A Novel Approach for Predicting and Understanding Road Danger in the Developing World:
Deep Video-Classification of Roads in Nairobi, Kenya
Alexandr Lenk, Matias Cersosimo, Negin Raooof
Stanford University

OUR VIDEO
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MOTIVATION
Providing traffic safety and lowering the rate of road accidents in Nairobi, Kenya is a major concern. With a road traffic death rate of 27.8 per 100,000 inhabitants in 2016, Kenya has nearly twice as much road fatalities as the world average.

Collaborating with the World Bank, we are the first ones to construct a deep learning model entirely based on videos of several road segments from Nairobi. The model allows us to analyze different road conditions and predict danger level of roads.

DATA PROCESSING AND MERGING
Data consists of:
- Geospatial Dataset of 902 100-meter long road segments.
- Geospatial Dataset of 1428 crash hotspots linked to the number of annual crashes between 2012-2018.
- 852 road and pedestrian activity videos.

Center of Nairobi with roads (blue) and hotspots (red)

Road Segment matched to 1 Hotspot
Road Segment matched to 4 Hotspots

Following the World Bank data collecting strategy, we match road segment i to hotspot j as long as the distance between i and j is less than 130m.

LABELING STRATEGY AND CLASS IMBALANCE
For road segments matched to multiple hotspots, the final number of crashes associated to a road was calculated as the average of the number of crashes occurring in all hotspots matched to that road weighted by the inverse of its distance from the road.

We labeled the videos using an ordinal approach to avoid measurement error likely to be present in the crash data, which is a continuous variable. We classify the videos into 4 categories using a k-means algorithm.

Danger Level 1: Moderate
Danger Level 2: High
Danger Level 3: Very High
Danger Level 4: Extremely High

For the model, each clip is assigned a category confidence score. A clip is considered to belong to one of the 4 danger classes.

CONCLUSIONS AND FUTURE WORK
- Decent first-step results for a complex classification task.
- Need to improve performance. Different strategies to follow:
  - Try Deep 3D-pretrained models in which some of the earlier 3D layers are transferred as well to account for the novelty of class prediction.
  - For longer video-clips, possibly come up with a structure that reduces the loss of information due to averaging and pooling across the network before reaching the fully connected layers.
  - Explore the ordinality of our classes. During training, a true label belonging to category 1 should have higher mass of assigned predicted probability to categories 1 and 2 rather than 3 and 4 since 3 and 4 are increasingly more dangerous than 2.

MAIN REFERENCES