IMAGE-BASED ROAD TYPE CLASSIFICATION

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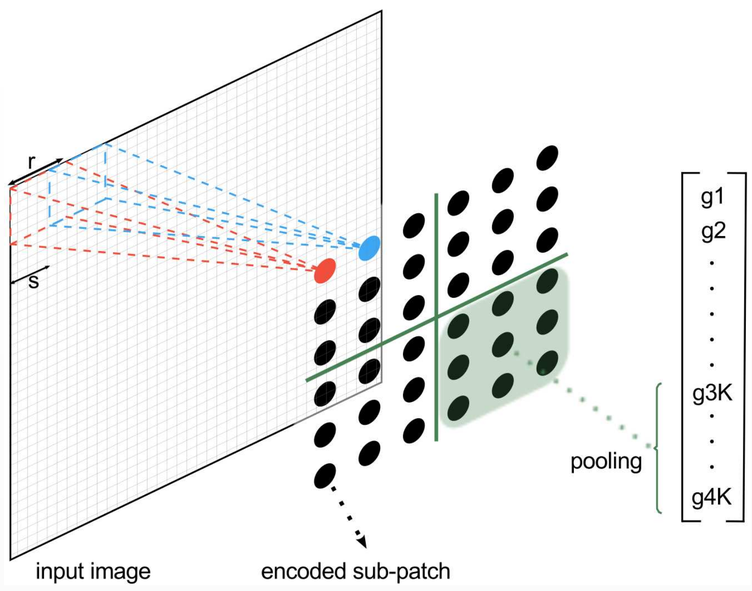
Abstract

The ability to automatically determine the road type from sensor data is of great significance for automatic annotation of routes and autonomous navigation of robots and vehicles. In this paper, we present a novel algorithm for content-based road type classification from images. The proposed method learns discriminative features from training data in an unsupervised manner. Experiments performed on a comprehensive real-world road image dataset show the advantages of our approach.

Feature learning



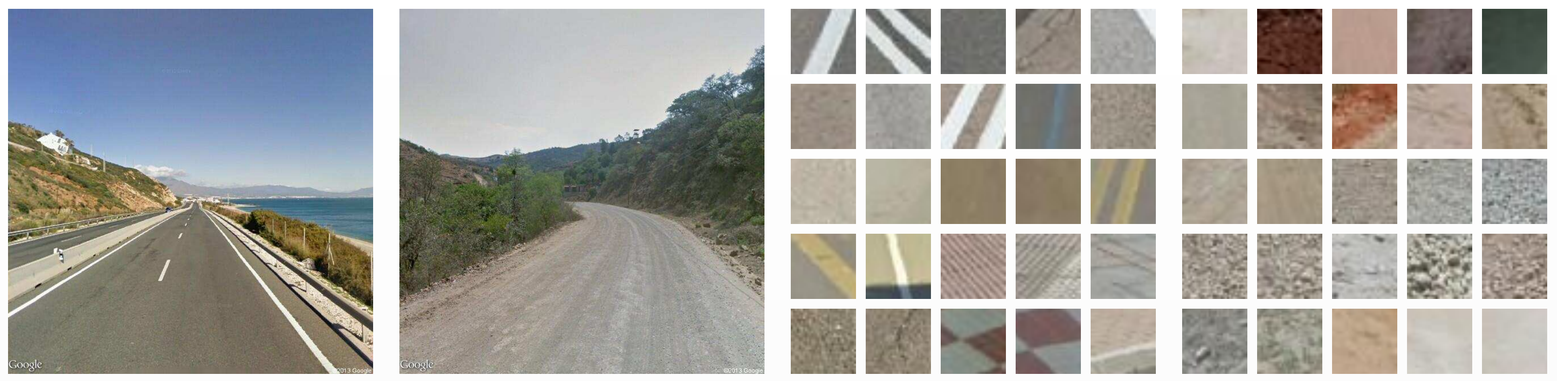
Encoding & classification

- Sparse non-linear encoding [1]
- Feature dimensionality reduction
- Linear SVM classification [2]

Results

Algorithm	OCA
Baseline	74.23%
Engineered Features	84.25%
Unsupervised Features	**85.30%**

Road image dataset



(a) (b) (c) (d)

Google Street View sample images from the paved (a) and unpaved (b) road classes. Examples of extracted sub-images, from each class respectively, are shown in (c) and (d).

Mini-batch stochastic gradient descent algorithm

procedure KMEANS(k, b, t, X)
  Input: k, mini-batch size b, iterations t, dataset X
  Return: centroids C
  Initialize each $c \in C$ with $k - means++$ initialization
  $v \leftarrow 0$ ▷ Per-centroid counts
  for $i \leftarrow 1, t$ **do**
    $M \leftarrow b$ examples picked randomly from X
    $m \leftarrow 0$ ▷ Batch centers
    $u \leftarrow 0$ ▷ Batch per-center counts
    for all $x \in M$ **do**
      $d \leftarrow f(C, x)$ ▷ Cache centroid nearest to x
      $D \leftarrow D \cup d$
      $u[d] \leftarrow u[d] + 1$
      $m[d] \leftarrow m[d] + x$
    end for
    for all $c \in D$ **do**
      $\mu \leftarrow \frac{m[c]}{u[c]}$ ▷ Mean sample
      $v[c] \leftarrow v[c] + u[c]$ ▷ Update counts
      $\eta \leftarrow \frac{1}{v[c]}$ ▷ Learning rate
      $c \leftarrow (1 - \eta)c + \eta\mu$ ▷ Take gradient step
    end for
  end for
  return C ▷ Return the centroids
end procedure

References