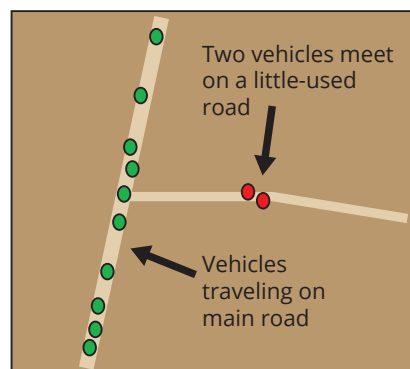


Video Summarization and Search: Object Tracking

Problem:

Aerial surveillance demands full attention to video by PED teams

- Manual, error-prone process
- Technical barriers including object detection, and tracking
- Limitations result in poor pattern detection in a surveilled region



- Vehicle tracks used to train LSTM autoencoder that learns normal behavior in order to identify anomalous tracks
- Results shown are for perfect data -- reality is not so pretty due to inadequate object detection and tracking
- This results in lost tracks and many "tracklets" that are difficult to correlate

Solution

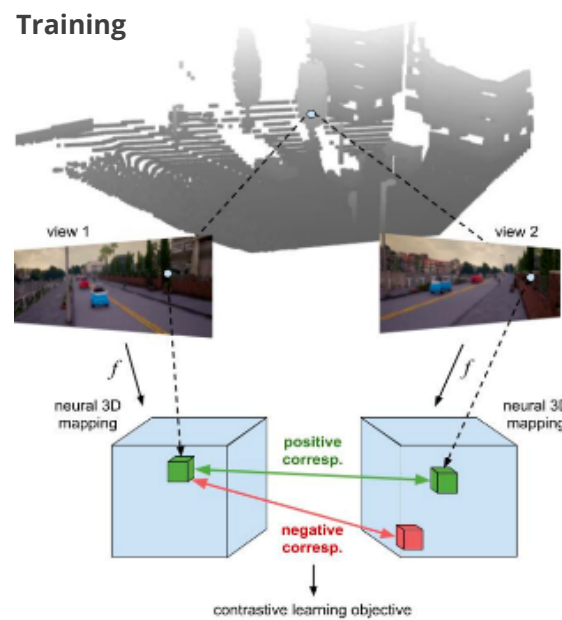
- Work directly with DoD to improve pattern detection in aerial surveillance data patterns
- Work with researchers to address core technology problems of tracking of objects

Impact (FY18-20)

- Improved DoD pattern detection in aerial surveillance data
- Developing unsupervised 3D tracking algorithms to improve on other unsupervised methods and achieve performance similar to supervised methods

3-D Tracking Research: **learning correspondence** from **static 3D points** causes **3D object tracking** to emerge.

Training



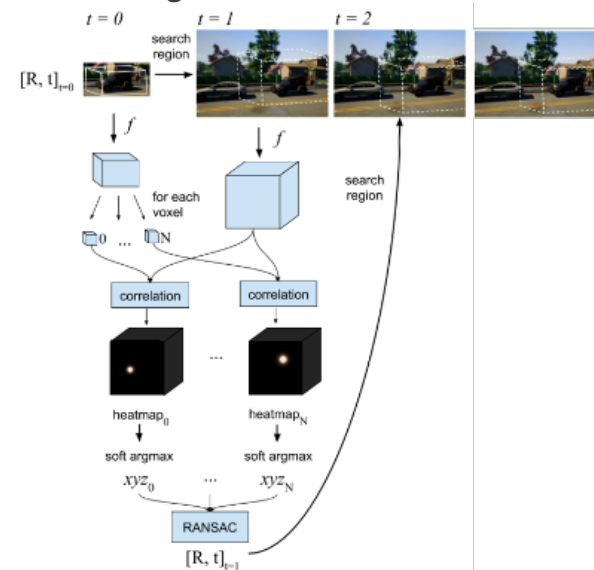
Given the bounding box for object

- Generate features for the object
- Generate features for search region
- For each voxel of object, compute correlation with search region
- Estimate the total motion with RANSAC
- Update the box automatically

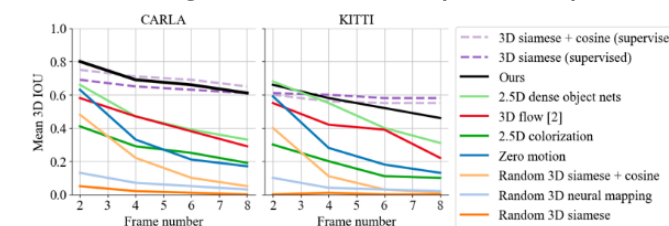
Given 2 viewpoints of the same object:

- a neural 3D mapping for each
- Identify the corresponding voxel pair in the two mappings
- Treat all other mappings as negative correspondences
- Train the features to indicate the correspondences automatically

Tracking



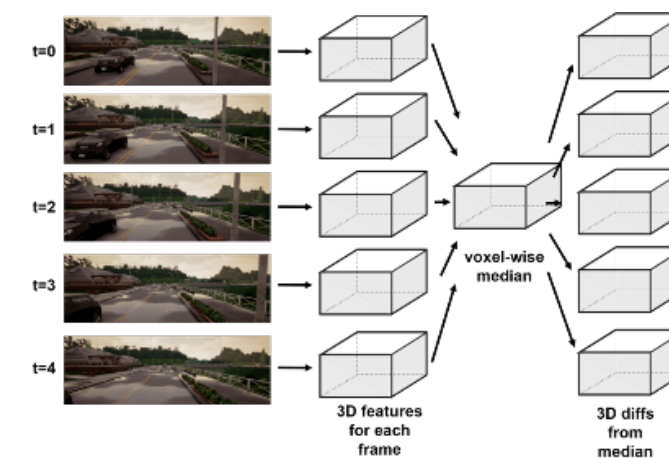
Results: Tracking based on learned correspondence of points



Object Discovery

What if the need is for a system that will discover objects autonomously?

- Extract 3D features for each frame
- Determine voxel-wise median
- Determine the difference from the median for each frame



Early results are promising!

- Work on 3D tracking will continue as part of Adam Harley's work toward his PhD at Carnegie Mellon University

Contact:

Ed Morris
info@sei.cmu.edu

Adam Harley
info@sei.cmu.edu

Copyright 2020 Carnegie Mellon University.

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

The view, opinions, and/or findings contained in this material are those of the author(s) and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

NO WARRANTY. THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

[DISTRIBUTION STATEMENT A] This material has been approved for public release and unlimited distribution. Please see Copyright notice for non-US Government use and distribution.

Internal use:* Permission to reproduce this material and to prepare derivative works from this material for internal use is granted, provided the copyright and "No Warranty" statements are included with all reproductions and derivative works.

External use:* This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other external and/or commercial use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

* These restrictions do not apply to U.S. government entities.

Carnegie Mellon® is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

DM20-0883