Technische Universiteit
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Multiple face detection and tracking under occlusion

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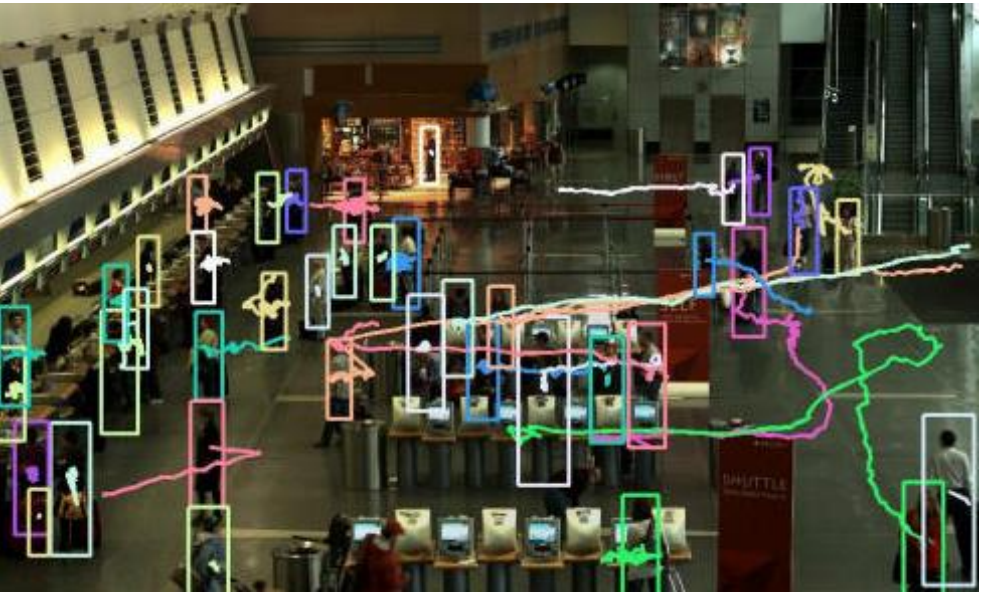
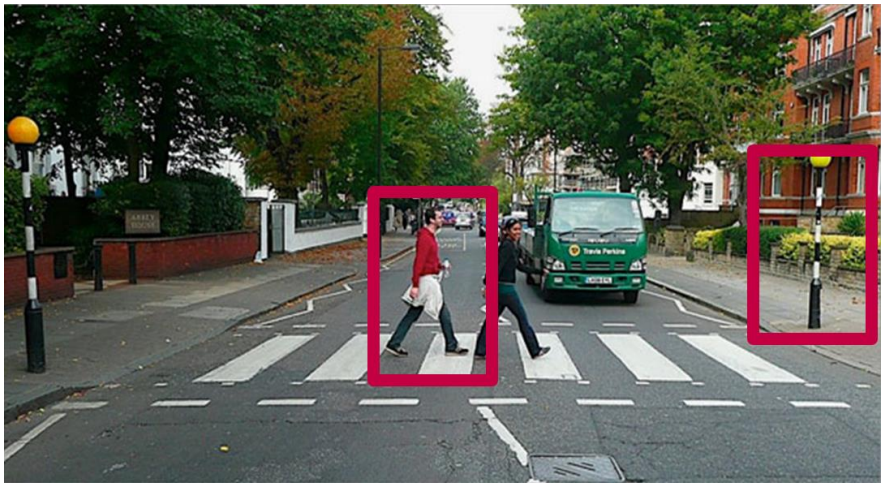
Introduction

- Detection and tracking applications



Challenges

- Changes in the position and scale of object
- False positives and negatives
- Partial or full occlusion

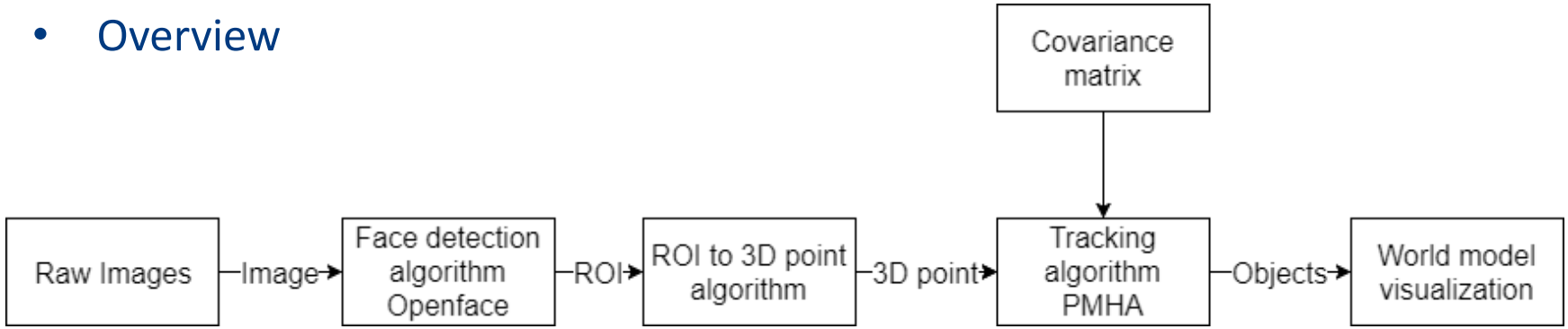


Solving those challenges (an overview)

- Face detection algorithm with good performance
  - Low false positives and negatives

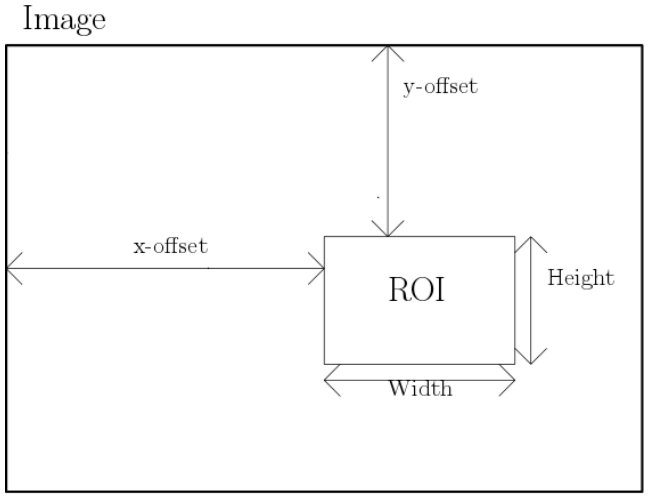
- A multiple hypothesis tracker
  - Maintain multiple hypothesis
  - Delay ambiguous situations until new evidence

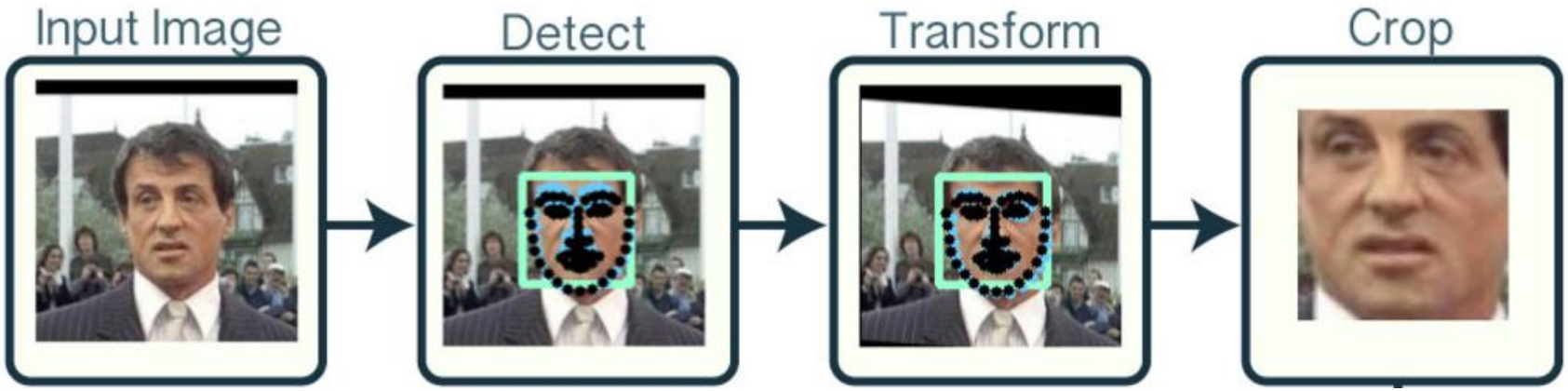
- Overview



Face detection

- Openface[1]
- Low false positives and negatives[2]
- Transforms faces to feed a neural network
- Input → Raw RGB image
- Output → ROI

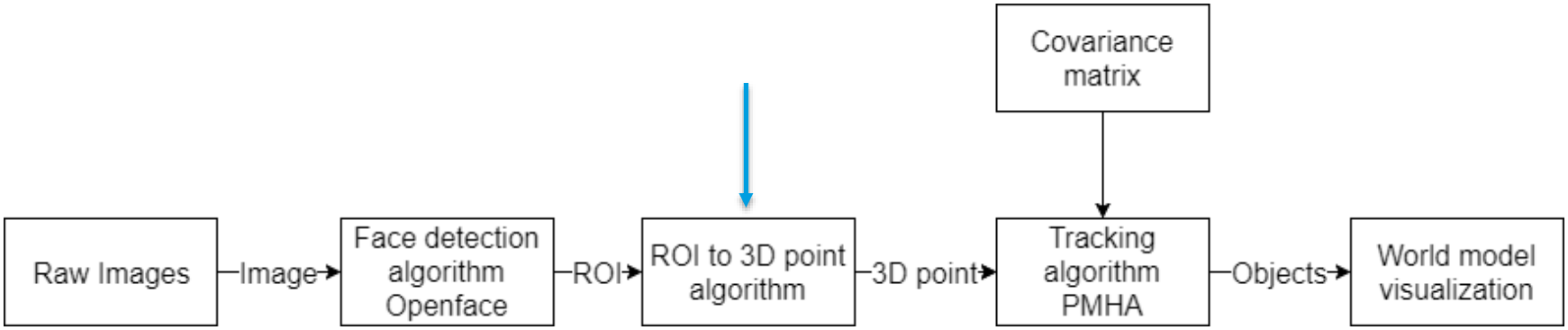




[1] Brandon Amos, Bartosz Ludwiczuk, and Mahadev Satyanarayanan. OpenFace: A general-purpose face recognition library with mobile applications. 2016.
[2] Brandon Amos, Bartosz Ludwiczuk, and Mahadev Satyanarayanan. Models and Accuracies - OpenFace. http://cmusatyalab.github.io/openface/models-and-accuracies/.

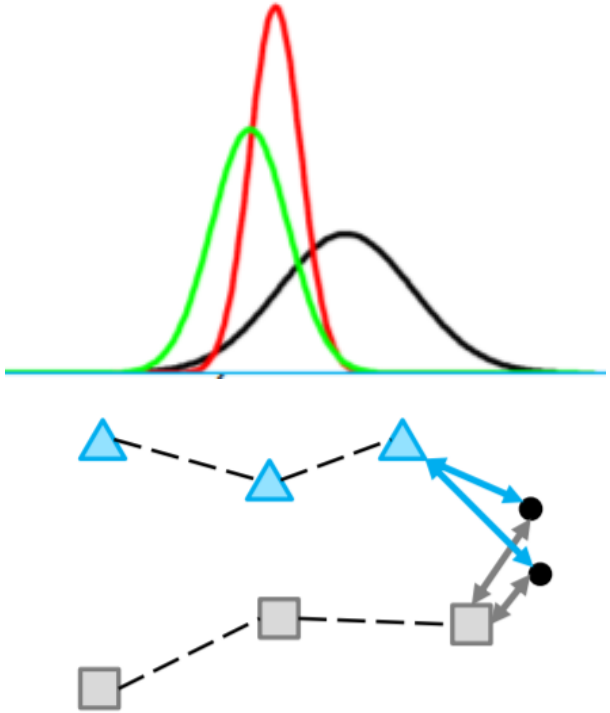
ROI to 3D point

- Need to match input tracking algorithm
- Converting ROI to x,y,z position
- Uses depth information
- Reference frame



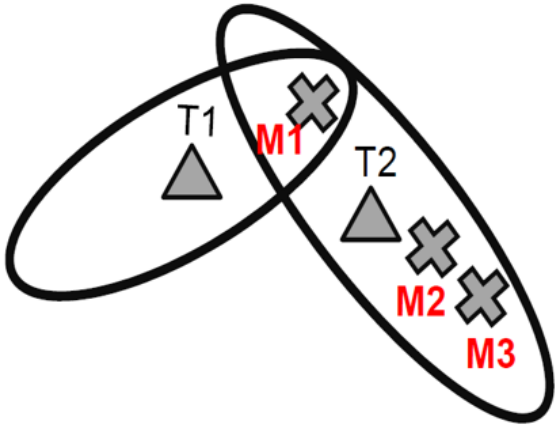
Comparing tracking algorithms

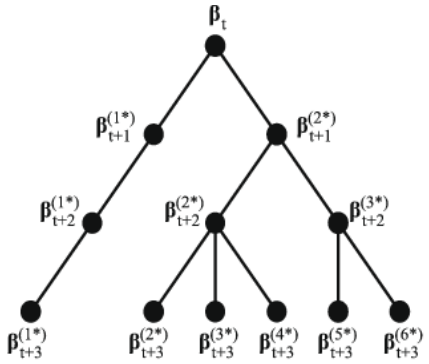
- Tracking algorithms GNN, JPDAF, MHT
- Most tracker algorithms basics
  - Kalman filter prediction
  - Data association
  - Kalman filter update
- Occlusion handling
  - Lost track
- MHT occlusion handling capabilities



The multiple hypothesis tracker

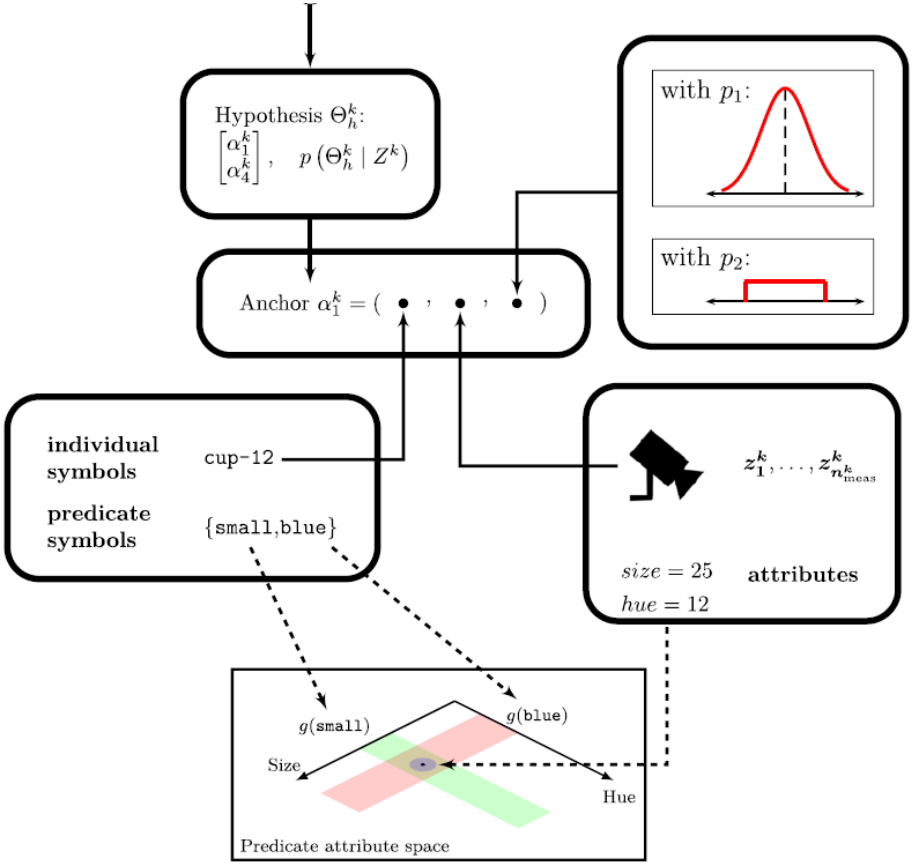
- Maintains multiple hypotheses
  - Each hypothesis tracks with covariances
- Chooses most probable state
- Gate computation
  - Remove unlikely associations
- Forming hypothesis
  - 3 scenarios per measurement
  - Unknown number of measurements
- Increase computational efficiency
  - N most probable hypothesis





Probabilistic multiple hypothesis anchoring[3]

- Extension of MHT
- Probabilistic anchoring
  - Represents an object
- A multiple model approach
  - Constant velocity
  - Uniform distribution
- Handling occlusion
  - Fixed Guassian
- Motion model uncertainty
- Chosing prior probabilities

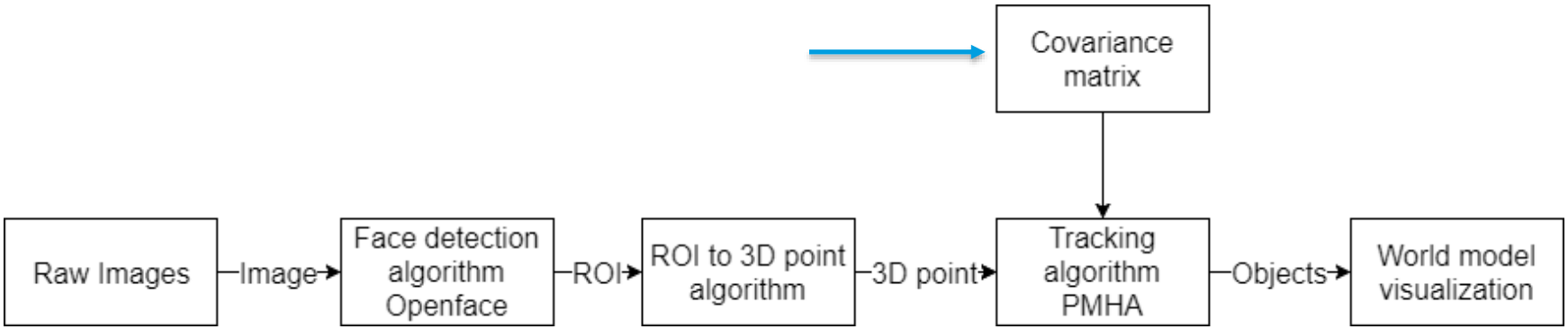


[3] J (Jos) Elfring, S (Sjoerd) Es, van den, MJG (René) Molengraft, van de, and M (Maarten) Steinbuch. Semantic world modeling using probabilistic multiple hypothesis anchoring. Robotics and Autonomous Systems, 61(2), 2013.

Adding covariance matrix

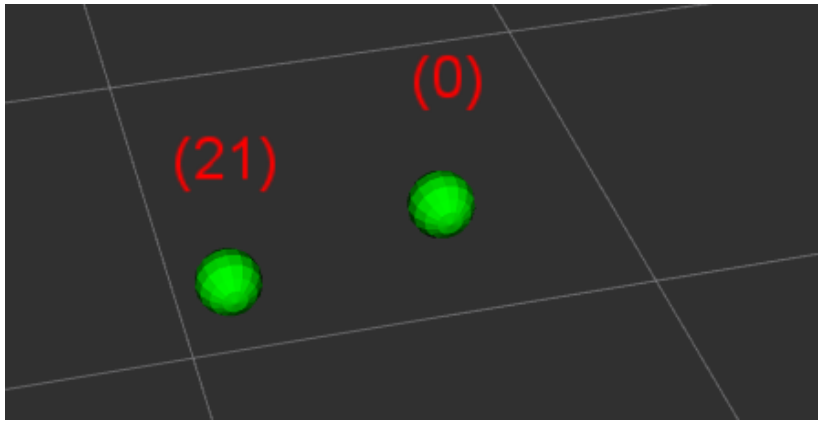
- Indicate spread of measurement
- Needed for PMHA
- Not too high → one object becomes two
- Not too low → two objects become one
- Testing on real person
  - Check depth dependency

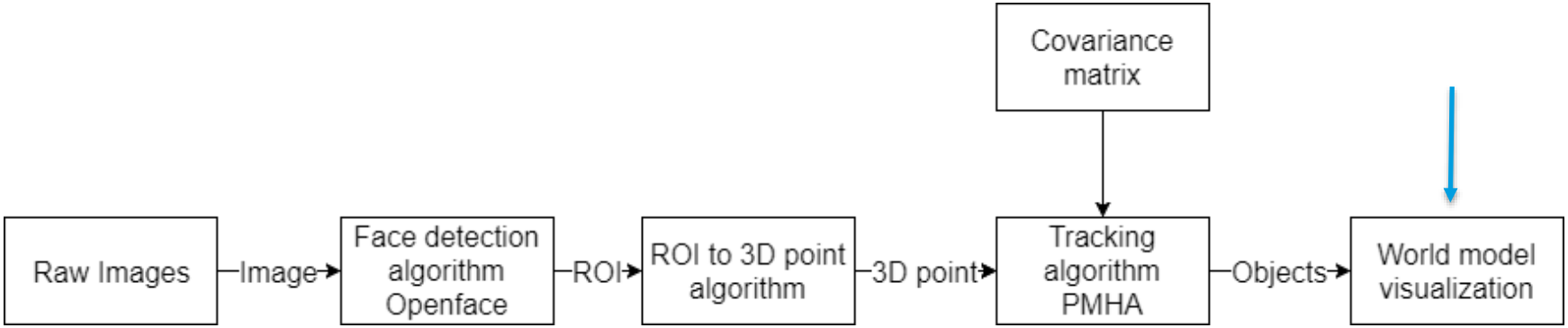
$$\begin{bmatrix} \mathrm{Var}(X) & \mathrm{Cov}(X,Y) & \mathrm{Cov}(X,Z) \\ \mathrm{Cov}(X,Y) & \mathrm{Var}(Y) & \mathrm{Cov}(Y,Z) \\ \mathrm{Cov}(X,Z) & \mathrm{Cov}(Y,Z) & \mathrm{Var}(Z) \end{bmatrix}$$



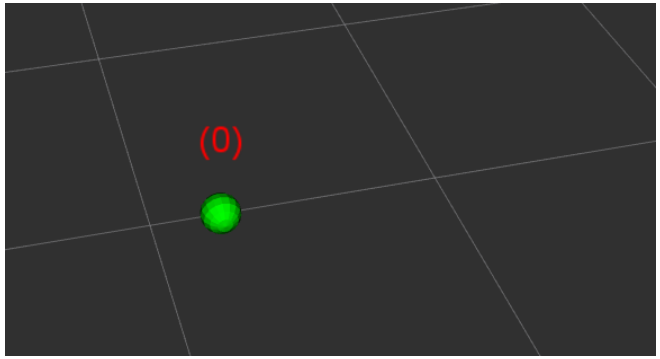
World model visualization

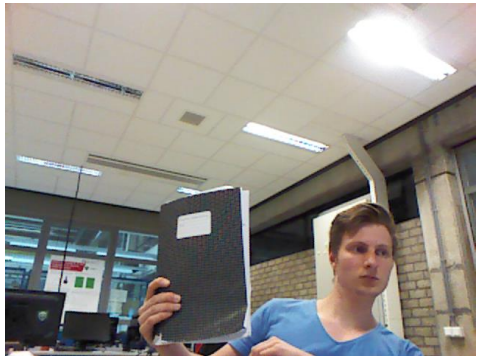
- Output PMHA
  - Class
  - Mean
  - Covariance matrix
  - ID

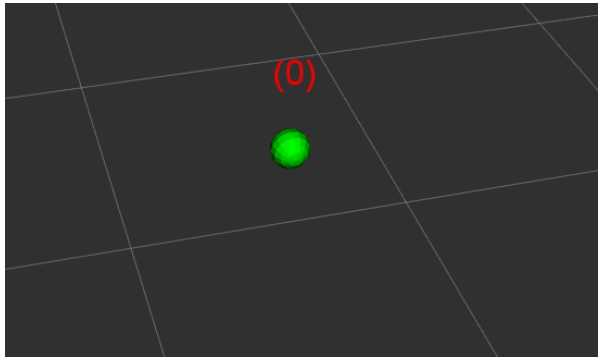


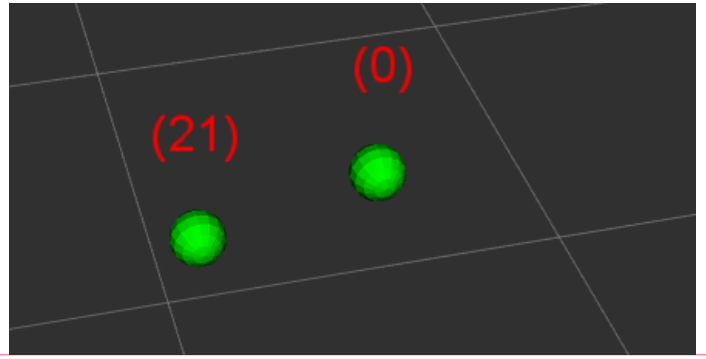


Measurements and results



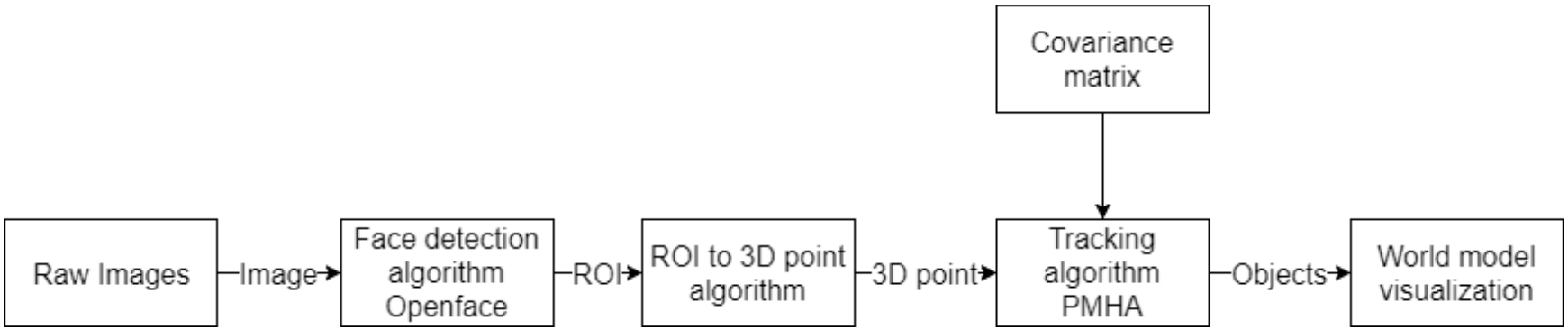






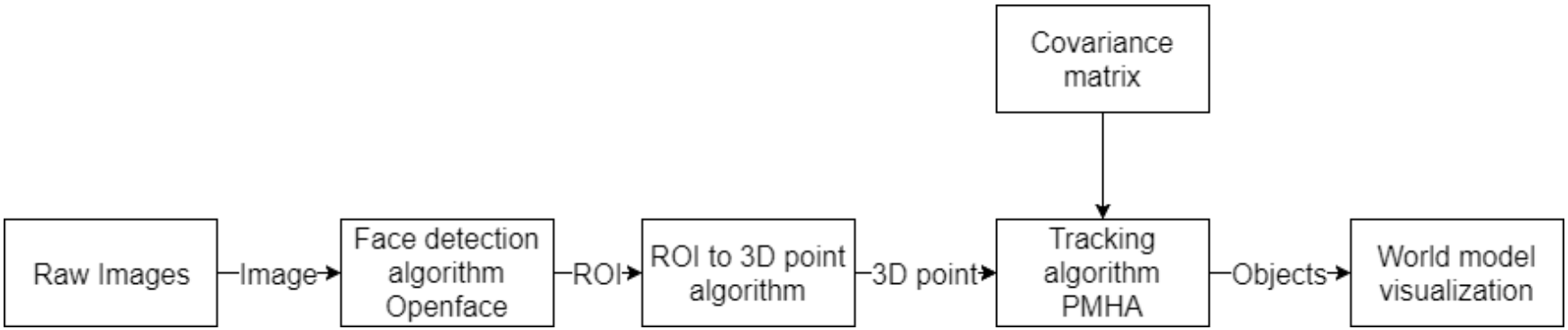
Conclusion

- Detection and tracking
- Openface
- Occlusion handling
- Covariance matrix
- PMHA



Future work

- Adding different class: e.g. torso
- Face and torso matching
- More robust people tracking
- Added covariance matrix speed dependent



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