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Automatic fog detection for public safety by using camera images

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Fog and reduced visibility have considerable impact on the performance of road, maritime, and aeronautical transportation networks. The impact ranges from minor delays to more serious congestions or unavailability of the infrastructure and can even lead to damage or loss of lives.
Visibility is traditionally measured manually by meteorological observers using landmarks at known distances in the vicinity of the observation site. Nowadays, distributed cameras facilitate inspection of more locations from one remote monitoring center. The main idea is, however, still deriving the visibility or presence of fog by an operator judging the scenery and the presence of landmarks. Visibility sensors are also used, but they are rather costly and require regular maintenance. Moreover, observers, and in particular sensors, give only visibility information that is representative for a limited area. Hence the current density of visibility observations is insufficient to give detailed information on the presence of fog.
Cameras are more and more deployed for surveillance and security reasons in cities and for monitoring traffic along main transportation ways. In addition to this primary use of cameras, we consider cameras as potential sensors to automatically identify low visibility conditions. The approach that we follow is to use machine learning techniques to determine the presence of fog and/or to make an estimation of the visibility. For that purpose a set of features are extracted from the camera images such as the number of edges, brightness, transmission of the image dark channel, fractal dimension. In addition to these image features, we also consider meteorological variables such as wind speed, temperature, relative humidity, and dew point as additional features to feed the machine learning model.
The results obtained with a training and evaluation set consisting of 10-minute sampled images for two KNMI locations over a period of 1.5 years by using decision trees methods to classify the dense fog conditions (i.e. visibility below 250 meters) show promising results (in terms of accuracy and type I and II errors). We are currently extending the approach to images obtained with traffic-monitoring cameras along highways. This is a first step to reach a solution that is closer to an operational artificial intelligence application for automatic fog alarm signaling for public safety.