Review Questions – CV 2

- In computer vision scheme, what characteristic is particularly important in tracking, compare to other problems?
- How do you understand articulated tracking, active tracking, elements of tracking?

1. Single Object Tracking

- What are the 4 approaches to Single Object Tracking?

a. Background modeling

- What are the assumptions and general comments here for this approach?
- What are the 5 methods for simple background modeling?
- Describe *simple background subtraction, single frame differencing, temporal scale, three frame differencing, adaptive background modeling*.
- What are the 3 methods for statistical background modeling?
- Describe *Single Gaussian* with running estimate and exponential moving average filter scheme for background modeling.
- Describe *MoG* approach, *Stauffer-Grimson* methods with Online Adapting (for matching components) for background modeling?
- Describe *Kernel background modeling* approach?

b. Template based tracking

- Describe *Lucas Kanade Optical flow*, what are the 3 key assumptions here? What is the Aperture problem? How is the least-square related to LK optical flow? What are the 2 problems of original Lucas Kanade approach, and what are the solutions to them?
- Describe *KLT Tracker*. What is drifting problem and how to avoid it?
- Describe *KL Template Tracking*. What previous assumption of KLT Tracker is now problematic, how to solve it? What should be noted about the initialization and frame rate here?

c. Tracking by online classification

- Describe *Online Boosting*. Compare offline boosting and online boosting? What to note about the convergence of online boosting? What are the options for choosing features? Describe Selector idea?
- Describe *Online Classification* approach, which samples to add, what is online feature exchange scheme? What to note about drift and what are three drift compensation strategies? What is *Semi-supervised learning*?

d. Tracking-by-detection

- What is the general idea of tracking by detection? Describe the idea of tracking with sliding window approach, HoG, SVM, Image Pyramid, NMS.
- Describe *DPM*, what are common components?
- Describe *Integral Channel Features*, what are the possible feature channels?
- What extra design that *VeryFast Detector* also applies?
- What type of CNN is used for detection?

2. Bayesian Filtering

- What are the 3 filters we studied?
- Describe *Kalman Filter (KF)*.
- Describe *Extended Kalman Filter (EKF)*.
- Describe *Monte-Carlo sampling* and *Importance Sampling*.
- Describe *Sequential Importance Sampling Algorithm (SIS)*, and SIS with *Transitional Prior*.
- What is the *Degeneracy Phenomenon*, how to deal with it?
- How to sample given the weights? Describe *Inverse Transform Sampling*, *Arulampalam's Resampling Algorithm*. Where do we use these algorithms?

- Describe *Generic Particle Filter, Sampling Importance Resampling*.
- What is the relationship, differences between SIS, Generic PF, SIR, Inverse Transform Sampling, Arulampalam's Algorithm?
- Application of Bayesian Filtering.

3. Multi-Object Tracking

- What is the general idea for Multi-object tracking, what are the challenges?
- Describe *Gating* idea, *Nearest Neighbor filter*. What does *innovation* imply here?
- What is the problem of Gating approach, and how do we move on from it?
- Describe *Track-splitting filter*, what are the pruning strategies?
- Describe *MHT*, applications, tricks.
- Describe *LAP, Greedy Algorithm, The Munkres Assignment algorithm.*
- Describe *Network flow optimization* approach, pros and cons

4. Visual Odometry

- What is Visual Odometry in general?
- What are available *representations* for 3D rotation? Briefly describe them with cons.
- What are the *sensor types* for Visual Odometry? Describe their pros and cons.
- Describe *direct/indirect methods* of Visual Odometry and their loss function formulations.
- What are the 3 approaches for *Point-based Visual Odometry*? Sketch out their algorithms.
- Sketch out Eight-point algorithm, Direct Linear Transformation.
- Describe Relative Scale Recovery, Key frames idea, bundle adjustment idea, their needs.
- Describe Direct methods for Visual Odometry with Lie Algebra
- Gauss-Newton method and Levenberg-Marquardt Method.

5. Visual SLAM and 3D Reconstruction

- What is *SLAM, Visual SLAM* and its challenges and application? How to ensure map consistency? Compare global and local optimization method for SLAM?
- What is the difference between Online Slam and Full SLAM?
- What are the approaches for *Online SLAM, Full SLAM*?
- Describe *EKF SLAM, Loop Closure*.

6. Deep Learning for Video Analysis

- Describe *RNN and LSTM*, their application.
- What is CNNs for matching and correspondence estimation used for?
- What are the two metrics learning for this kind of CNNs and what are their differences?
- Describe *Spatial Transformer Network, Universal Correspondence Network*.
- Describe *FlowNetS, FlowNetC*, Refinement stage, *FlowNet 2.0*.
- Describe *VOS* tasks, strategies, basic elements. What is *MOTS?*

7. Formula

- Simple background modeling, single frame differencing, temporal scale, three-frame differencing, adaptive background subtraction
- Single Gaussian background modeling, running estimate, exponential moving average filter
- Staffer-Grimson MoG background modeling with online adapting, Kernel background modeling
- Lucas Kanade optical flow, LK Template tracking, Online Boosting, DPM
- KF, EKF, Arulampalam's Resampling Algorithm, SIS, Generic PF, SIR.
- Gating with Nearest neighbor filter, innovation, Tracking splitting filter, MHT, LAP, Network Flow optimization for Tracking.
- 8-points algorithm, DLT, 3D-3D visual odometry,
- Direct visual odometry, Lie Algebra, geometric loss, photometric loss.