Dynamic Security-Level Maximization for Stabilized Parallel Deep Learning Architectures in Surveillance Applications

Joongheon Kim, Yeong Jong Mo (School of Computer Science and Engineering, Chung-Ang University, Korea)
Woojoo Lee (Department of Electronics Engineering, Myongji University, Korea)
DaeHun Nyang (Department of Computer Science and Engineering, Inha University, Korea)
E-mails: joongheon@cau.ac.kr , spacelee@mju.ac.kr , nyang@inha.ac.kr

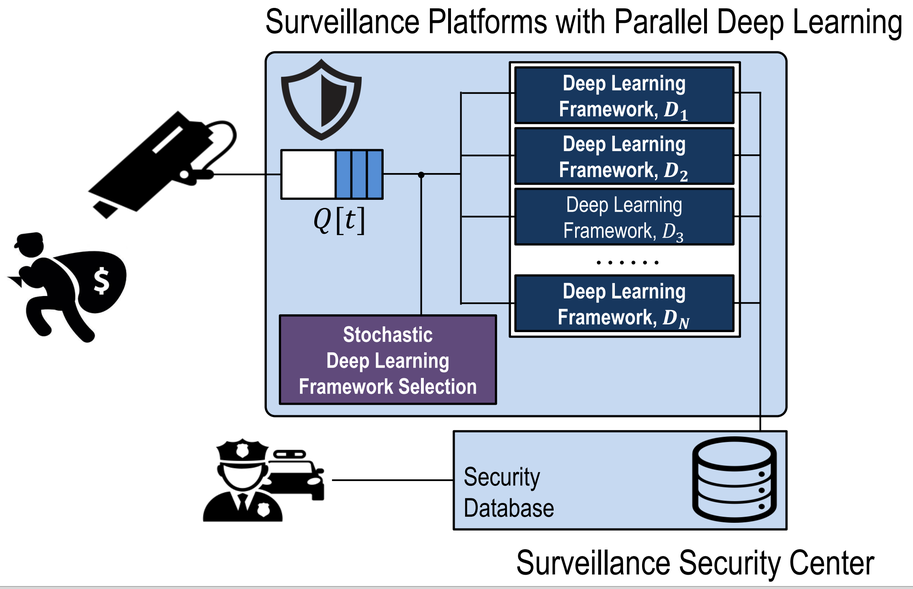
Introduction and Reference System Model

Introduction

- **CCTV Surveillance Applications for Target Network Monitoring**
  - → Monitoring target network fields with CCTV cameras
  - → Utilizing learning-based face-recognition algorithms in CCTV camera systems can realize automated surveillance systems.

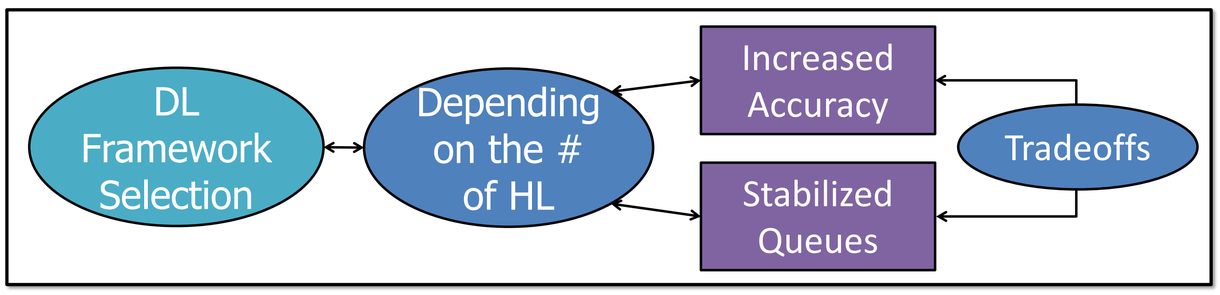
- **Deep Learning (DL) based CCTV Security Systems**
  - → With many hidden layers (HL) in DL, it improves accuracy, but it is slow.
  - → With less hidden layers in DL, it is fast but achieves less accuracy.
  - → This paper proposes adaptive queueing-delay control for time-average recognition accuracy maximization subject to stability (slow computation leads to queueing delays in the CCTV real-time systems).

Reference Surveillance System Model

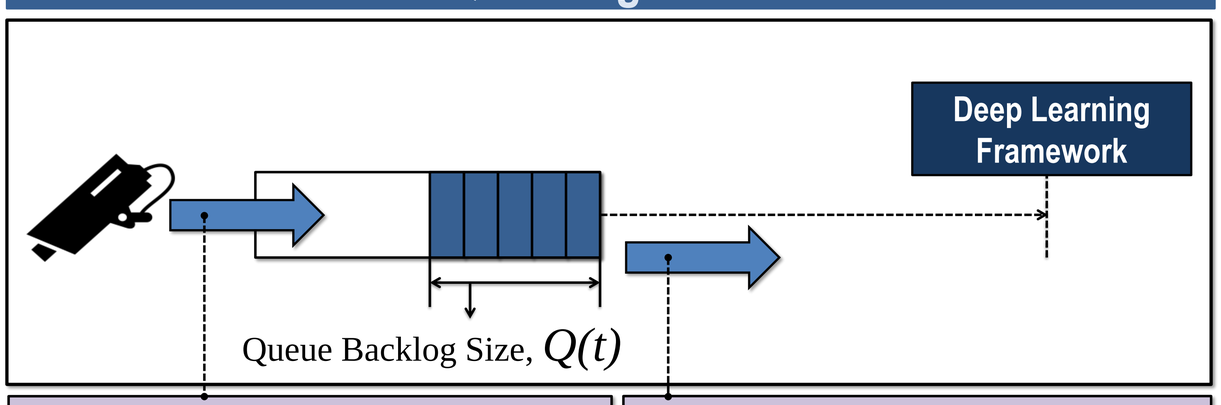


Deep Learning Framework Selection for Queue-Stable Recognition-Accuracy Maximization

Tradeoffs



Queueing Model



Arrival Process:
CCTV Video Streams

Departure Process (Control Decision):
Processing with DL Framework

Lyapunov Optimization Approach

Objective Function:
Time-Average Recognition-Accuracy Maximization subject to Stability

$$\max : \lim_{t\to\infty} \frac{1}{t} \sum_{\tau=0}^{t-1} S[\tau]$$

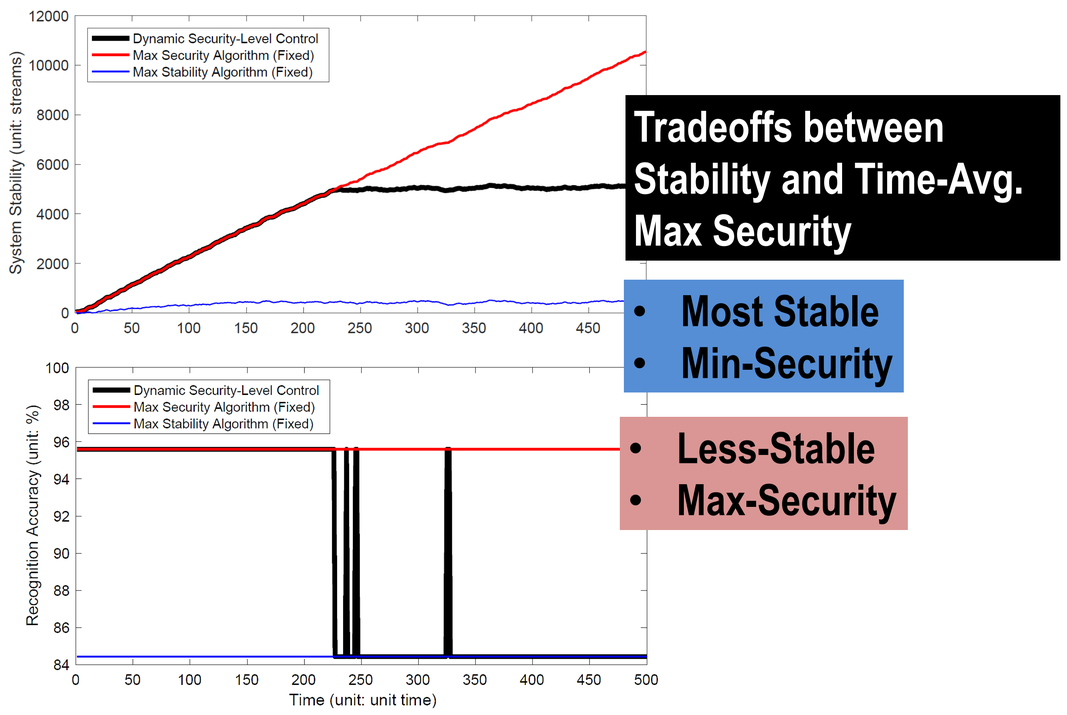
$$\text{subject to: } \lim_{t\to\infty} \frac{1}{t} \sum_{\tau=0}^{t-1} \mathbb{E}[Q[\tau]]$$

Lyapunov Optimization

$$D_o \leftarrow \arg\max_{D_i \in \mathcal{D}} \{V \cdot S(D_i) + Q[t] \cdot P(D_i)\}$$

Performance Evaluation and Concluding Remarks

Performance Evaluation



Tradeoffs between Stability and Time-Avg. Max Security

- **Most Stable**
- **Min-Security**
- **Less-Stable**
- **Max-Security**

Concluding Remarks

- **Concluding Remarks**
  - → Dynamic DL selection for time-average security max subject to stability
  - → Jointly optimization of security-level maximization and queue-stability depending on queue-backlog sizes.

- **Future Work**
  - → Real-world implementation with OpenFace library
  - → Arrival process control algorithm design

- **References**

Joongheon Kim, Giuseppe Caire, and Andreas F. Molisch, "**Quality-Aware Streaming and Scheduling for Device-to-Device Video Delivery**," IEEE/ACM Transactions on Networking, 24(4):2319–2331, August 2016.

Michael J. Neely. ***Stochastic Network Optimization with Application to Communication and Queueing Systems***. Morgan & Claypool, 2010.

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