

Progress Report

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1 Progress

Following items are listed in order of priority:

- I looked into PrOD, Sim2Real, Habitat Challenge and RoboTHOR in detail and decided to work towards Sim2Real Challenge. The challenge consist of three levels, in the first level the challenge is to perform SLAM algorithm in a simulated environment and navigate from point A to point B where the agent has to avoid obstacles. Second level challenge is similar to the first except the agent might run into stationary objects which it is encouraged to interact with. For example, the agent's path is partially blocked by a box and the agent slowly pushes against it to continue moving toward destination. The third level is populated with dynamic moving participants that are moving along pre-planned trajectories in the apartment and the agent has to plan navigation with respect to their trajectory and moving patterns.
- I began reading on SLAM and it implementation. I am currently going through tutorial and working on my Linux setup currently.
- Still working on [2], [3], [4], [5].
- Continue reading on RL, DRL and SLAM. If I'm going to start implementing SLAM which I am interested in, I can start playing with codes from [2], [3], [5] papers.
- Read [6], began to dissect it. It's a heavy paper, I have already read it twice, I need to go back and read it again and learn the material.

2 Plans

Following items are listed in order of priority:

- (On pause) Resume Machine Learning course with Andrew Ng as soon as possible.
- (On pause) I am working through Jason Brownlee's ML Mastery book, [8].
- (On pause) Resume Robotic Perception course as soon as possible.

- (On pause) Need to read [9], [10], [11], and [12]; these papers seem fundamental to understanding the overall picture.
- (On pause) Get intimate with Python, Numpy, Pandas, Scipy, and Matplotlib, TensorFlow and PyTorch.
- (On pause) Read Digital Image Processing by Gonzalez and Woods.
- (On pause) Learn ROS.
- (On pause) (Supremely important) Read on scene understanding, semantic SLAM, graph SLAM, visual odometer, place recognition, and Kalman Filtering. Read Niko Sunderhauf’s research publications.

3 General Notes

This section summarizes general research leads. The following items are to be investigated, understood and briefly summarized.

- Open3D: An open source toolbox used for truth occupancy grid application and probably other things. Should review.
- Horn’s paper [4]: It introduces Unit Quaternions which allow for complex domain representation of kinematics. Very important paper for robotic motion. Should review.
- Bayesian Learning: This probabilistic ML approach treats model parameters as random variables. Read [13] for more details.
- Convex Optimization:
- Q-Learning: A learning model of reinforcement (RL), learning from delayed reward.
- Deep Reinforcement Learning:

4 Literature Review

4.1 Dynamic Graph CNN for Learning on Point Clouds [6]

This paper introduces a new model for training CNNs to learn similar features of point cloud objects.

4.1.1 Keywords

- PointNet
- Extrinsic and intrinsic descriptors:
- Permutation variance:

4.2 Single Image Super-Resolution Using Multi-Scale Convolutional Neural Network - MSSR [14]

Paper proposes an architecture with two parallel path with different depths (which correspond to scales) for residual learning; where one path (module L) is used for large factor up-scaling (x4, x8) and the other (module S) for small factor up-scaling (x2). At the end, it combines the outputs by summation (a form of ensembles). In contrast to previous work where the focus is on small factor up-scaling (x2) and repeat if needed, this model takes higher factor up-scaling into consideration while training the network which helps with reducing blurriness of output image for higher factor up-scaling. The model uses multi-scale residual learning to train on general model for multiple up-scaling factors; hence, saving memory and processing time. This paper provides experiment results that show higher output image integrity where peak signal to noise ratio (PSNR) and structural similarity index (SSIM) are higher or comparatively close to state-of-the-art methods.

4.2.1 Keywords

- Lanczos re-sampling:
- Statistical priors:
- Stochastic Neighbor Embedding (paper by G. Hinton [15]): Read paper.
- Parse coding:
- GoogLeNet:
- YCbCr color space:
- Caffe package (paper by Jia, Y., Shelhamer, E., Donahue, J., Karayev, S., Long, J., Girshick, R., Guadarrama, S., Darrell, T.): Convolutional architecture for fast feature embedding. [Read and write literature review.](#)

- Adam method (paper by Kingma, D., Ba, J.): A method for stochastic optimization.
- PSNR (performance metric): Peak Signal to Noise Ratio represents the ratio between max (peak) possible value (power) of a signal (image) and the power of distorting noise.
- SSIM (performance metric): Structural Similarity Index, is the ratio of structural features of a processed image to the original image. The value represent percentage of structural features/information retained throughout image processing.
- A+ (SR method, paper):
- SelfEx (SR method, paper):
- SRCNN (SR method, paper): Image Super Resolution Using Deep Convolutional Networks. Read again and write literature review.
- FSRCNN (SR method, paper):
- VDSR (SR method, paper):

4.3 Value Iteration Networks - VIN [16]

4.3.1 Keywords

- Imitation Learning: ****need to finish reading [17].****
- CNNs applied to reinforcement learning:
- MDP (Markov Decision Process):
- VI Algorithm (Value Iteration):
- SGD (stochastic gradient decent):
- Theano Code: "Theano is a Python library that allows you to define, optimize, and evaluate mathematical expressions involving multi-dimensional arrays efficiently. It can use GPUs and perform efficient symbolic differentiation."
- Grid-World Domain:

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