

# Gaussian Splatting: A Method for All

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## Abstract

*This project analyzes the use of Gaussian Splatting in two domains: internet marketplaces and home sales. Given the prevalence of users in these domains that are likely unaware of Gaussian Splatting, this project also combines several resources into an easy to use pipeline for non-technical users to create their own Gaussian Splats from videos taken on personal devices.*

## 1. Introduction

Recent advancements in Gaussian Splatting have led to exciting improvements in scene rendering. Of particular interest is the ability to reconstruct a 3D scene using a few images and Gaussian Splatting. Additionally, Gaussian Splatting can render scenes significantly faster than its counterpart, Neural Radiance Fields. As such, there is particular excitement in the field of robotics and video game design. In robotics, Gaussian Splatting can help create environments for robots to learn how to interact with the world. In video game design, Gaussian Splatting may be able to efficiently render high quality, realistic scenes.

Gaussian Splatting has the potential to have broader impact than just robotics and video game design as there are numerous ways in which the everyday consumer may be able to use Gaussian Splatting to improve aspects of life. In this project, I explore some of these domains where Gaussian Splatting may have a transformative affect on the everyday consumer. Specifically, I propose that this concept may be applicable to online sales (e.g. Facebook marketplace, eBay, etc.), where the seller can provide a 3D model of the item in addition to pictures. This would allow buyers to have a better visual representation of what they could buy. Additionally, Gaussian Splatting may be transformative in virtual tours (e.g. home buying, campus visits, national park tours, etc.). In addition to discussing these potential new domains, this paper provides a scaffold for everyday users to easily create their own Gaussian Splats with their own videos.

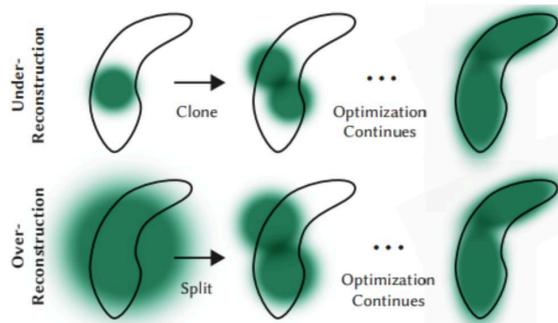


Figure 1. A visualization from [2] that shows the Gaussian blob update process.

## 2. Related Work

Gaussian Splatting was introduced in [2] as a fast way to create a 3D reconstruction of a scene. The key idea behind this method is to create and update 3D Gaussian blobs, or splats, where the density of the scene is non-zero. As the optimization process continues, these blobs morph into the shape of objects in the scene and their colors are adjusted so that the 3D scene is properly rendered. Figure 1 visualizes this process. If the object being reconstructed is “under-reconstructed” then more Gaussian blobs are added to the scene to fill out the object. On the other hand, objects that are “over-reconstructed” are split into smaller Gaussian blobs. In each case the mean and 3D covariance of the blob are adjusted so that the reconstruction loss is minimized.

Another influential work for this project is the recently published survey of the Gaussian Splatting field [1]. In this paper, Chen and Wang detail possible avenues for improvement and a vast number of potential use cases for Gaussian Splatting. Specifically, the authors describe that Gaussian Splatting might further be advanced by developments in memory and data efficiency. They also describe how Gaussian Splatting may be improved via other optimization techniques and 3D structured information. These are all thought-provoking, technical ideas that researchers should

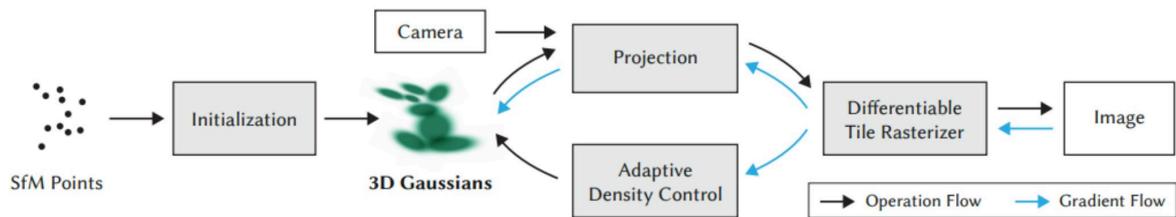


Figure 2. A visualization from [2] of the Gaussian Splatting model, which converts structure from motion (SfM) points into 3D scene renders.

explore in the future. Additionally, [1] notes new fields that Gaussian Splatting may be able to advance. For example, the authors describe how Gaussian Splatting can be used in autonomous driving and medical imaging. These ideas helped form the inspiration for this project to explore how Gaussian Splatting can be used in consumer domains like online sales and 3D home tours.

### 3. Approach

This project implements the model outlined in [2] and visualized in Figure 2. The model uses structure from motion points, camera information, and images to create a 3D reconstruction of the environment. Since one of the goals of this project is to create an easy process for non-technical users to take their videos and create Gaussian Splats, the following paragraphs describe in detail the approach to convert video into 3D Gaussian Splats.

Google Colab was used for this project because Colab is a free and easy to use location where everyday users can experiment with their own videos and code while having access to CPU and GPU runtime environments. For this reason, readers will notice an exclamation mark in the code, which indicates to Colab that we wish to run a shell command.

This project is built around the Gaussian Splatting code published on GitHub<sup>1</sup>. Unfortunately, the K-Nearest Neighbors (KNN) code implementation that [2]’s source code references no longer exists. As such, this project relied on another code base<sup>2</sup> that has a working KNN algorithm. This GitHub repository can be cloned in Google Colab.

Readers who wish to implement their own Gaussian Splats can follow the one-time setup process:

- Open a Colab document and connect your Google Drive account
- Clone GitHub repository by running:

```
1 !git clone --recursive https://github.com/camenduru/gaussian-splatting
```

<sup>1</sup><https://github.com/graphdeco-inria/gaussian-splatting>

<sup>2</sup><https://github.com/camenduru/gaussian-splatting>

Next, for every Gaussian Splat that a user wants to create, simply follow these steps:

1. Capture a video of the environment and upload it to Google Drive
2. Install and use the ffmpeg command to convert the video into images
3. Install COLMAP and run the convert.py file to convert the images into a structure from motion format that Gaussian Splatting expects
4. Install Gaussian Splatting submodules
5. Run the train.py file

The above bullet points are rewritten below, but in code:

```
1 !sudo apt install ffmpeg
2 !ffmpeg -i yourVideoTitle.MOV -qscale:v 1 -qmin 1 -vf fps=2 %04d.jpg
3 !sudo apt install colmap
4 !python convert.py -s data/yourVideoTitle/ --no-gpu
5 !pip install -q plyfile
6 !pip install -q ./submodules/diff-gaussian-rasterization
7 !pip install -q ./submodules/simple-knn
8 !mkdir ./output
9 !python ./train.py -s ./data/yourVideoTitle/ -m ./output/
```

The above code can be used in a Google Colab document. Also notice the conversion operation on line 4 specifically states not to use the GPU. This was a design choice in order to save compute time on Google’s T4 GPU for the training step in line 9. Users who are not concerned about running out of GPU time can remove this argument to convert images using the GPU. This change will likely result in faster runtime of the entire process.

In the output folder, the training process will include results after 7,000 and 30,000 iterations. At the completion of the training process, one can run this Google Colab file<sup>3</sup>,

<sup>3</sup>[https://colab.research.google.com/github/camenduru/gaussian-splatting-colab/blob/main/gaussian\\_splatting\\_viewer\\_colab.ipynb](https://colab.research.google.com/github/camenduru/gaussian-splatting-colab/blob/main/gaussian_splatting_viewer_colab.ipynb)

	Plant	Golf Clubs	Kitchen
Video Length	20 sec.	56 sec.	56 sec.
Number of Images	40	112	111
Convert Time	18 min.	1 hour 34 min.	1 hour 5 min.
Train Time	1 hour	1 hour 30 min.	1 hour 23 min.
Total Time	1 hour 18 min.	3 hours 4 min.	2 hours 28 min.

Figure 3. Quantitative analysis of three Gaussian Splats.

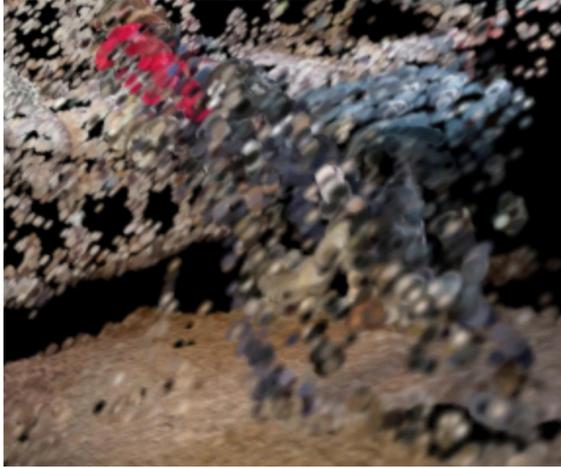


Figure 4. An early iteration of the golf club splat shows ellipsoid structure.

which creates a viewing environment in the web browser. To view the output of the generated splat, a user should download the 30,000 iteration file from Google Drive and then drag and drop that file into the web viewer. The web viewer will load the file and then the user is able to roam the 3D scene reconstruction!

#### 4. Data & Evaluation Metrics

Three unique scenes were used in this project. In the first scene, a short video of a house plant is used to confirm proper implementation of Gaussian Splatting. Next, a 360 degree view video of a set of golf clubs is used to create a Gaussian Splat. This splat will help determine the viability of using splats in online marketplaces. Finally, a video of an apartment kitchen is used. This Gaussian Splat will help determine if splats can be used for virtual home tours. In addition to the qualitative output of these results, this project also compares the runtime of these three splats in order to complete a quantitative assessment of usefulness for an everyday, non-technical user.



Figure 5. Screenshot of plant Gaussian Splat.

#### 5. Experiments & Analysis

Figure 3 shows the runtime results of the three scenes. One result that particularly stands out is the comparison between the golf club and kitchen scenes. Both scenes are 56 seconds long and the number of images in the scenes only differ by one, yet the golf club scene takes over half an hour longer than the kitchen scene. This result may be due to the fact that the golf club video is a 360 degree view of a single object. As such there are likely many more corresponding points between images. Overall, equal to or less than 3 hours seems like a reasonable amount of time for a user to wait to create their own 3D scene reconstructions for internet marketplace sales or 3D home tours.

Now, let's look at some visual results. First, Figure 4 is included in this paper to give an example of the Gaussian blob structure discussed in the Related Works section 2. Figure 4 clearly shows several ellipsoid objects that are



Figure 6. Screenshot of golf clubs Gaussian Splat.

starting to form the scene. The figure also shows dark areas where the model has decided there are no objects. This screenshot is a great “real world” visualization of the graphic in Figure 1.

Figure 5 is a screenshot of the Gaussian Splat plant scene. This video simply hovers over the plant and was used as a verification that the process described in the Approach section 3 was correct. The visual results of the plant scene are very promising. There is amazing detail and sharpness in the leaves of the plant. Even as I zoomed in on the leaves and root of the plant, which are aspects that were not captured directly on video, the Gaussian splat viewer showed some very good results.

Figure 6 is a screenshot of the Gaussian Splat golf club scene. The video is a 360 degree view of the golf clubs and one might use a video like this if selling the item on an online marketplace. The visual results of this scene were somewhat disappointing because the reconstruction was not completely life-like. Throughout the Gaussian Splat, there is a decent reconstruction of the golf bag; however, some artifacts remain. For example, Figure 6 has a blurry background and the golf club covers and heads do not seem as sharp as they do in real life. For this reason, Gaussian Splatting may not be completely ready for use on internet marketplaces.

Figure 7 is a screenshot of the Gaussian Splat kitchen scene. The video is a simple walk-through of a kitchen apartment. One might include such a video in a home listing. Like the golf club scene, the Gaussian Splat of the kitchen is a little disappointing as a lot of artifacts remain. Figure 7 shows many blurred areas in the kitchen. Specifi-

cally, straight lines along the cabinets start straight, but later become blurred. Additionally, there is a lot of blurring and deformations around the windows. For these reasons, home sellers are unlikely to include Gaussian Splats in their home listing.

Videos of these Gaussian Splats are linked in the Supplementary Material section 7.

One possible reason for the blurred splats in Figures 6 and 7 is that both videos experience a lot of sunlight coming through the windows. These rays of sun cause glare and reflections in the video, which likely made finding corresponding points difficult. Another possible reason for these results is that the scene might require more images or a longer training time. Future work could explore how changing these parameters affect the output of the Gaussian Splatting model.

## 6. Conclusion

This project found that Gaussian Splatting is not yet ready for use on internet marketplaces and home sale listings. The Gaussian Splatting process thrives with an ideal scene without glare or reflections, which is tough to find in real life settings. Despite this limitation, non-technical users can still create very decent 3D reconstructions of their own environment. This project was successful at combining several resources and outlining a process for non-technical users to create their own Gaussian Splats from video. Armed with a phone or tablet and Google Colab, users can create their own 3D reconstructions in just a few hours!

## 7. Supplementary Material

Video of plant Gaussian Splat: [here](#)

Video of golf club Gaussian Splat: [here](#)

Video of kitchen Gaussian Splat: [here](#)

Link to code used in this assignment: [here](#)

## References

- [1] Guikun Chen and Wenguan Wang. A survey on 3d gaussian splatting, 2024. 1, 2
- [2] Bernhard Kerbl, Georgios Kopanas, Thomas Leimkühler, and George Drettakis. 3d gaussian splatting for real-time radiance field rendering. *ACM Transactions on Graphics*, 42(4), July 2023. 1, 2



Figure 7. Screenshot of kitchen Gaussian Splat.