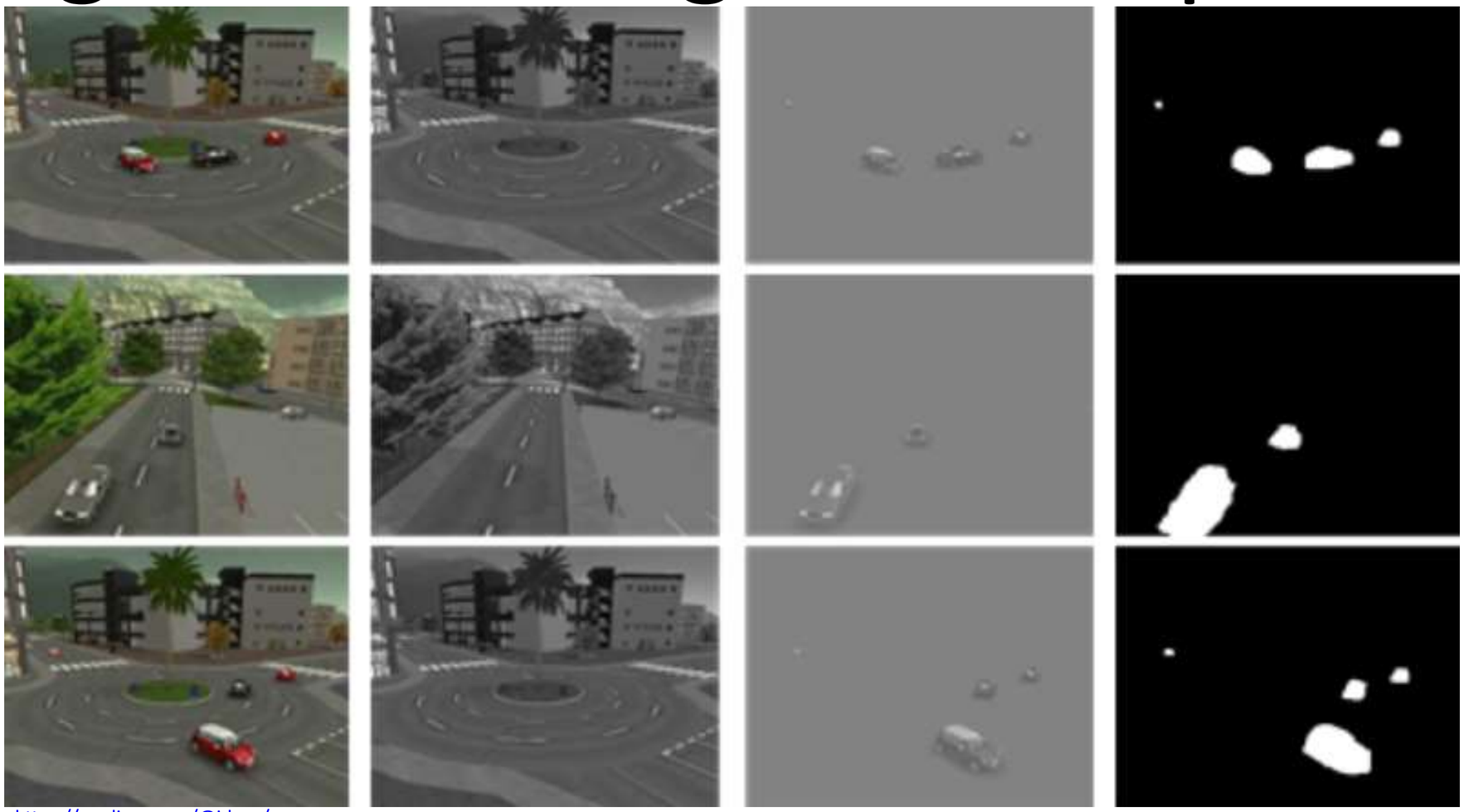
Foreground-Background Separation



https://medium.com/@jdseo/...

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Chosen dataset:

We are using the **Change Detection Dataset**, available on Kaggle.

- **Source:** https://www.kaggle.com/datasets/maamri95/cdnet2014
- **Purpose:** Designed for benchmarking algorithms in foreground – background separation and motion detection.
- **Content:** Video sequences from diverse and dynamic environments such as crowded areas, highways, and natural scenes.
- **Challenges Captured:** Includes moving people and vehicles, shadows, camera jitters, and other real-world variations that make foreground – background separation difficult.

We chose this dataset because it closely represents real-world conditions for surveillance and scene analysis.

About the dataset

- **Size & Scale:** This dataset consists of 11 video categories, each containing 4 to 6 videos sequences. Each video sequence has 1,500+ frames.
- **Resolution:** Frames vary between 320×240 and 720×486 pixels, representing both low- and medium-resolution video
- **Key Variables:**
  - Input frames (video sequences)
  - Ground truth masks (per-pixel labels marking foreground objects vs. background)

This dataset is particularly suited for testing optimization-based background–foreground separation methods, since it covers both controlled and highly challenging scenarios.

Folder structure of the dataset

```
CDnet/
├─ baseline/
│  ├─ highway/
│  │  ├─ input/
│  │  │  ├─ 000001.jpg
│  │  │  ├─ 000002.jpg
│  │  │  └─ ...
│  │  └─ groundtruth/
│  │     ├─ 000001.png
│  │     └─ ...
├─ dynamicBackground/
│  └─ ...
```

Real world problem

In real-world applications like video surveillance, robotics, traffic monitoring, and medical imaging, cameras capture both static backgrounds and moving objects.

- **Problem:** How can we reliably separate **foreground** from **background** in the presence of noise, shadows, and dynamic environments?
  - Background: stationary elements (walls, roads, furniture, sky)
  - Foreground: moving objects (people, cars, animals, anomalies)

Since manually analyzing thousands of video frames is impractical and time-consuming, there is a strong need for methods that can perform this separation more efficiently.

Why do we need optimization?

- A single video contains millions of pixel values that must be processed.
- Naive methods like subtraction or thresholding often fail in real-world scenarios (e.g., fast movements, noise, etc).

- Optimization-based methods provide a structured way to:
  - Extract clean foreground objects
  - Preserve the background scene’s structure
  - Handle noise and variations efficiently
  - Reliably separate background from moving objects

Thus, optimization is required to get accurate results while ensuring that the solution is scalable, and practical for real-world use cases.

Impacts of our solution

- **Object Detection and Tracking:** Foreground objects can be detected and tracked more accurately if the background is separated.
- **Efficient Background Reconstruction:** Static scenes are stored in a compact form, reducing storage and computation.
- **Faster Analysis:** Enables quick real-time video processing without much manual effort.
- **Supports real-world applications** in surveillance, autonomous driving, and medical imaging
  - Robotics & Autonomous Driving: Help machines focus on moving obstacles for safe navigation.
  - Medical Imaging: Highlight abnormal cells or motions for faster, more accurate diagnosis.
  - Traffic Monitoring: Identify congestion, accidents, and flow patterns automatically.

Thank you!