Moving object detection

Background Subtraction

- The process of separating out foreground objects from the background in a sequence of video frames.
- Background subtraction is widely used for detecting moving objects from static camera

Intuition

- The object in motion will have change in intensity across the frames
- The background will have consistent values

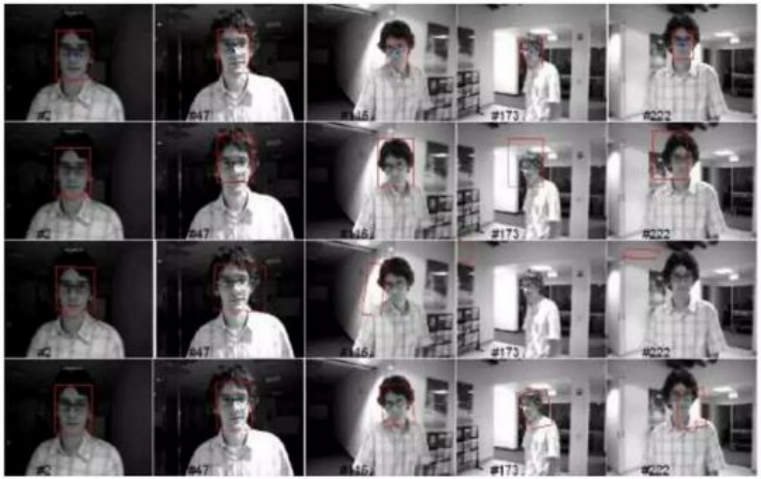
Background Subtraction

- Background subtraction should segment the objects of interest when they first appear or re-appear in the scene.
- An appropriate pixel-level stationary criteria should be defined
- The background model should adapt to both sudden and gradual changes in the background
- Background model should take into account changes at different scales.

K. Toyama, J. Krumm, B. Brumitt and B. Meyers, "Wallflower: principles and practice of background maintenance," *Proceedings of the Seventh IEEE International Conference on Computer Vision*, Kerkyra, Greece, 1999, pp. 255-261 vol.1, doi: 10.1109/ICCV.1999.791228.

Problems

- **Illumination changes:** The variation in the light intensity



Gradual

Sudden

Problems

- **Motion changes:** noise induced by camera oscillations, high frequency background object

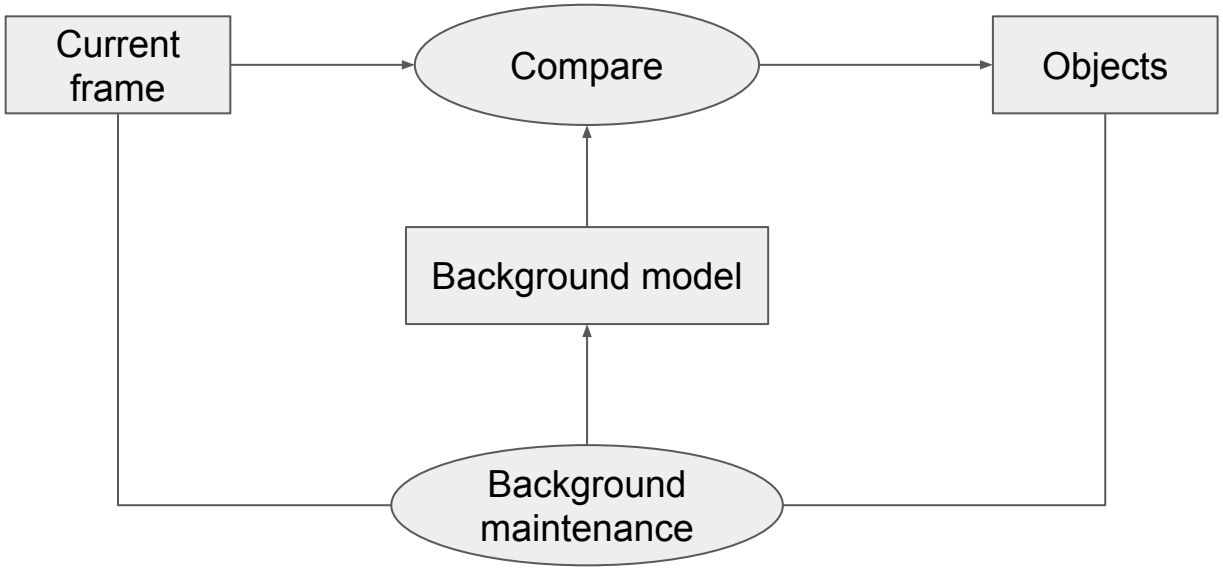
Problems

- **Change in the background**

Parked cars

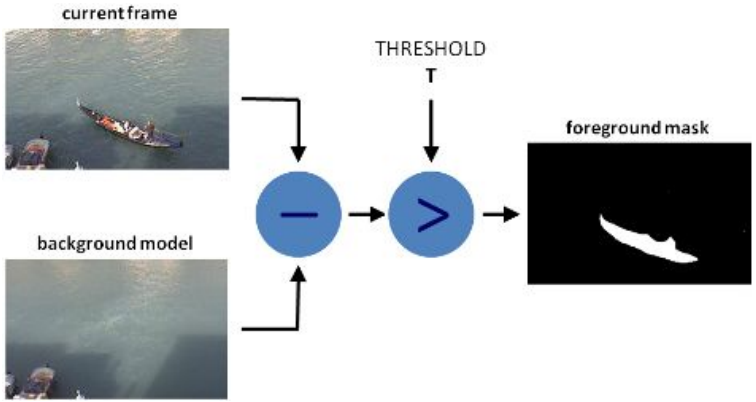
Moving object detection

Objects are in motion and background is static.



Background Subtraction

- Create a static background
- Maintain a model of static background (update after certain pixels)
- Pixels are labeled as object: 1, background: 0

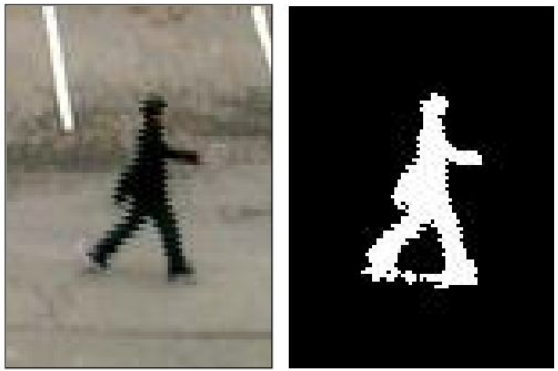


Static Background

- Capture an initial frame before entrance of object
- Create a static background by approaches like median filtering

Background Subtraction

- Background subtraction does a reasonable job of extracting the shape of an object, provided the object intensity/color is sufficiently different from the background
- If object is camouflaged then then difficult to detect



a) Input frame b) Object

Background Subtraction

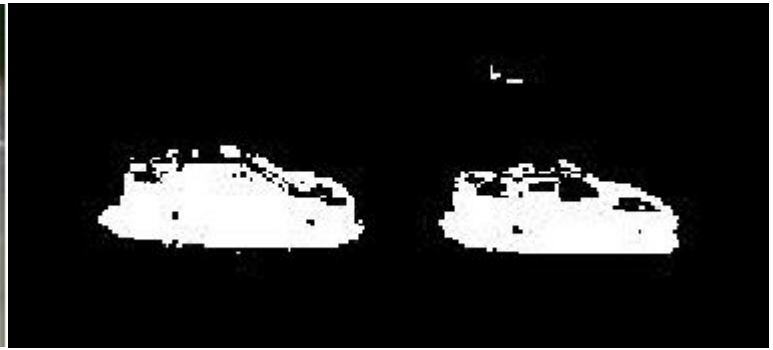
- Objects that enter the scene and stop continue to be detected, making it difficult to detect new objects that pass in front of them

a) Input frame b) Objects

Background Subtraction

- If part of the assumed static background starts moving, both the object and its negative ghost (the revealed background) are detected

a) Input frame



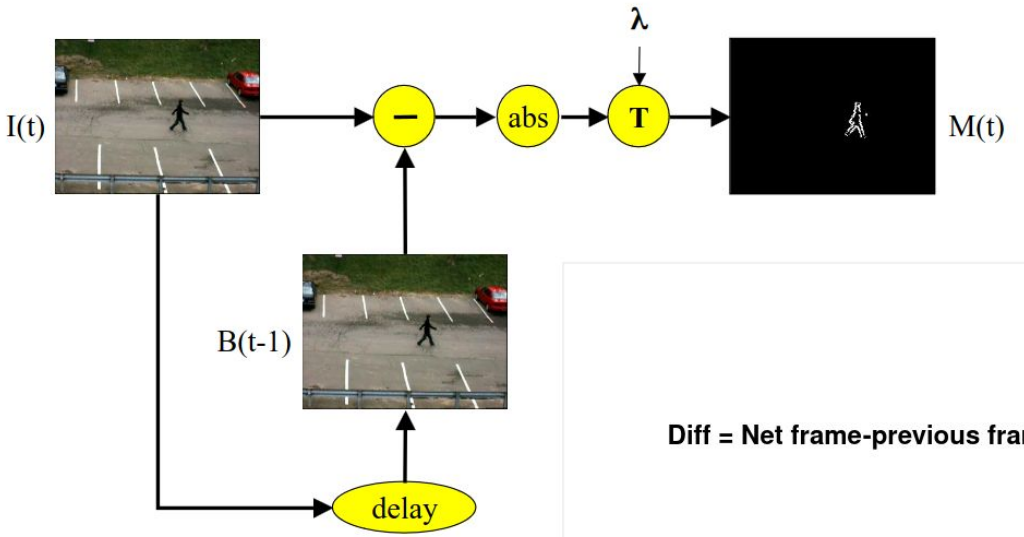
b) Detected objects

Background Subtraction

- Background subtraction is sensitive to changing illumination and unimportant movement of the background (for example, trees blowing in the wind, reflections of sunlight off of cars or water)

Simple Frame Differencing

Background model is replaced with the previous image



Simple Frame Differencing

- Frame differencing is very quick to adapt to changes in lighting or camera motion
- Objects that stop are no longer detected. Objects that start up do not leave behind ghosts.
- Hard to detect an object moving towards or away from the camera

Temporal scale

Temporal information when we perform frame differencing at different frame rates

Temporal scale