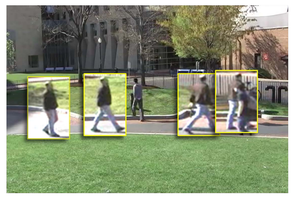
Robust Pedestrian Tracking for Assistive Systems

Caglayan Dicle, Wendy Birdsong, Octavia Camps, Mario Sznaier
Northeastern University, Department of Electrical and Computer Engineering

Robust Systems Lab



Main Goal

Tracking pedestrians robustly under occlusion and appearance change.

Applications

- Pedestrian Aware Cars
- Surveillance
- Activity Recognition
- Assisted living

Challenges

- Occlusions
- Cluttered background
- Different poses
- Appearance change during motion

Contribution 1 - COMPLETION OF MISSING DATA WITHOUT SYSTEM IDENTIFICATION

Hankel matrix captures the dynamics of the sequence and missing data is completed such that rank of **Hankel** matrix is minimized.

$$\min_{y_n} rank\, H = \begin{bmatrix} y_1 & y_2 & \cdots & y_{n/2} \\ y_2 & y_3 & & y_{n/2+1} \\ \vdots & & & \vdots \\ y_{n/2} & y_{n/2+1} & \cdots & y_n \end{bmatrix}$$

NP - HARD

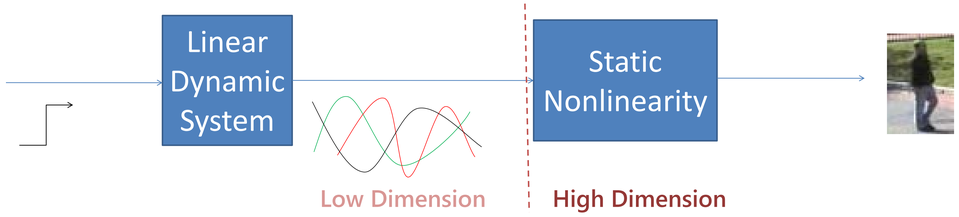
$$\min_{V,W} \; tr(V)+tr(W) \quad subject\ to \begin{bmatrix} V & H \\ H^T & W \end{bmatrix}$$

$$where \quad V=V^T \quad and \quad W=W^T$$

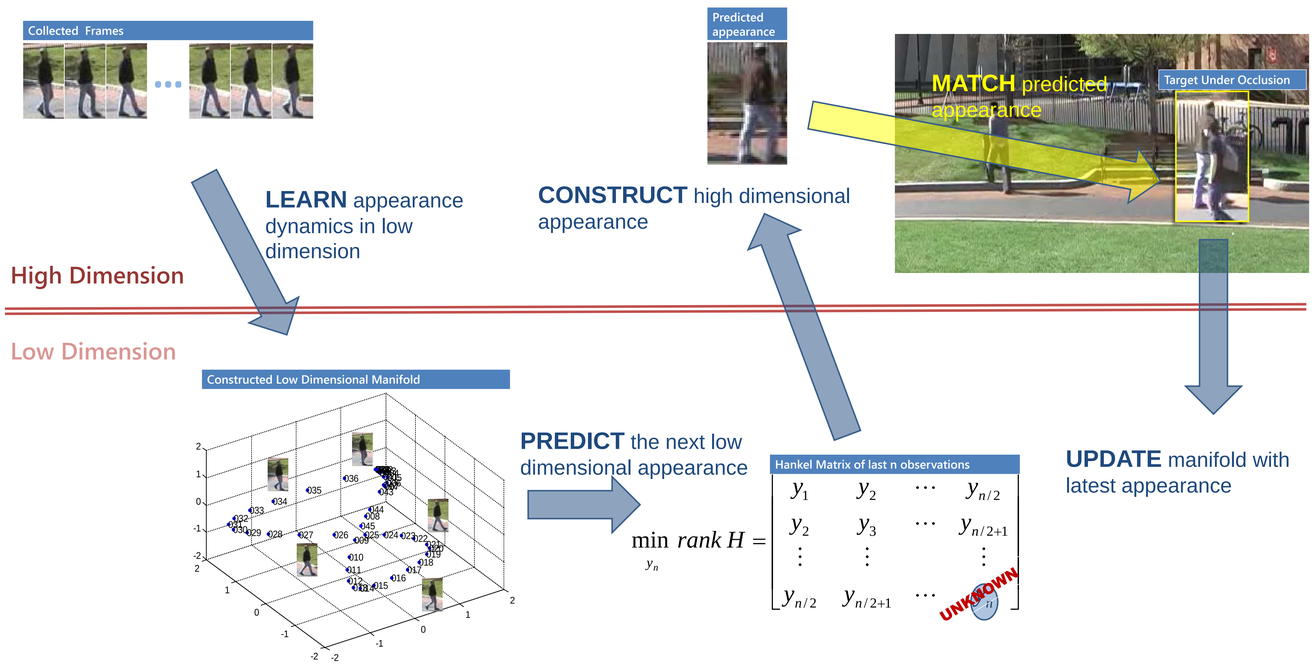
Convex. Often Exact

Proposed Approach

We model the appearance and motion of the pedestrian as an output of a **Hammerstein** system. That is, a linear dynamic system followed by a static nonlinearity. Linear system outputs a **low dimensional** (low rank) manifold and a static nonlinearity maps the points on the manifold to a high dimensional space representing the appearance of the target



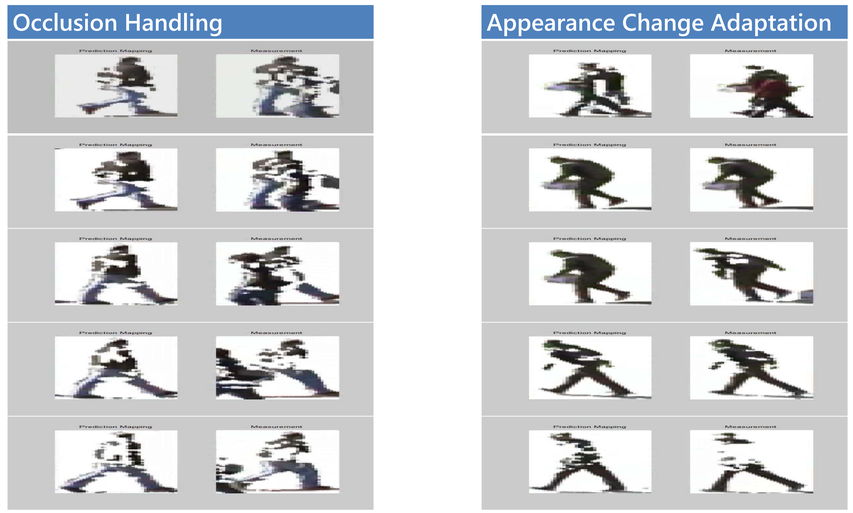
System Overview



$$\min_{y_n} rank\, H = \begin{bmatrix} y_1 & y_2 & \cdots & y_{n/2} \\ y_2 & y_3 & & y_{n/2+1} \\ \vdots & \vdots & & \vdots \\ y_{n/2} & y_{n/2+1} & \cdots & ? \end{bmatrix}$$

Contribution 2 – APPEARANCE CHANGE ADAPTATION and OCCLUSION HANDLING

The manifold of the appearance is updated with new measurements so tracker can adapt the appearance changes

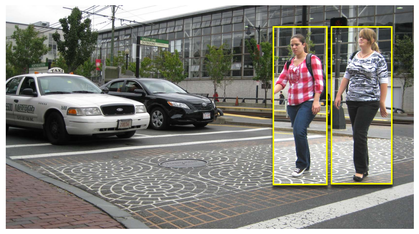


Conclusion & Future work

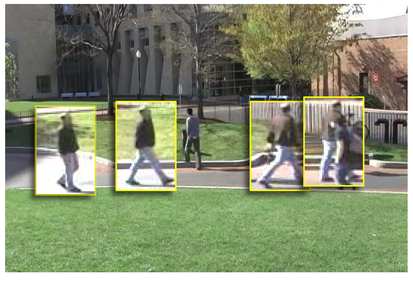
The system can track pedestrians that change appearance, turn, leave or lift an object. The track is consistent under mild occlusions.

We want to decrease the system sensitivity on background subtraction and distinguish occlusion from appearance change more accurately.

This material is based upon work supported by the U.S. Department of Homeland Security under Award Number 2008-ST-061-ED0001. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied of the U.S. Department of Homeland Security.



Pedestrian Aware Cars



Tracking under occlusion and
appearance change