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Survey on Video-based Anticipation for Anomaly Detection

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Introduction

- Anticipation: **obtaining future outcomes** based on **past observations**

- Anomaly detection: **detecting deviations** comparing nominal and observed

Introduction

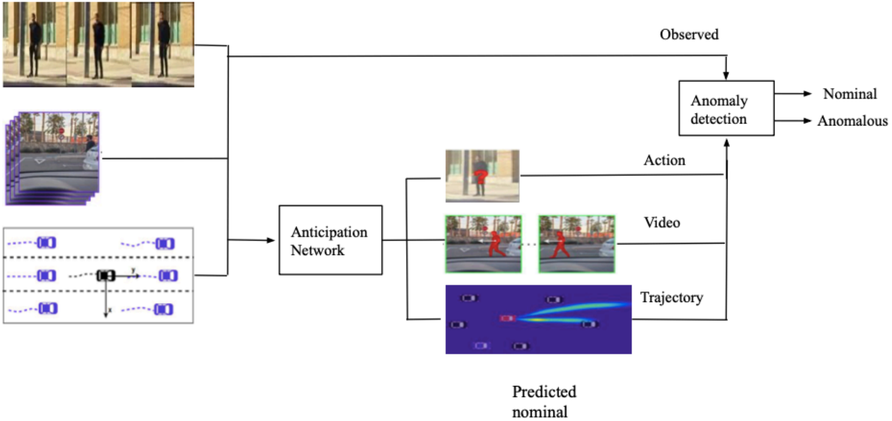

Figure 1: Block diagram of anticipation

Introduction

Objectives

- Anticipation methods for anomaly detection
- Identify approaches applied to detect anomalies
- Compare different types of anticipation

Methods

- Feedforward: Convolutional Neural Network (CNN) [Zhao et al., 2017]
- Recurrent model: Long-Short Term Memory (LSTM) [Sadegh Aliakbarian et al., 2017]
- Generative model: Generative Adversarial Network (GAN) [Kwon and Park, 2019]

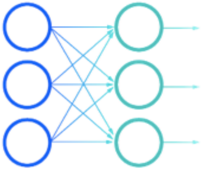

Figure 2: Feedforward architecture

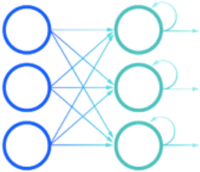

Figure 3: Recurrent model

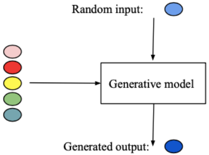

Figure 4: Generative model

Survey topics

- Action anticipation
- Video prediction
- Trajectory prediction
- Anomaly detection

Action anticipation: feedforward architecture

Prediction in one shot: **shorter processing time**

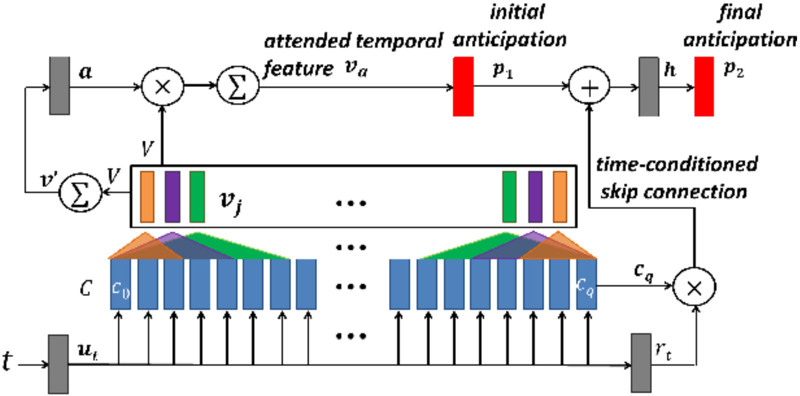

Figure 5: Architecture of time-conditioned action anticipation [Ke et al., 2019]

Action anticipation

Feedforward architectures: **greater accuracy for long predictions**

Method	**Advantages**	**Disadvantages**
Feedforward architecture	Short and long term anticipation	Application specific
Recurrent models	Early anticipation, high accuracy for shorter sequences	Less prediction accuracy for longer sequences
Generative models	Long term, realistic predictions	Less accuracy

Table 1: Summary of action anticipation

Video prediction: generative model

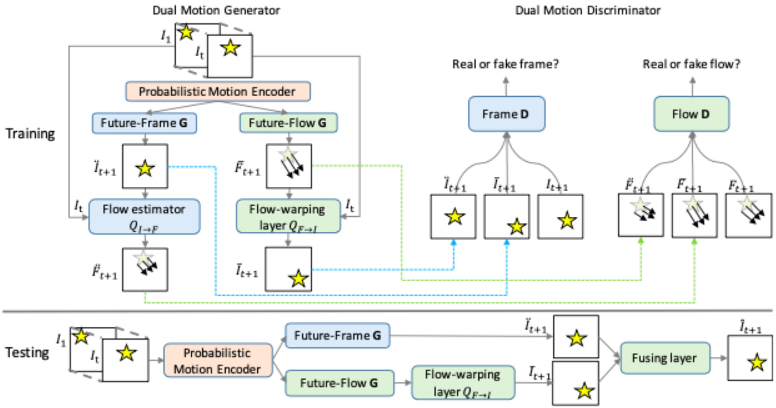

Figure 6: Dual GAN architecture for video prediction [Liang et al., 2017]

Video prediction

Generative models: **high quality predictions**

Method	**Advantages**	**Disadvantages**
Feedforward architecture	Long-term prediction	Blurry prediction, not suitable for real-world scenarios
Recurrent models	Long-term clear predictions	High computational cost
Generative models	High quality frame prediction	Not suitable for real-world complex scenarios

Table 2: Summary of video prediction

Trajectory prediction: recurrent model

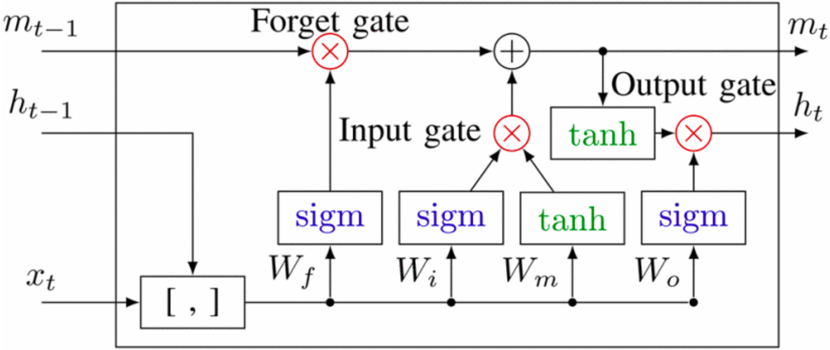

Figure 7: LSTM internal structure for trajectory prediction [Altché and de La Fortelle, 2017]

Trajectory Prediction

Recurrent models: **long-term predictions, complex scenarios**

Method	**Advantages**	**Disadvantages**
Feedforward architecture	Immediate, realistic predictions	Fails for real-world applications
Recurrent models	Long-term prediction, complex scenarios	Delayed prediction
Generative models	Long-term, accurate predictions	Not suitable for complex scenarios

Table 3: Summary of trajectory prediction

Summary

Type of anticipation	Method	Application
Action anticipation	**Feedforward architectures**	Long and short-term prediction
	Recurrent models	Early action anticipation
	Generative models	Long-term realistic predictions
Video prediction	Feedforward architectures	Long and short-term prediction
	Recurrent models	Long-term prediction
	Generative models	Accurate predictions
Trajectory prediction	Feedforward architectures	Immediate prediction
	Recurrent models	Long-term crowded scenarios
	Generative models	Accurate long-term predictions

Table 4: Summary of methods used for anticipation

Anticipation for anomaly detection

- Network is trained only based on nominal data
- In testing phase, network is provided with a new set of values
- Output from network: **normal/anomalous event**
- Reconstruction error [Chandola et al., 2009]

$$\delta_i = \frac{1}{n}\sum_{j=1}^{n}(x_{ij} - o_{ij})^2 \tag{1}$$

Autoencoder

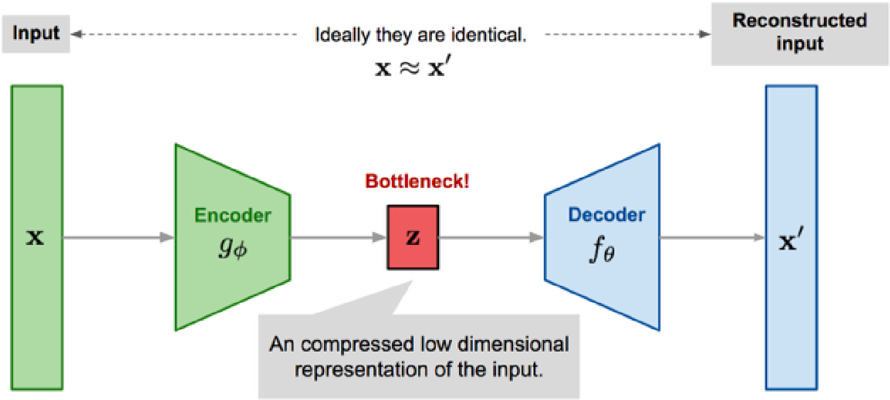

Figure 8: Basic architecture of autoencoder [Ulger et al., 2021]

Conclusions

- Long-term predictions: feedforward architectures, generative models
- Early long-term predictions: recurrent models: less accuracy
- Accurate long-term anticipations
  - Recurrent models + feedforward architectures
  - Recurrent models + generative models
- Anticipation along with anomaly detection
  - GAN
  - Autoencoders
  - Autoencoder-based

Contributions

- Categorization of anticipation
- Highlighted best method for each anticipation
- Recommended best approach for anticipation along with anomaly detection

Thank You

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