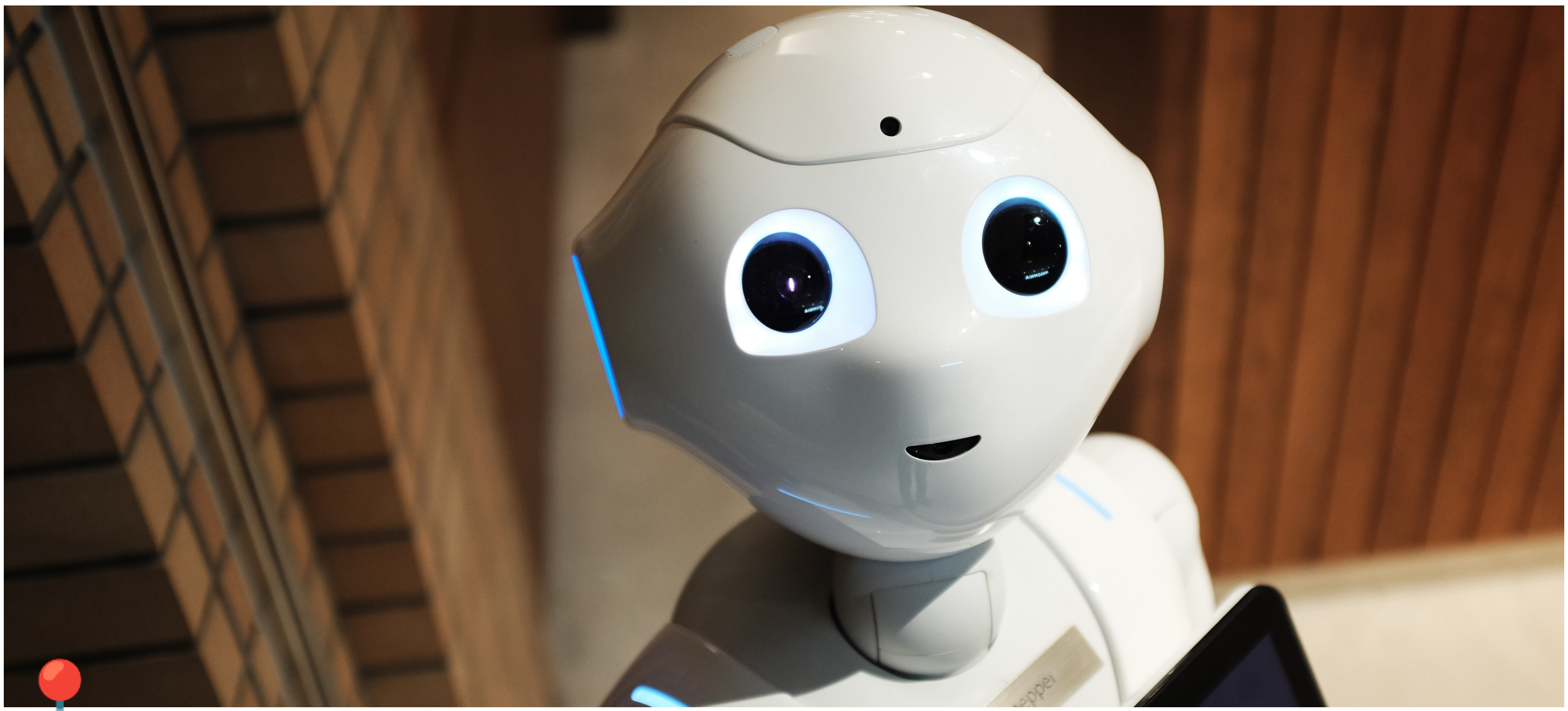

Quadruped Robot Localization

Tags	CNN Localization PCA TCN
Author/Owner	Ahmed Mohamed
URL	
Type	
Related Draft	

I'll try to summarize deep learning techniques used in numerous publications for quadruped robots' simultaneous localization and mapping in this document, and I'll also respond to the questions below.

- How can we benefit from 3D-lidar and stereo camera for TCN?
- how can we process lidar/stereo data to use it for TCN. Does it even make sense to use lidar/stereo for TCN?

Topometric Localization with Deep Learning

- vision-based (camera) localization approach that learns from LiDAR-based localization methods by using their output as training data
- The approach consists of two deep networks trained on visual odometry and topological localization
- First CNN is used to estimate the relative motion between two consecutive image sequences, which is accumulated across the traversed path to provide a visual odometry solution.
- Second deep CNN is used In order to reduce the drift often encountered by visual odometry
- The outputs of the two networks are fused to an accurate location estimate.

In response to the first question, CNNs rather than TCN are capable of performing vision-based localization (using information from stereo cameras).

Results:

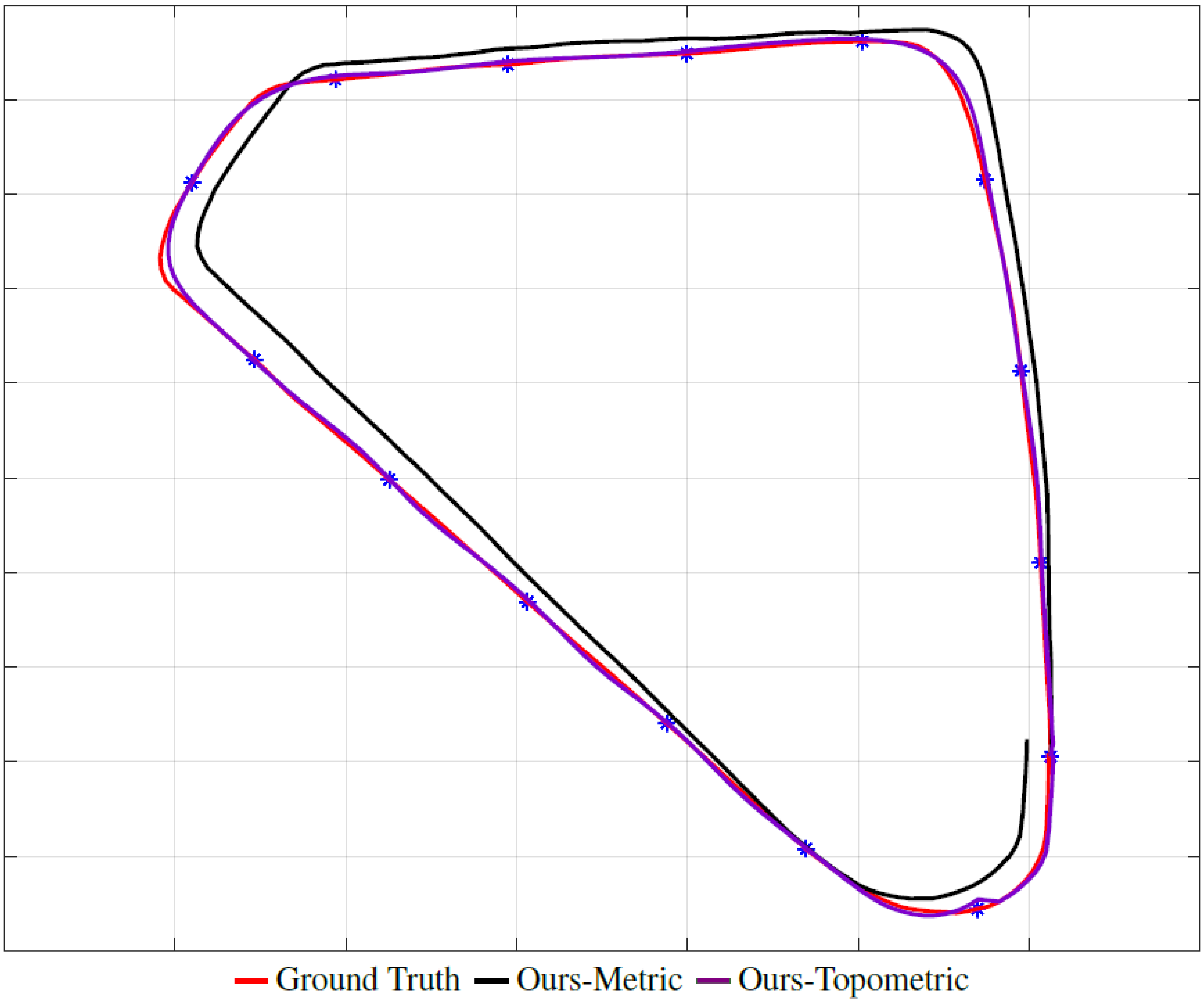

Fig. 6: Seq-1, metric vs topometric.

Reference:

https://arxiv.org/pdf/1706.08775.pdf

Positioning of Quadruped Robot Based on Tightly Coupled LiDAR Vision Inertial Odometer

- The point cloud data obtained by 3D LiDAR, the image feature information obtained by binocular vision, and the IMU inertial data are combined to improve the precise indoor and outdoor positioning of a quadruped robot.
- This method reduces the errors caused by the uniform motion model in laser odometer as well as the image blur caused by rapid movements of the robot

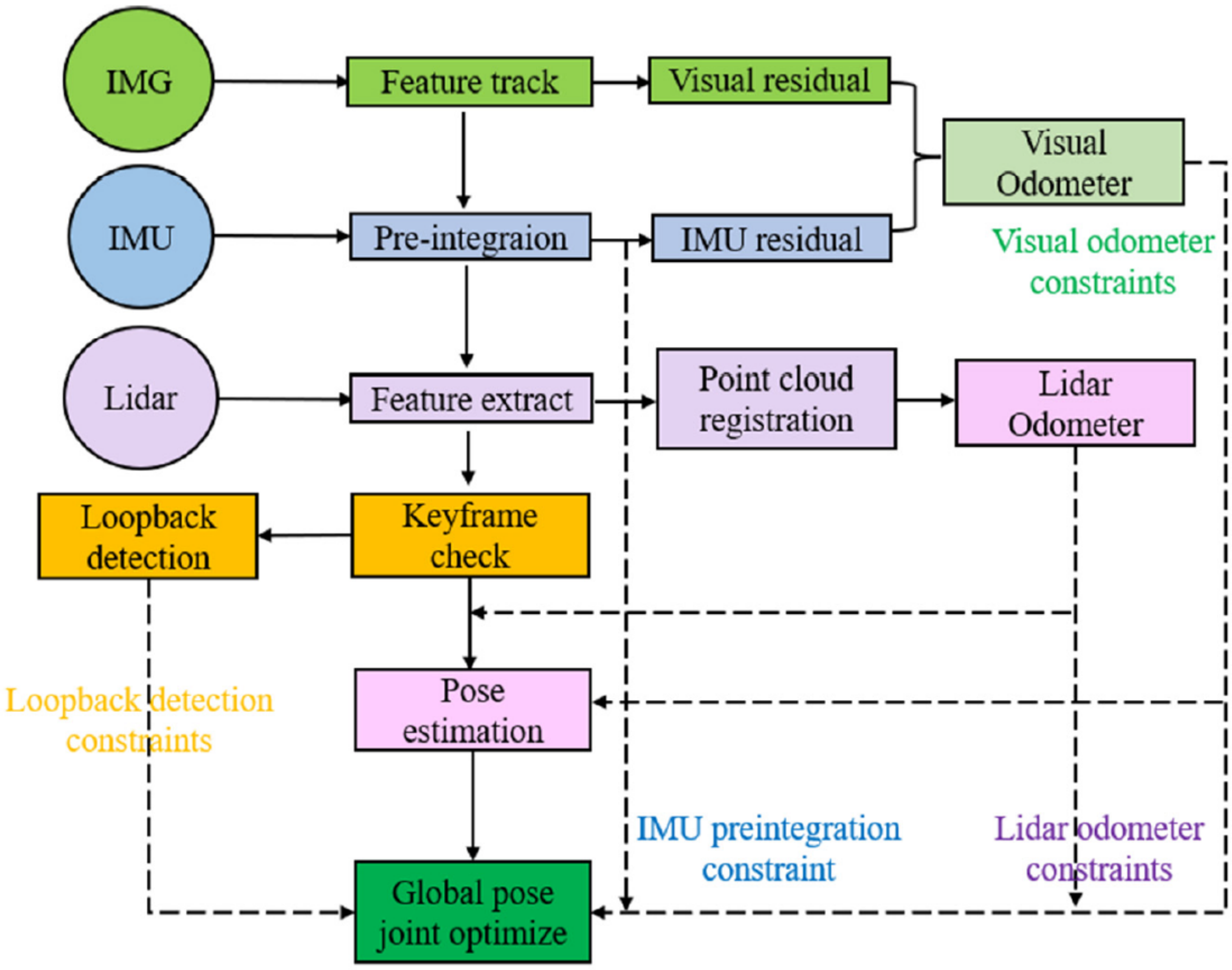

Figure 10. LiDAR vision inertial odometer algorithm flow chart.

No need for neural networks for this approach using Lidar, also Lidar is not mentioned with ML methods in any publication, therefore it does not make sense to use Lidar information in TCN or any ML model in general.

- Results:

Figure 21. Outdoor LVIO operation trajectory (the red line).

- Reference:

https://www.mdpi.com/2072-4292/14/12/2945/pdf?version=1655722584

Improved visual inertial odometry based on deep learning

- Not specifically for quadruped robots
- Positioning accuracy of visual inertial odometer in the scene
  of perspective change is improved using deep learning into the visual inertial odometer system for key point detection.
- The encoder part of **MagicPoint network** is improvedby depthwise separable convolution, and then the network is trained by self-supervised method.
- Reference:

https://iopscience.iop.org/article/10.1088/1742-6596/2078/1/012016/pdf

Mobile Robot Localization via Machine Learning

- Not specifically for quadruped robots
- Using recent manifold learning
  techniques, a new geometrically motivated solution is proposed.
- The solution includes estimation of the robot localization mapping from the appearance manifold to the robot localization space, as well as estimation of the inverse mapping for image modeling.
- Reference:

https://www.researchgate.net/publication/317639846_Mobile_Robot_Localization_via_Machine_Learning