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Multiple instance learning to decrease annotation effort

For multiple instance learning (https://en.wikipedia.org/wiki/Multiple-instance_learning), we do not need to annotate the exact position of positive samples, but annotations of larger crop or even images that might contain positive samples. From those, it can learn to ignore the negative samples while pinpointing the positive samples.

Scope: Find an implementation of multiple instance learning and try it on one of our problems (traffic signs, light poles, bag shapes, etc)

Relevance: This might reduce the annotation effort within the company to obtain large dataset for training allowing us to more rapidly detect and recognize different kind of objects.

Data-set augmentation via auto-encoders

One of the current problems in machine learning is that for some classes many real-world examples exist while other classes have only a few examples. Machine Learning methods however need to learn the appearance of a class. Auto encoders provide a way to augment (create a virtual appearance of) a class allowing us to train on the augment examples. For traffic sign, learning based on the icons and real images might allow you to augment traffic sign images with icons where we do not have enough examples:

Scope: Create a network architecture that is able to augment objects of interest (traffic signs, light poles, bag shapes, etc)

Relevance: This might reduce the annotation effort within the company where most of the effort will be in annotating the rare examples

Context dependent detection and recognition

Often certain traffic sign appears only on the highway or at rail crossing, investigate how easy it is to use this context either to save computation effort in running multiple detectors or improving the detection/recognition rate by using this context information. The context information does not have to be limited to GIS databases, it can also be road patterns, open street map, etc

Scope: Create a prototype that uses context information to either improve the performance in computation or in detection rate, notice that database design where the context is stored and how it is obtained is very important

Relevance: Context information might reduce costs in computation and might improve performance due to the face that decisions are based on more information

Road condition classification: “Detecting holes and weak spots”

Our cars can be easily used for road condition classification, however the challenge here is to obtain dataset about good and bad road. A couple of possibilities are: looking in the lidar data for none flat road surfaces, looking if we can get road construction logs, allowing us to take historical data of roads before maintenance and after maintenance and relate that to other roads.

Scope: Create a prototype that predicts the road conditions based on either cycloramas or lidar data.

Relevance: Road condition estimation and weak spot detection can be sold to either municipalities of road maintenance companies.

Cyclorama illumination normalization of shadows and sun back light

The illumination in cycloramas can be “easily” predicted because the only light source is often the sun, which has well known position. Another nice property of cycloramas is that they are the perfect probe sphere, where you have the integral of the light conditions that make up the scene. Lidar also allows us to compute the normal of the surface allowing us to back compute large parts of reflectance equations like the Lambertian reflectance model. More interesting is that cars often have driven on similar location during different hours allowing us to make prediction models.

Scope: Developing an implementation that can render the same cyclorama or point scene under different light (and maybe weather) conditions, try to estimate the correctness with historical data.

Relevance: For virtual and augmented reality having a 3D scene can be of interest, however being able the render the scene under different conditions allows us to understand the full implications of appearance changes.

Illumination normalization of shadows and sun in the aerial images

Shadows and sun reflection in aerial images are often not aesthetically desired, where for instance by 3D printing they are corrected by humans. Computer vision allows both for ways to estimate the shadow areas based on appearance and the direction of the sun, there are also ways to correct for the shadow areas by improving color and hue channels, where information about the appearance of the shadow areas can boost this even more (also historical data might be nice to look at).

Scope: Develop a method and prototype to remove the shadow areas from our aerial images

Relevance: Some of our customers might find aerial images without shadows more aesthetically desired, for instance for 3D printing of buildings

Moving object detection for cleaning lidar and blurring

Finding pedestrian in cycloramas is difficult, because of the large variations in appearance. However a large amount of pedestrians are walking/moving, where their obvious change in position can help to detect/segmented them out of the scene. The goal of this assignment is to develop techniques which uses the lidar and possible stereo disparity to detect moving objects in the scenes. It is interesting for us to detect both the cars/cyclist/pedestrians which can be achieved by finding the obvious differences in our images data over time and lidar data which will show sparse point could.

Scope: Develop a method to detect moving object in the image and lidar dataset and remove it from the depth cycloramas

Relevance: Currently, we have algorithms to compute depth images where moving objects often give strange artifacts due to the recording setup. Removing these artifacts is one goal while the second goals is to use this information in the blurring finding both face and license plate which are location on cars, pedestrians and cyclists.

Rooftop type detection

Insurance company and municipality are interested in the different rooftop type of houses and if house contain solar panels on their rooftops. Your task is to classify the different rooftop type in aerial pictures. A set of aerial pictures from Cyclomedia together with the different rooftop type will be provided. We already have deep learning algorithms that perform classification, however house might have multiple type of roofs. Dealing with the different appearances of the houses is challenge, because the methods needs to be rotation invariant, because rotation and shape of the houses in the images can vary. A literature review on object detection focused towards aerial image is necessary. An implementation of a method to find solar panels in aerial images need to be described together with experiments on the performance of this method.

Creating Virtual World for drones/robots to navigate (group assignment using Cyclomedia data)

The 3D pipeline allows us to create a dense mesh of a certain location. This dense mesh can be interesting for robots/drones/self driving cars to virtual test the software. In this case, the sensor input can be simulated by inputting the virtual world mesh, which allows us to not only simulate virtual camera input but lidar and proximity sensors. Our virtual environment however does not contain other effect like gravity, wind, friction, etc. It is interesting to see if our data can be imported in an environment for robot simulation or that we can build an environment for robot simulation that has these effects.

Scope: Check possibilities for robotic simulation and create demo environment for simple robot

Relevance: This might attract new customers in robots, especially drones simulation will become big, where for instance building inspection of existing buildings can be planned in advance.