Synthetic computer vision: get our hands dirty

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May 18, 2017

Project Name changed

- A survey of ways to synthesize data (images) with Simulation Software.
- A survey of synthetic computer vision

Since the SERVEY can be too large for me to cover, and what I intend to do is replicating the results of some papers and try some tools and get familiar with all these stuff, so I changed my project name into:

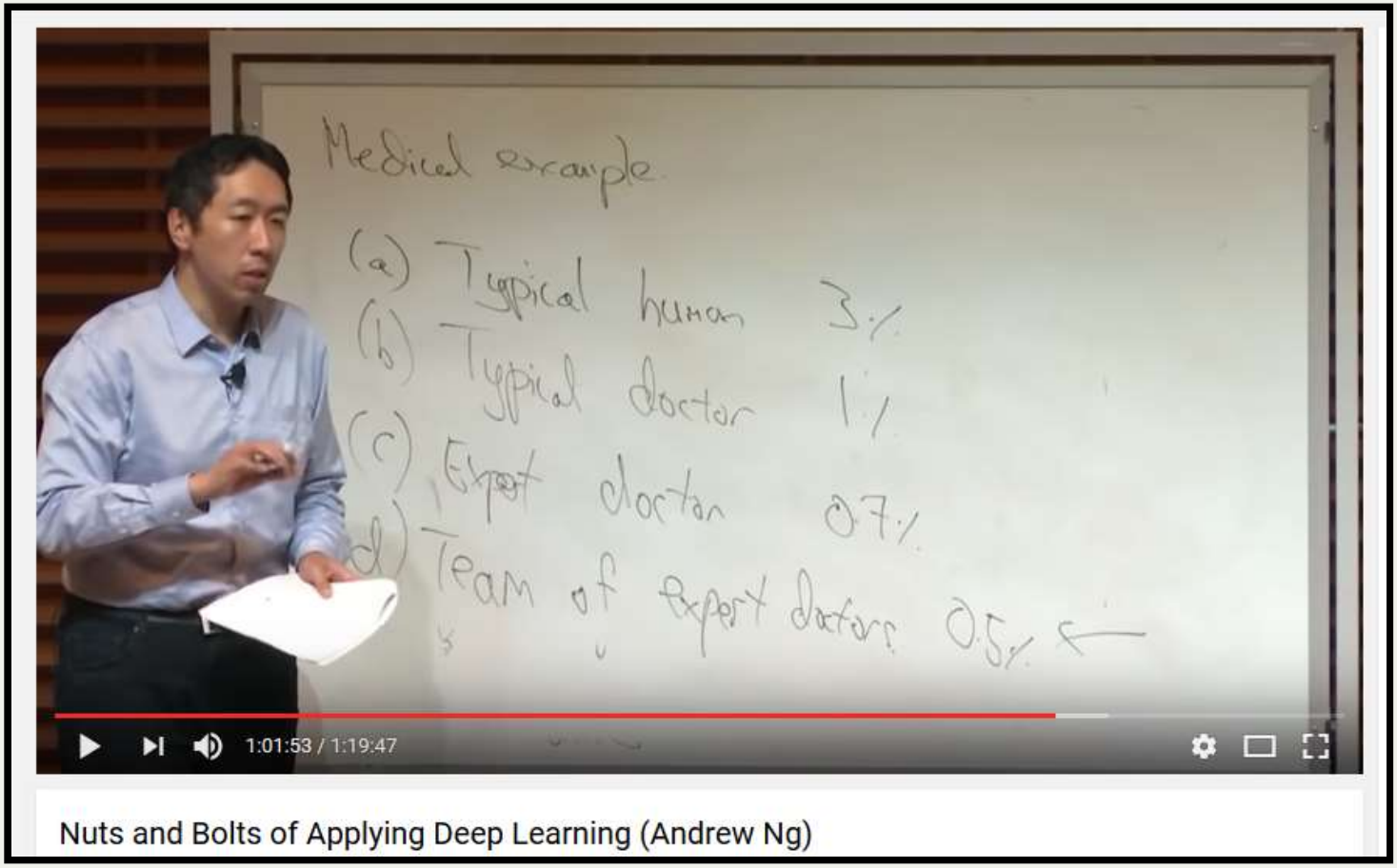
Synthetic computer vision: get our hands dirty

Why -- motivation

- personal preference
- pros and cons (real world/synthetic data)
  - available
  - privacy
  - controllable
  - accuracy

Question about `human level accuracy`

-- Andrew Ng in his 『Nuts and Bolts of Applying Deep Learning』



human level accuracy

AND back to our motivation, there are plenty of prior works ...

plenty of prior works #1

OpenAI

- gym:

  A toolkit for developing and comparing reinforcement learning algorithms.

- universe:

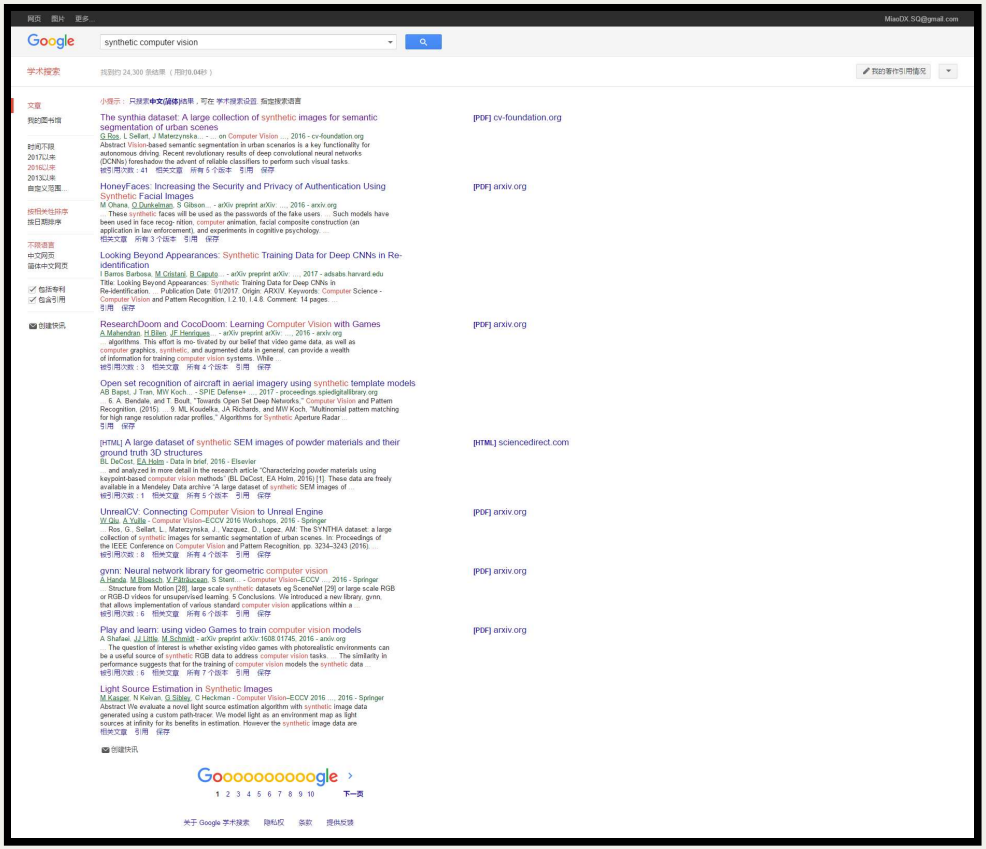
  A software platform for measuring and training an AI's general intelligence across the world's supply of games, websites and other applications.

- brand new roboschool:

  Open-source software for robot simulation

plenty of prior works #2

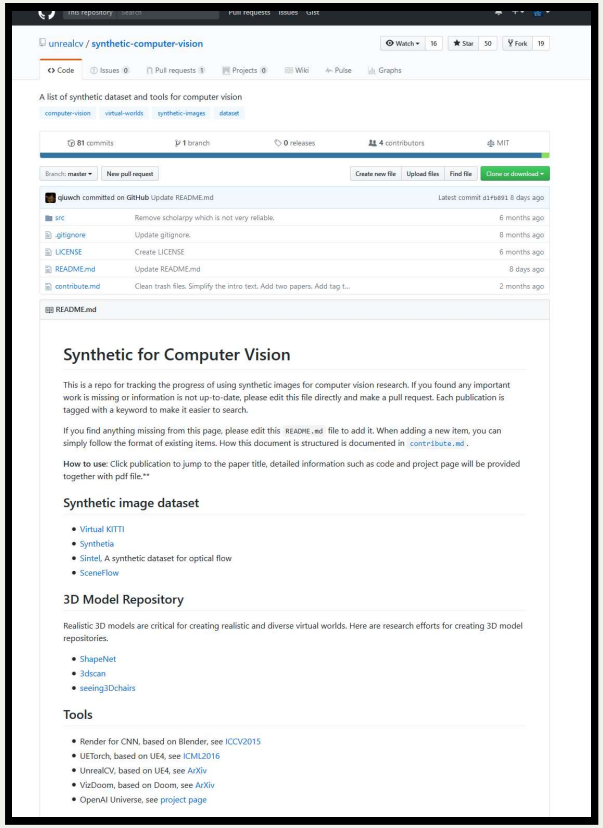
Google scholar `synthetic computer vision` **results:**



synthetic_computer_vision

plenty of prior works #3

synthetic-computer-vision,
A list of synthetic dataset and tools for computer vision:



unrealcv / synthetic-computer-vision

A list of synthetic dataset and tools for computer vision

Synthetic for Computer Vision

This is a repo for tracking the progress of using synthetic images for computer vision research. If you found any important work is missing or information is not up-to-date, please edit this file directly and make a pull request. Each publication is tagged with a keyword to make it easier to search.

If you find anything missing from this page, please edit this `README.md` file to add it. When adding a new item, you can simply follow the format of existing items. How this document is structured is documented in `contribute.md`.

How to use: Click publication to jump to the paper title, detailed information such as code and project page will be provided together with pdf file.**

Synthetic image dataset

- Virtual KITTI
- Synthetia
- Sintel, A synthetic dataset for optical flow
- SceneFlow

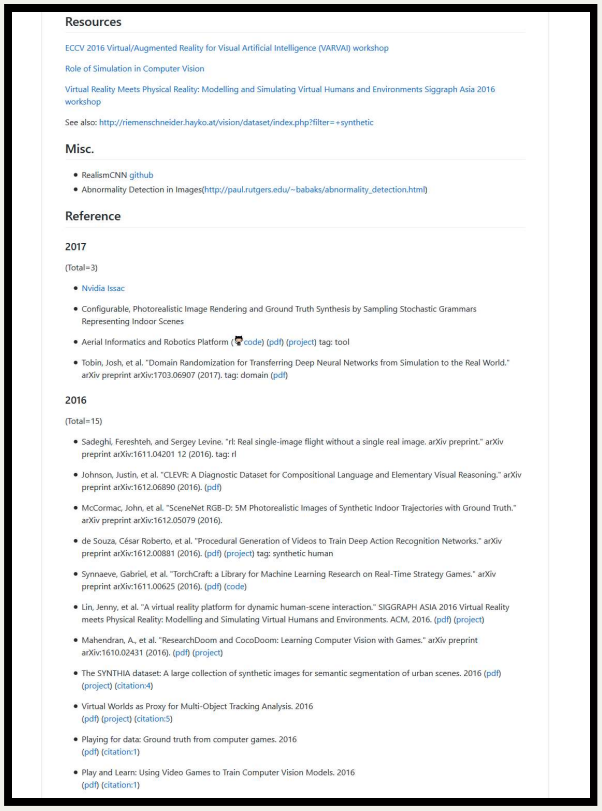
3D Model Repository

Realistic 3D models are critical for creating realistic and diverse virtual worlds. Here are research efforts for creating 3D model repositories.

- ShapeNet
- 3dscan
- seeing3Dchairs

Tools

- Render for CNN, based on Blender, see ICCV2015
- UETorch, based on UE4, see ICML2016
- UnrealCV, based on UE4, see ArXiv
- VizDoom, based on Doom, see ArXiv
- OpenAI Universe, see project page



Resources

ECCV 2016 Virtual/Augmented Reality for Visual Artificial Intelligence (VARVAI) workshop

Role of Simulation in Computer Vision

Virtual Reality Meets Physical Reality: Modelling and Simulating Virtual Humans and Environments Siggraph Asia 2016 workshop

See also: http://riemenschneider.hayko.at/vision/dataset/index.php?filter=+synthetic

Misc.

- RealismCNN github
- Abnormality Detection in Images(http://paul.rutgers.edu/~babaks/abnormality_detection.html)

Reference

2017

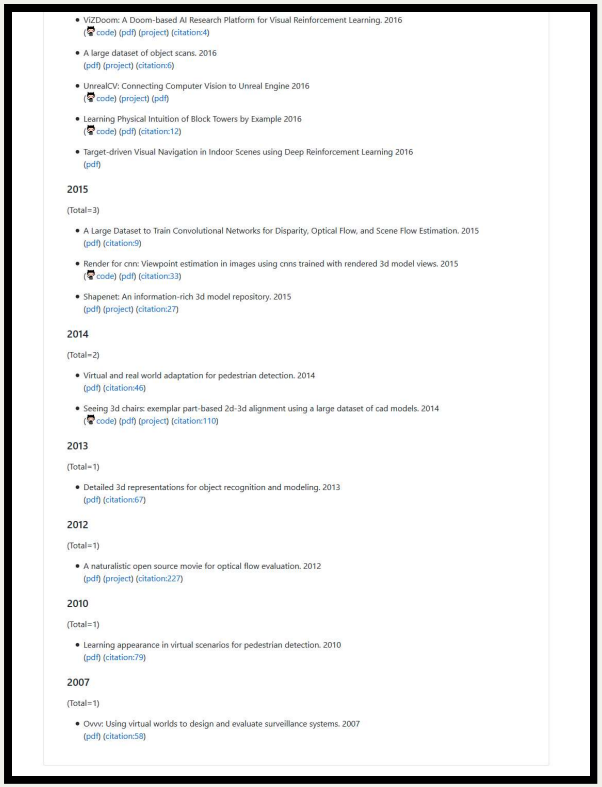
(Total=3)

- Nvidia Issac
- Configurable, Photorealistic Image Rendering and Ground Truth Synthesis by Sampling Stochastic Grammars Representing Indoor Scenes
- Aerial Informatics and Robotics Platform, (code) (pdf) (project) tag: tool
- Tobin, Josh, et al. "Domain Randomization for Transferring Deep Neural Networks from Simulation to the Real World." arXiv preprint arXiv:1703.06907 (2017). tag: domain (pdf)

2016

(Total=15)

- Sadeghi, Fereshteh, and Sergey Levine. "rl: Real single-image flight without a single real image. arXiv preprint." arXiv preprint arXiv:1611.04201 12 (2016). tag: rl
- Johnson, Justin, et al. "CLEVR: A Diagnostic Dataset for Compositional Language and Elementary Visual Reasoning." arXiv preprint arXiv:1612.06890 (2016). (pdf)
- McCormac, John, et al. "SceneNet RGB-D: 5M Photorealistic Images of Synthetic Indoor Trajectories with Ground Truth." arXiv preprint arXiv:1612.05079 (2016).
- de Souza, César Roberto, et al. "Procedural Generation of Videos to Train Deep Action Recognition Networks." arXiv preprint arXiv:1612.00881 (2016). (pdf) (project) tag: synthetic human
- Synnaeve, Gabriel, et al. "TorchCraft: a Library for Machine Learning Research on Real-Time Strategy Games." arXiv preprint arXiv:1611.00625 (2016). (pdf) (code)
- Lin, Jenny, et al. "A virtual reality platform for dynamic human-scene interaction." SIGGRAPH ASIA 2016 Virtual Reality meets Physical Reality: Modelling and Simulating Virtual Humans and Environments. ACM, 2016. (pdf) (project)
- Mahendran, A., et al. "ResearchDoom and CocoDoom: Learning Computer Vision with Games." arXiv preprint arXiv:1610.02431 (2016). (pdf) (project)
- The SYNTHIA dataset: A large collection of synthetic images for semantic segmentation of urban scenes. 2016 (pdf) (project) (citation:4)
- Virtual Worlds as Proxy for Multi-Object Tracking Analysis. 2016 (pdf) (project) (citation:5)
- Playing for data: Ground truth from computer games. 2016 (pdf) (citation:1)
- Play and Learn: Using Video Games to Train Computer Vision Models. 2016 (pdf) (citation:1)



- VizDoom: A Doom-based AI Research Platform for Visual Reinforcement Learning. 2016 (code) (pdf) (project) (citation:4)
- A large dataset of object scans. 2016 (pdf) (project) (citation:6)
- UnrealCV: Connecting Computer Vision to Unreal Engine 2016 (code) (project) (pdf)
- Learning Physical Intuition of Block Towers by Example 2016 (code) (pdf) (citation:12)
- Target-driven Visual Navigation in Indoor Scenes using Deep Reinforcement Learning 2016 (pdf)

2015

(Total=3)

- A Large Dataset to Train Convolutional Networks for Disparity, Optical Flow, and Scene Flow Estimation. 2015 (pdf) (citation:9)
- Render for cnn: Viewpoint estimation in images using cnns trained with rendered 3d model views. 2015 (code) (pdf) (citation:33)
- Shapenet: An information-rich 3d model repository. 2015 (pdf) (project) (citation:27)

2014

(Total=2)

- Virtual and real world adaptation for pedestrian detection. 2014 (pdf) (citation:46)
- Seeing 3d chairs: exemplar part-based 2d-3d alignment using a large dataset of cad models. 2014 (code) (pdf) (project) (citation:110)

2013

(Total=1)

- Detailed 3d representations for object recognition and modeling. 2013 (pdf) (citation:67)

2012

(Total=1)

- A naturalistic open source movie for optical flow evaluation. 2012 (pdf) (project) (citation:227)

2010

(Total=1)

- Learning appearance in virtual scenarios for pedestrian detection. 2010 (pdf) (citation:79)

2007

(Total=1)

- Ovvv: Using virtual worlds to design and evaluate surveillance systems. 2007 (pdf) (citation:58)

Outline

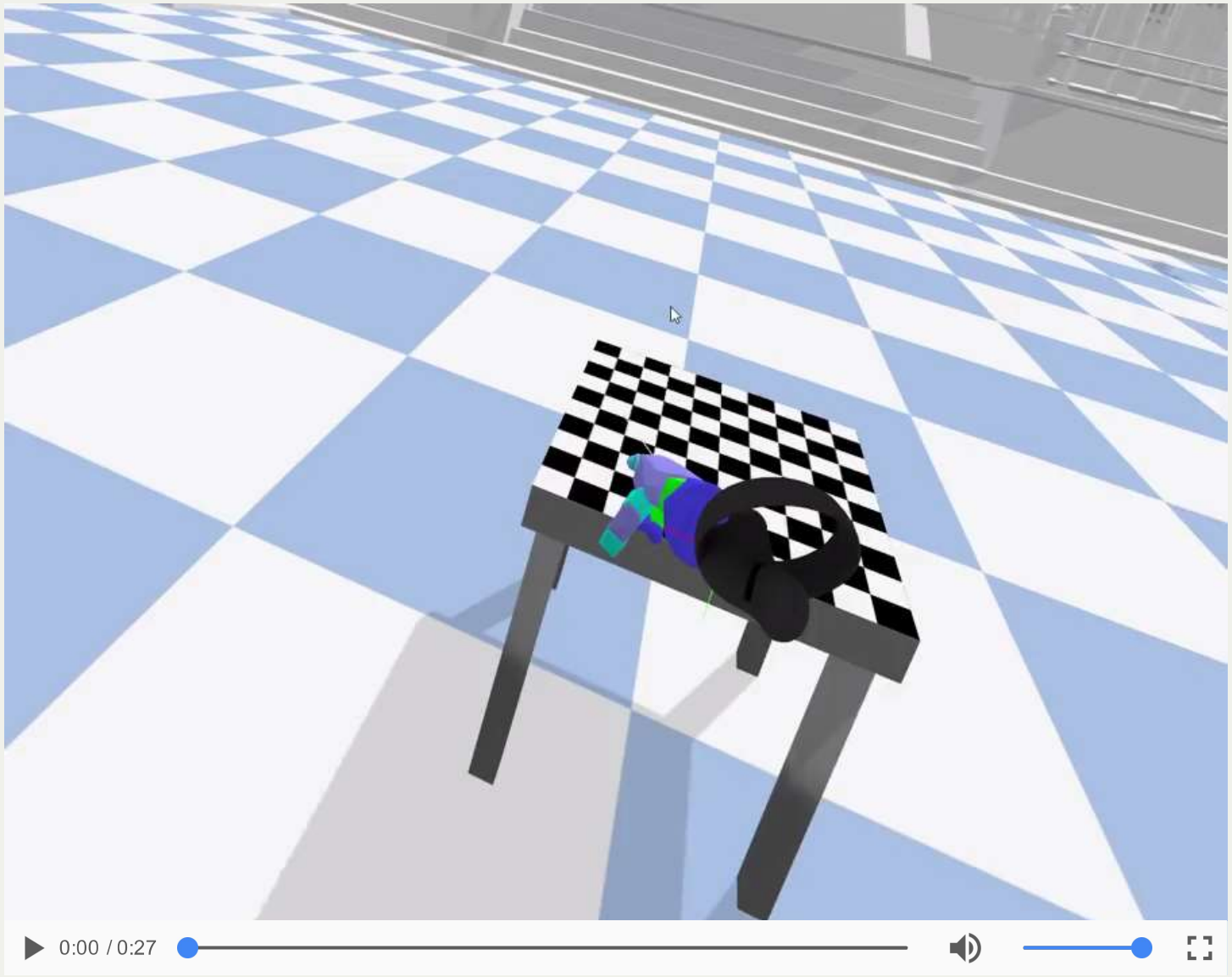
There are (at least) three main fields of synthetic systems:

- Physics Simulations, like Bullet, Havok, MuJoCo, ODE and PhysX, etc
- Game Engines, like Unity3D, Unreal, cocos2d-x, godot and so on
- Closed source games with (unofficial/community) API for developer, like GTA V

The first one can be part of the second one, and for synthetic computer vision, the second and third one can be more appealing and suitable since they provide abundant images in various scenarios, and what's more, they looks really real.

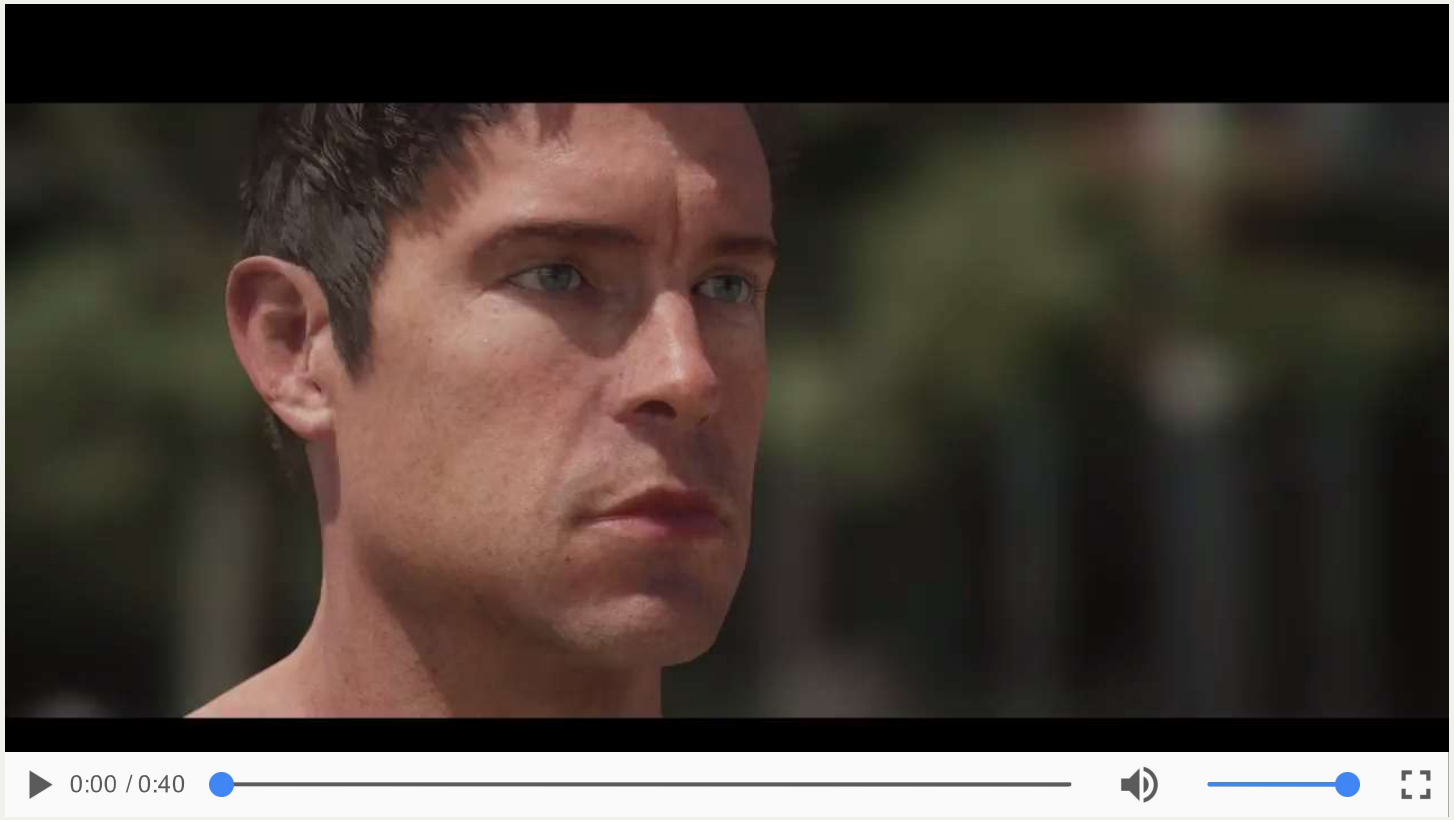
Some example images/videos from the field listed above

Example#1 Bullet



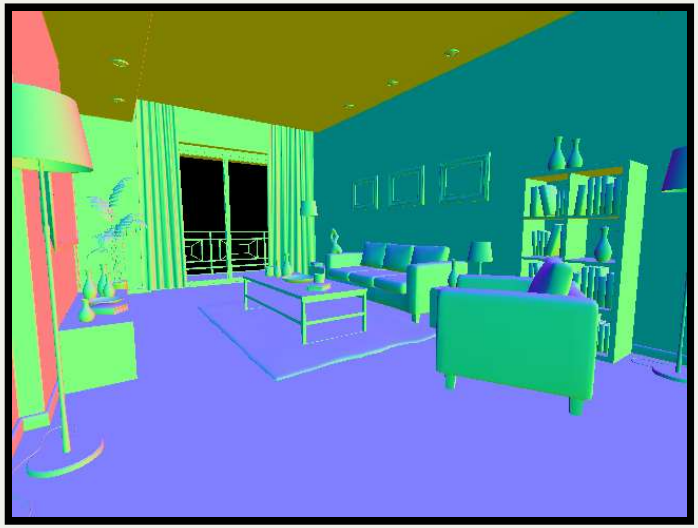
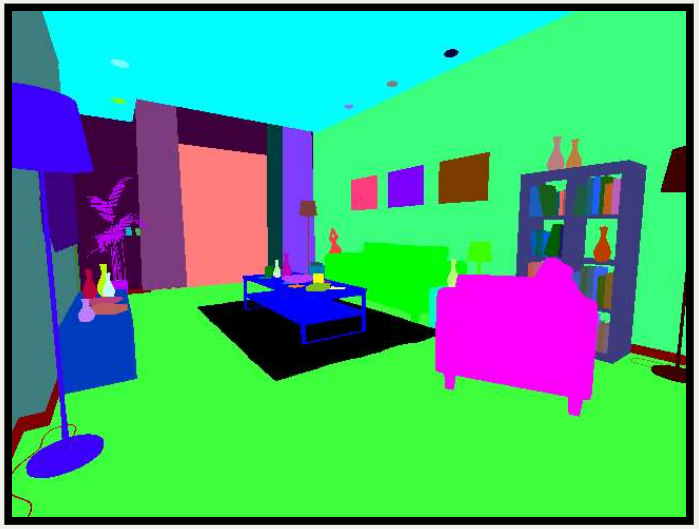
Bullet 2.86 VR haptics glove.

Example#2.1 Unreal 4

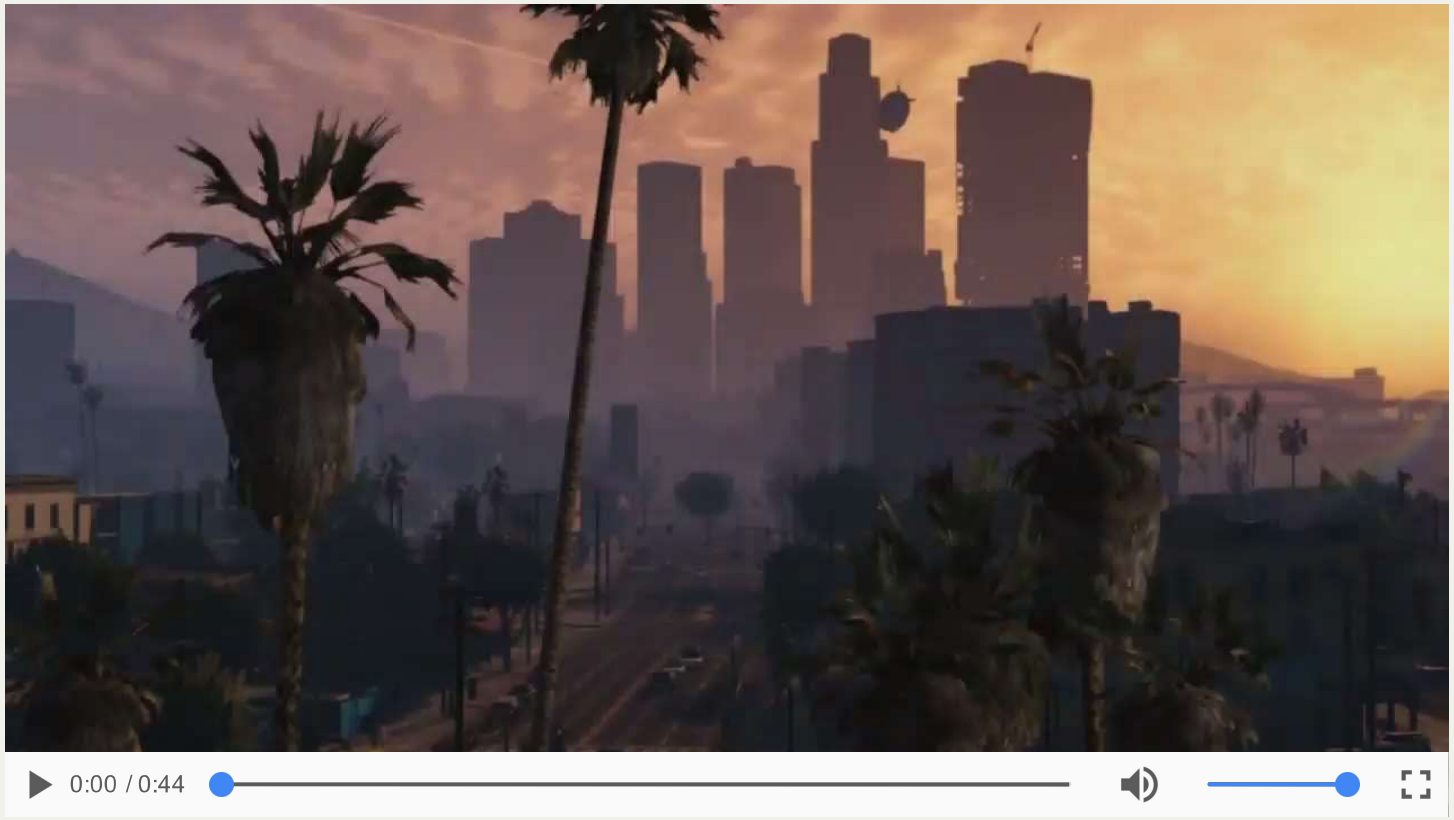


Photorealistic Character Sample

Example#2.2 Unreal 4 -- unrealcv


Example#3 GTA V



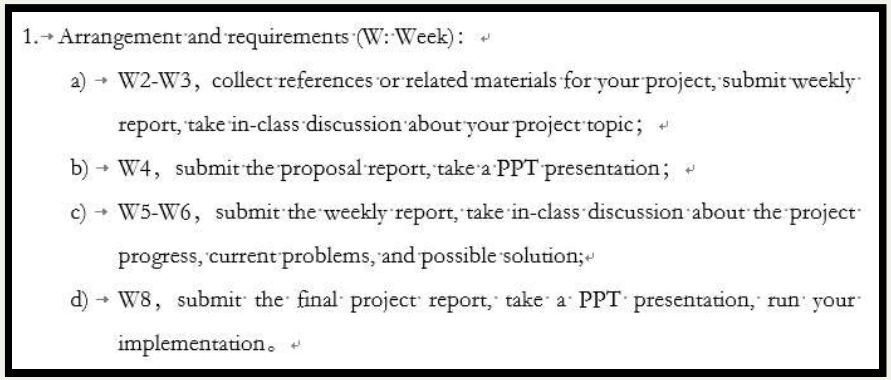
GTA V official trailer

Planed experiments

Papers/experiments I want to replicate or tools I want to try:

- * unrealcv: Connecting Computer Vision to Unreal Engine
- * Using Virtual Worlds, Specifically GTA5, to Learn Distance to Stop Signs
- * DeepGTAV: A plugin for GTAV that transforms it into a vision-based self-driving car research environment.
- AirSim: Open source simulator based on Unreal Engine for autonomous vehicles from Microsoft AI & Research
- * openai gym: A toolkit for developing and comparing reinforcement learning algorithms.
- openai universe: A software platform for measuring and training an AI's general intelligence across the world's supply of games, websites and other applications.
- * openai roboschool: Open-source software for robot simulation

Timeline



1. Arrangement and requirements (W: Week):
   a) W2-W3, collect references or related materials for your project, submit weekly report, take in-class discussion about your project topic;
   b) W4, submit the proposal report, take a PPT presentation;
   c) W5-W6, submit the weekly report, take in-class discussion about the project progress, current problems, and possible solution;
   d) W8, submit the final project report, take a PPT presentation, run your implementation。

To be more specific:

- Week 3: unrealcv
- Week 5: DeepGTAV
- Week 6: openai gym & openai roboschool
- Week 7-8: paper work

That's all, thank you

Good luck & have fun.

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