level evaluation, the pixel-level evaluation, and the time complexity for abnormal object detection and localization tasks. But the problem with this model is that it requires a lot of computational power which can make it costlier and complex to implement.

3. **Improved YOLOv5-Efficient Object Detection Using Drone Images under Various Conditions :** In this paper, an improved YOLOv5 model was proposed to obtain high-accuracy object detection at various altitudes and weather conditions. The architecture of YOLOv5 was modified for better performance. The model was trained with VisDrone dataset and other drone captured images. Improved YOLOv5 model when tested achieved higher precision object detection than the existing RCNN networks and previous YOLO models. However, this model was trained and tested for only 3 categories of objects.

4. **A High-Performance Parallel Approach to Image Processing in Distributed Computing :** The main work of this paper includes two aspects - one is the separation of the video data stream into separate frames and distribute them among nodes using ZeroMQ, and the second is spectral analysis of the image using OpenMP on multi-core platforms. ZeroMQ is a high-performance asynchronous messaging library which is best suited for a persistent distributed system that needs to be resilient to faults and network instability. OpenMP technology was used as an auxiliary tool for parallel processing. High processing speed was achieved with the parallel DCT algorithm with a good acceleration result. Higher performance is observed only in applications that comply with the principles of stream processing.

5. **Semi-Distributed Load Balancing for Massively Parallel Multi-computer Systems :** This paper presents a semi-distributed approach, for load balancing in large parallel and distributed systems, which is different from the conventional centralized and fully distributed approaches.The proposed strategy uses a two-level hierarchical control by partitioning the interconnection structure of a distributed or multiprocessor system into independent symmetric regions (spheres) centered at some control points. The central points, called schedulers, optimally schedule tasks within their spheres and maintain state information with low overhead. In addition to yielding high performance in terms of response time and better resource utilization, the proposed strategy incurs less overhead in terms of control messages that an efficient fully distributed strategy. It is also shown to be less sensitive to the communication delay of the underlying network.

6. **Live Video Analytics at Scale with Approximation and Delay-Tolerance :** This paper describes VideoStorm, a video analytics system that processes thousands of video analytics queries on live video streams over large clusters. Given the high costs of vision processing, resource management is crucial. Hence, two key characteristics of video analytics are considered: resource-quality tradeoff with multi-dimensional configurations, and variety in quality and lag goals. VideoStorm's offline profiler generates query resource quality profile, while its online scheduler allocates resources to queries to maximize performance on quality and lag, in contrast to the commonly used fair sharing of resources in clusters.

Deployment on an Azure cluster of 101 machines shows improvement by as much as 80% in quality of real-world queries and 7× better lag, processing video from operational traffic cameras.

7. **Video Analytics in Elite Soccer: A Distributed Computing Perspective :** In this paper, various methods of performing analysis on Soccer footage videos are mentioned along with an approach to parallelize the work load using distributed computing. A popular method of tracking is using Local Position Measurement(LPM) using GPS and Radio signals. A novel method to perform computations on the edge - Fog computing is also being considered.
8. **A Fog-Based Security Framework for Large-Scale Industrial Internet of Things Environments:** This paper explores the problems with the traditional cloud computing architecture for Industrial Internet of Things(IIoT) devices. Fog Layer computing is proposed as a better method to solve the issues along with protection from DDoS attacks in IIoT systems. However few concerns regarding authentication and energy concerns still remains to be explored.

3 Proposed System

The proposed system will use a Convolutional Neural Networks(CNN) with bi-directional Long-Short-Term Memory(LSTM) and Resnet50 Models to create a multi-layered architecture consisting of a distributed system for processing multiple live feeds on a cloud computing platform by dividing work among nodes and achieving parallelisation of anomaly detection. The system would include views for checking and verifying anomalies, an admin dashboard to see past anomalies, their location, time stamps, any false positives recorded, etc. The architecture would also include APIs for cameras and other sensors to connect and send camera data which will be processed and evaluated by the Resnet50 model. The system would be made efficient by using distributed computing over the edge.

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