Progress Report

William Beksi

September 19, 2016

Over the last two weeks I've completed the initial experimental results for the topological point cloud signature and finished the draft for ICRA. The results show that the signature is more reliable for objects that correspond to fundamental shapes such as rectangles, cylinders, etc., rather than objects with many fine details. This suggests that the signature would be more useful for category classification. There is still a lot of work to do in this area. For instance, we need to see how reducing (voxelizing) the size of the point cloud effects performance and run against a larger dataset. The metric used for comparing signatures also needs more investigation as this is currently the slowest computational piece in the pipeline. Finally, it would be very interesting to combine the topological signature with a local descriptor in an ensemble learning classifier for object classification.

I'm beginning to work on the presentation for IROS. I also need to work on my research statement for the IDF fellowship application.

Progress Report

William Beksi

September 5, 2016

After generating a topological signature based on 0- and 1-cycles for a set of point cloud objects I've been able to compare the distance of their persistence diagrams using [1]. The initial results look promising, the distance between point cloud views of the same object are much smaller when compared to the views of a different object. However, the slowest part of this pipeline is computing the Wasserstein distance between two point clouds. Right now I'm using the raw point clouds from the sensor, i.e. the points clouds have not been downsampled. These raw point clouds can generate a signature of length 50k - 200k. Voxelizing the point clouds could make this faster but the effect on accuracy needs investigation. Another area to investigate is if the much simpler bottleneck distance can be used to compare the persistence diagrams compared to the complicated approach taken in [1] to compute the Wasserstein distance. If the bottleneck distance is a sufficient metric then it could possibly be computed very quickly using GPUs. The next piece in this work would be to implement the SVM kernel described in [2] for training on and classifying persistence diagrams. Then an ensemble learning approach using both topological and geometric point cloud descriptors could be taken for object classification.

[1] M. Kerber, D. Morozov, and A. Nigmetov. "Geometry helps to compare persistence diagrams." Proceedings of the Eighteenth Workshop on Algorithm Engineering and Experiments (ALENEX). 2016.

[2] J. Reininghaus, S. Huber, U. Bauer, and R. Kwitt. "A stable multi-scale kernel for topological machine learning." Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR). 2015.

Progress Report

William Beksi

June 27, 2016

I'm continuing to work on using covariance descriptors for describing 3D regions and then merging them using topological persistence. The idea is to first initialize every point (region) using a point-wise covariance descriptor. Then, as the algorithm progresses and regions are merged, we update the covariance descriptor for each region. It may be possible to guide the topological filtration based on how much the covariance of the region changes, i.e. the filtration stops when the change (residual error) in the current step compared to the previous step is below a threshold. All recent techniques make use of k-means to do this.

I've been reading [1] and [2]. [1] gives an overview of the latest software for computing persistent homology. [2] provides an interesting way to find the number of holes in 2D images using persistence.

[1] Otter, Nina, et al. "A roadmap for the computation of persistent homology." arXiv preprint arXiv:1506.08903 (2015).

[2] Kurlin, Vitaliy. "A fast and robust algorithm to count topologically persistent holes in noisy clouds." Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2014.

Progress Report

William Beksi

February 22, 2016

The previous week I completed the final version of the ICRA 2016 paper. This involved rewriting parts of the paper and adding new experimental results based on a publicly available RGB-D segmentation dataset.

Over the weekend I finished collecting the experimental results for the IROS 2016 paper. I've devised a new algorithm that uses topological persistence in conjunction with a homogeneity criterion to perform region growing segmentation. The approach is automated and does not require the selection of initial seed points. The connectivity of the space is maintained using topology and regions are grown based on the local similarities (color, surface normal) between nearest neighbors. The segmentation results are good considering the level of noise in the point cloud data and the resolution of the RGB-D sensor.

Progress Report

William Beksi

June 23, 2014

Final changes to the IROS point cloud culling paper have been made along with the digest file, everything is now submitted. I've also started to add more content to the object recognition engine technical report (work in progress) now that the point cloud culling paper has been accepted.

For the topological image segmentation project, the creation of a set up points using an edge detector is compete. I'm working on the preprocessing stage where given the set of edge points, and a fixed radius around each point neighborhood, the number of connected components, vertices, edges, and faces (triangles) is to be found at each step using persistent homology. This will allow for the calculation of the Betti number at each stage along with the identification of persistent regions, transient regions, and triangle regions which are to be merged in a later stage on based on their features.

Progress Report

William Beksi

April 21, 2014

I'm in the process of finishing up the experiments for the RGB-D covariance descriptors using dictionary learning. There was quite a lot of software that had to be written to perform all of the experiments for the different feature descriptors as described in Duc's thesis against the Lai database using dictionary learning. For the leave-sequence-out experiment, I have a 93% accuracy rate which beats the SVM classifier from Duc's work and is a bit better than the state of the art. For the category classification experiment, the current accuracy is around 75%. This is better than the SVM classifier in Duc's work, but I'd like to work on trying to boost it more. The experimental data is set up for the alternating-contiguous-frames experiment but not complete. This experiment should perform well so I've saved it for last since there should be no worries. As is, with the improved dictionary learning classifier and the flexibility of the approach as opposed to using other classifiers, I can begin writing a paper for this.

Progress Report

William Beksi

September 13, 2013

This week I finished writing my paper for ICRA along with the two other papers in collaboration with Duc and Dimitris. The last few days I've been writing the driver interface for the new firmware on the Microvision's microcontroller board (Xplained). In a few hours I'll test the driver with the robot's motors and IMU sensor. Then we'll assemble the robot for pictures and a new video. We should have the paper complete by tomorrow.

Progress Report

William Beksi

August 23, 2013

I'm working on the experimental results and writing the ICRA paper for my cloud robotics project. I've been writing the code and analyzing the results of the scale invariance for the covariance descriptors. For the same object, the geodesic distance between the covariance matrices at different scales is very small. When comparing one object to another object, at different scales, the distance between the covariance matrices is larger than the same object comparison, but it's not a very large value as we expected. For classification, zero mislabeling occurred for testing objects at different scales where the training was done at a fixed scale.

For the SUAV, I have the on-board Caspa camera for the Gumstix ready to stream and record video. This afternoon I will be volunteering at the state fair.