OBJECTIVE: Learn the relationship between traffic cameras in order to infer geographical locations and orientations of an ensemble of traffic cameras.

DESCRIPTION: As cities continue to urbanize, surveillance cameras are increasingly used for the purpose of traffic monitoring and surveillance in intelligent transportation systems worldwide. As imagery and video technology has become more sophisticated and affordable, the quantity of these cameras have increased as well as the resolution and temporal frequency of collection, often approaching high-resolution video quality. This trend will only increase with the adoption of 5G technology, causing traffic camera imagery to become ever richer and more prevalent.

The precise location and orientation of a traffic camera are frequently not included in its imagery, often due to limited access. Thus, given feeds from an ensemble of traffic cameras from a region of interest (such as a neighborhood, city, or even broader parts of a country), the geographic relations between cameras are unknown. This makes the task of tracking or geo-locating a target or object of interest that may appear in camera imagery unfeasible.

However, there is information in the image content that can be leveraged to establish relations between cameras. Object detection (to include vehicle detection) is a well-studied computer vision problem. In particular, there have been advances deep learning research toward the problem of vehicle re-identification [1] across multiple cameras with different angles, illuminations, and resolutions. The goal of this problem is to use computer vision techniques, including but not limited to vehicle re-identification, to model statistical correlations or similarities between pairs of cameras that correspond to geographical proximity. Given an ensemble of related traffic camera imagery, construct a proximal network among the cameras [2]. The induced network should approximate the physical road network thus providing estimates to camera location and orientation.

PHASE I: Develop algorithms and demonstrate ability to perform multi-camera vehicle re-identification. Identify the statistical techniques used to correlate pairs of cameras based on computer vision capabilities developed.

PHASE II: Construct a working prototype that builds a network representing camera proximities using the technologies and tools identified in Phase I at scale. Demonstrate that this induced network provides geographical information by incorporating open source information such as physical road networks. Quantify estimates of geographic resolution and uncertainty.

PHASE III DUAL-USE APPLICATIONS: Military Applications: Automated surveillance, Technical Intelligence, Photogrammetry, vehicle tracking and route prediction
Commercial Applications: Photogrammetry, Surveillance

REFERENCES:

KEYWORDS: computer vision, deep learning, photogrammetry, pattern recognition