Dynamic Autostereograms - Powered by DALL-E

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Introduction

Autostereograms, or Magic Eye pictures, are optical illusions that reveal hidden 3D images when viewed with the right focus. In this project, I set out to create dynamic autostereograms by combining DALL-E, a text-to-image model by OpenAI, and MiDaS, a depth estimation model by PyTorch. Unlike traditional autostereograms that rely on fixed patterns, my goal was to generate a more personalized and interactive experience where both the 3D object (hidden image) and the repeating pattern are generated dynamically based on user input. I envisioned this as a fun activity to enjoy with friends or family, adding a playful and personal touch to creating optical illusions together.

Approach and Methodology

1. **Image Generation with DALL-E:**

   The first step in my process was to generate two key images using DALL-E based on user prompts:

   - Prompt 1: Describes the object or scene to be hidden in the autostereogram (e.g., "a side profile of an Elephant").
   - Prompt 2: Describes the repeating pattern that will form the background (e.g., "a seamless repeating pattern of bananas").

   DALL-E then generates two images:

   - Source Image: Represents the object/scene for the hidden 3D image.
   - Pattern Image: Used as the repeating texture to cover the image.

Fig 1: Source Image

Fig 2: Pattern Image

2. **Depth Map Generation with MiDas:**
   Once the source image is generated, I used MiDaS, a depth estimation model, to generate a depth map. The depth map assigns a relative depth value to each pixel in the image.
   - Light regions: Represent closer objects.
   - Dark regions: Represent farther objects.

   This depth map is crucial for adding the 3D illusion to the autostereogram. It gives each part of the source image its proper depth, ensuring the hidden 3D image will be visible when viewed properly.

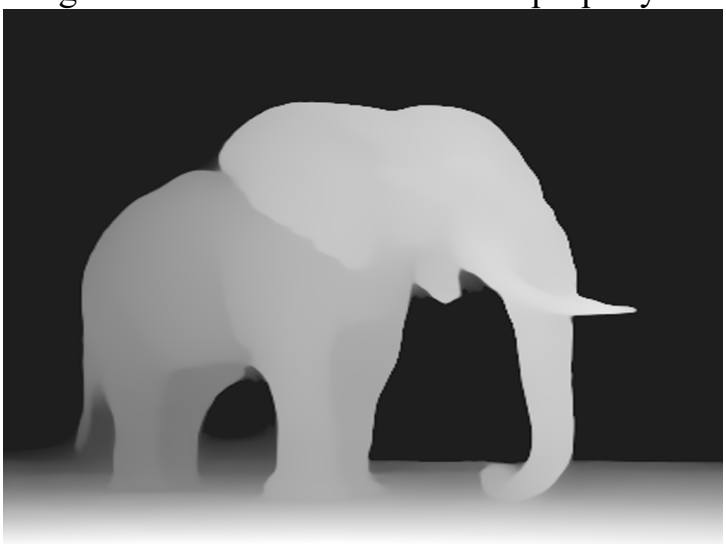

Fig 3: Depth Map of Source Image

3. **Pattern Reconstruction:**
   The next step involves reconstructing the pattern to align with the depth map. I ensured that the pattern image matches the depth map's size. This allows us to control the number of times the pattern repeats across the entire image. This step is essential to maintain the illusion of depth in the final autostereogram.
4. **Autostereogram Generation:**
   Finally, I combine the depth map and the pattern image. The horizontal displacement of the pattern is adjusted according to the depth values from the depth map:
   - Closer areas have a greater horizontal displacement.
   - Farther areas have a smaller displacement.

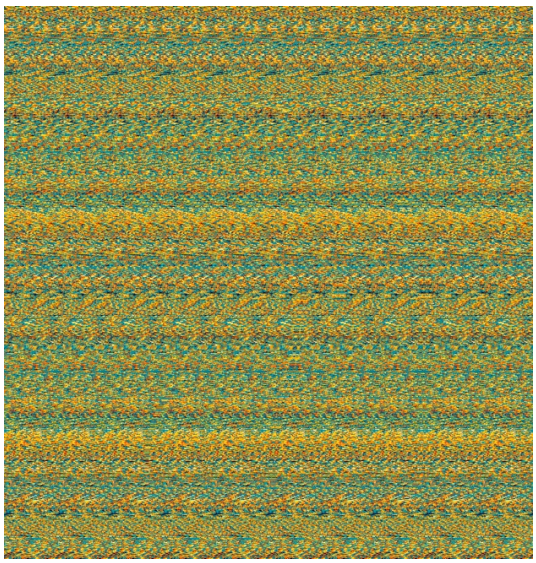

Fig 4: Final AutoStereogram

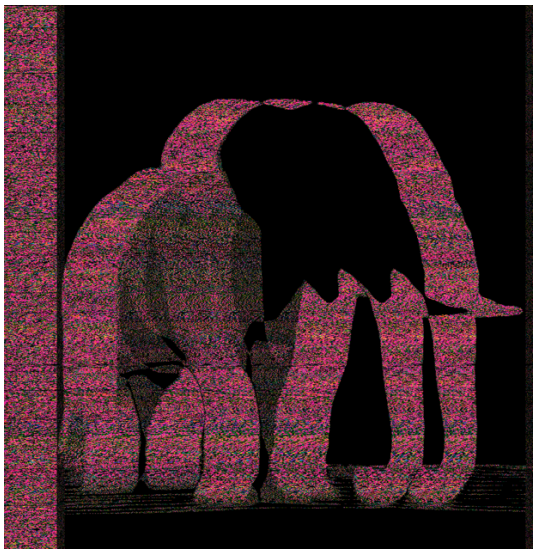

Fig 5: Hidden Source Image

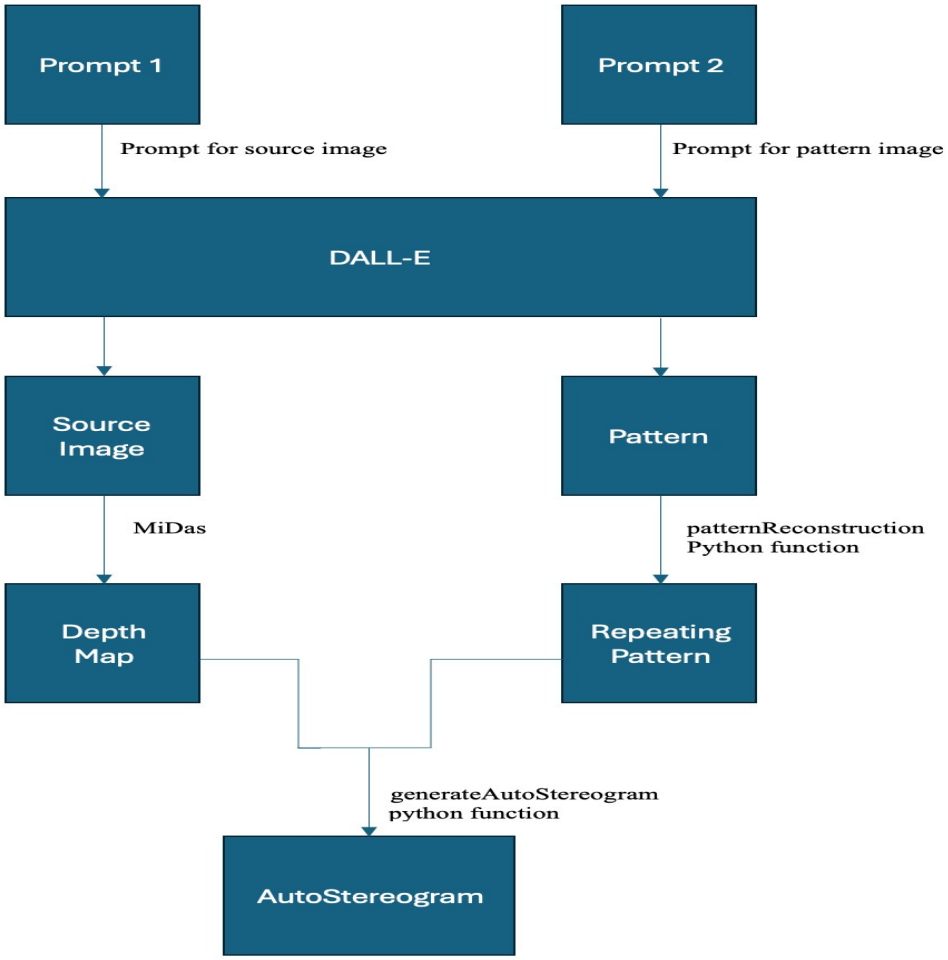

Fig 6: Flow Diagram

Results

The following image shows the User Interface where Users can enter prompts of their choice. Once the submit button is clicked, these prompts will be sent as a request to the OpenAI's DALL-E image generation API.

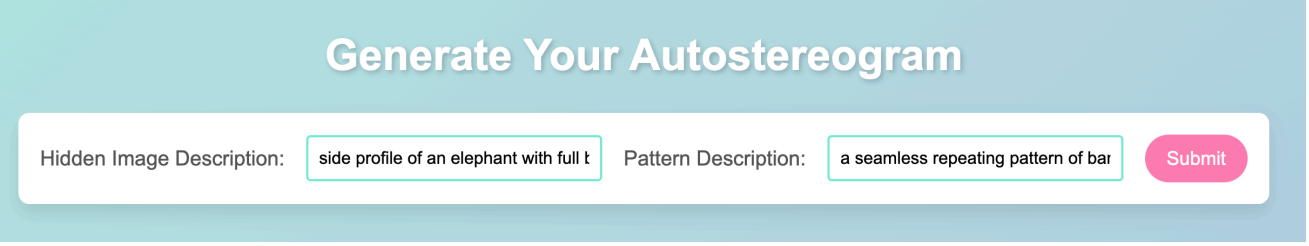

Fig 7: UI with fields to enter prompts

As a response, DALL-E sends images for each prompt. I use the "Source Image" to generate "Depth Map" and then use the Depth Map image and the Pattern image to generate the Autosteregram. The following image shows the User Interface displaying the generated Autostereogram.

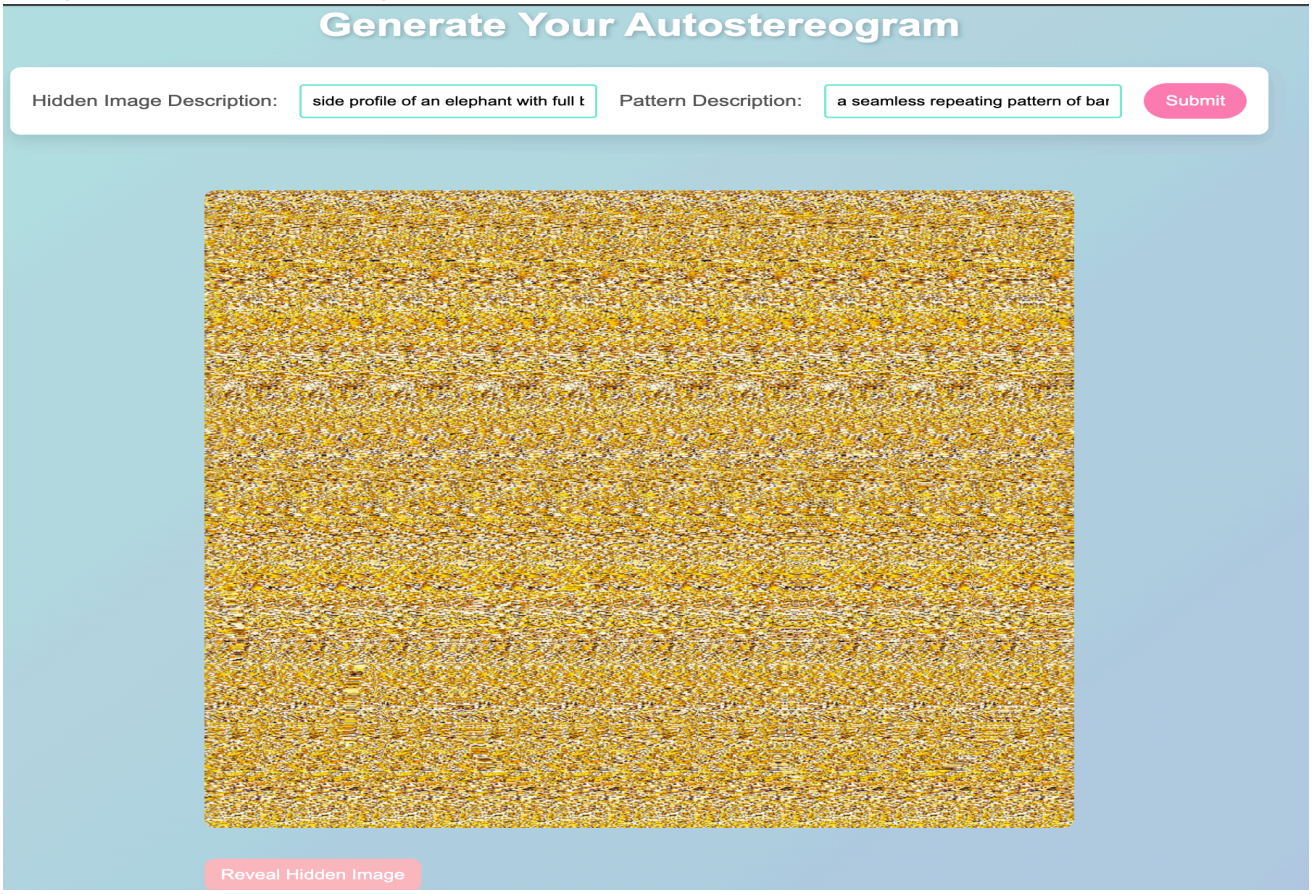

Fig 8: generated autostereogram

Users can verify their guess or discover the hidden image by clicking on the "Reveal Hidden Image" button.

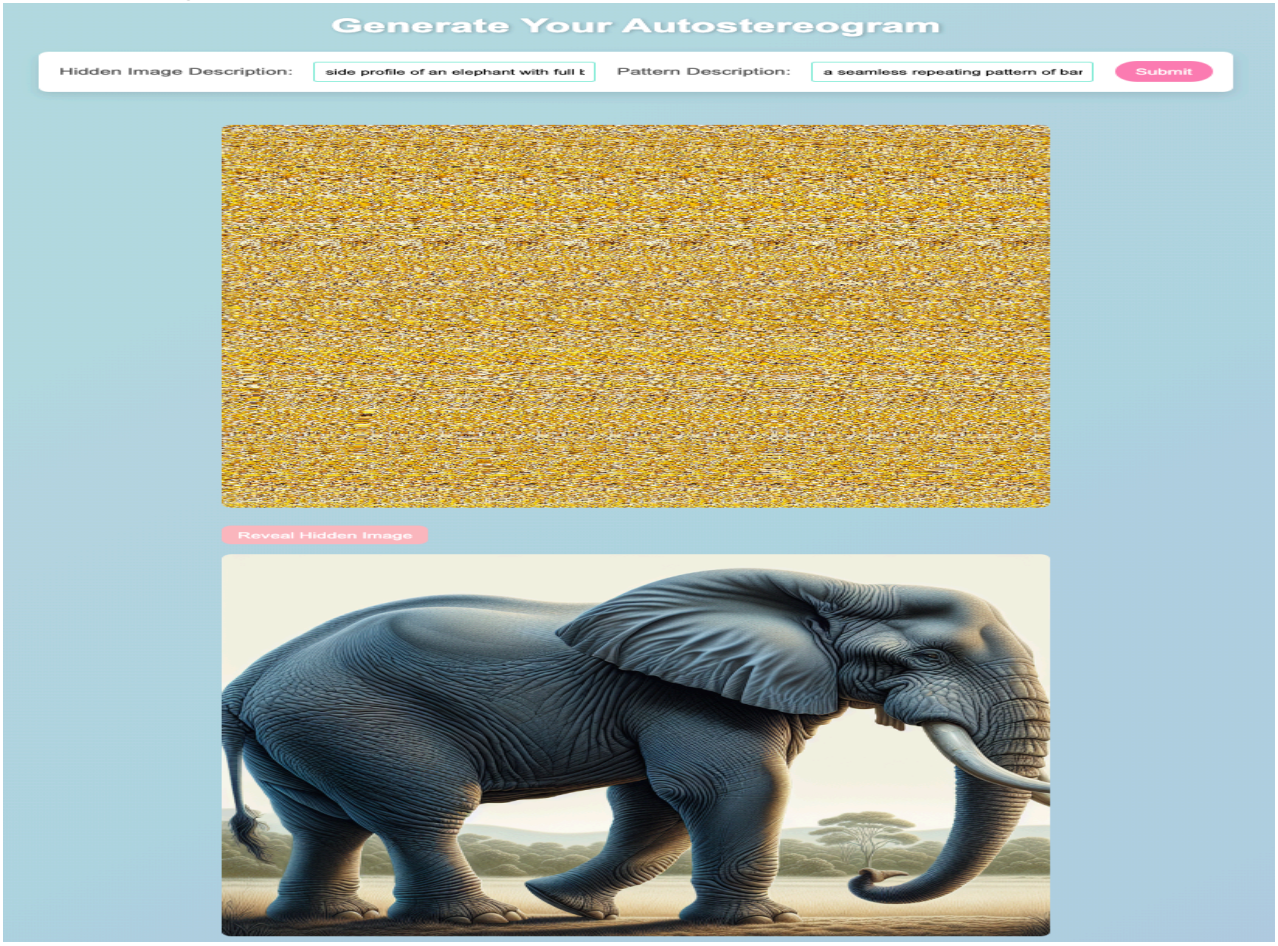

Fig 9: Output when user clicks on “Reveal Hidden Image”

Now Let’s create some more interesting Autostereogram’s and verify them using MagicEye Solver [1] website.

Let’s enter the following prompts in the UI and hit submit.
Hidden Image Description: Monkey.
Pattern Description: a seamless repeating pattern of coconuts.
DALL-E sent the following two images as response.

Fig 10: Source Image

Fig 11: Pattern Image

Fig 11: Depth Map

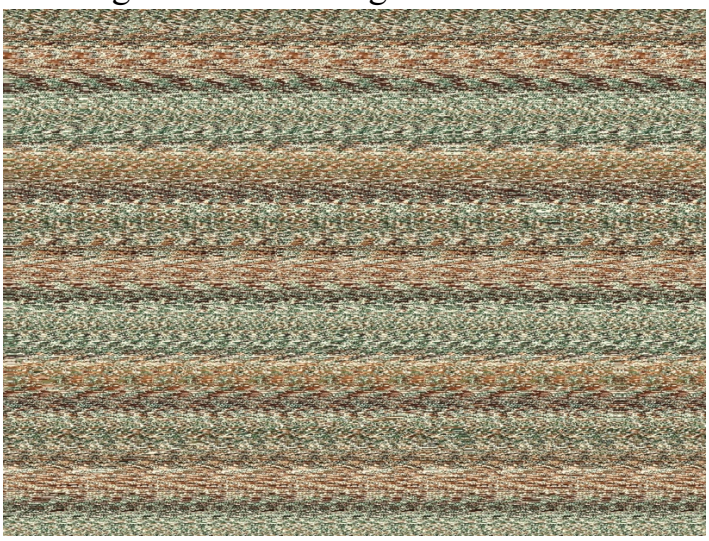

Fig 12: AutoStereogram

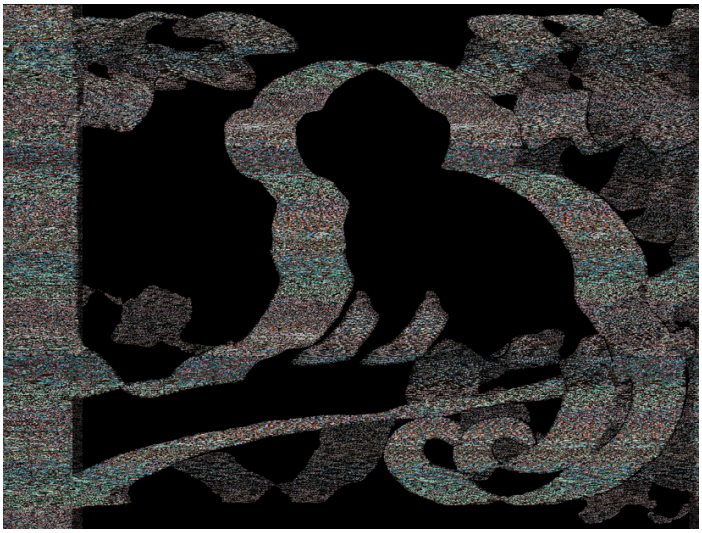

Fig 13: Output of MagicEye Solver showing the hidden image in the AutoSteregram.

Let’s hide a boat under Paddle’s
Hidden Image Description: Long empty wooden boat.
Pattern Description: a seamless repeating pattern of coconuts.
DALL-E sent the following two images as response.


Fig 14: Boat (Source) and Paddles (Pattern)

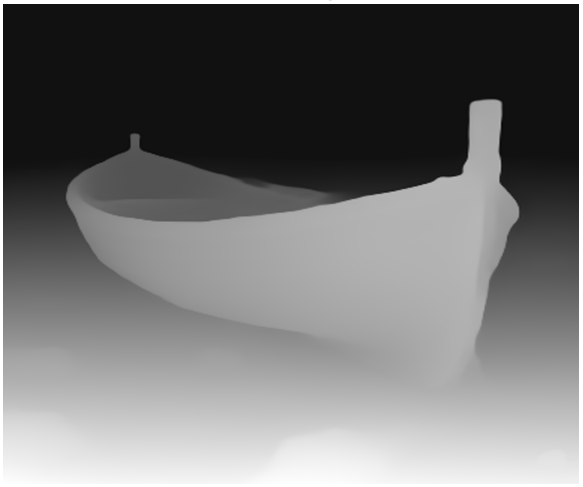


Fig 15: Depth map and the final Autosteregram

Fig 16: Output of MagicEye Solver showing the hidden image in the AutoSteregram

Now let’s hide a jacket under Ice.
Hidden Image Description: A nice winter jacket.
Pattern Description: a seamless repeating pattern of ice.
DALL-E sent the following two images as response.


Fig 17: Jacket (Source) and Ice (Pattern)


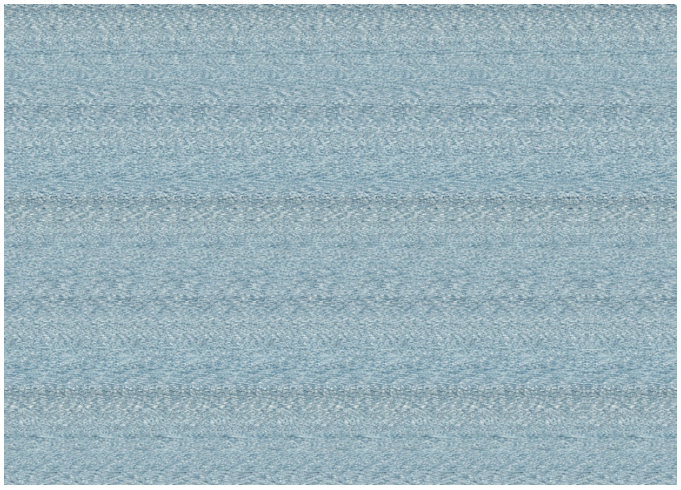

Fig 18: Depth map and the final Autosteregram

Fig 19: Output of MagicEye Solver showing the hidden image in the AutoSteregram

Future Work

- **Enhanced Depth Map Accuracy:** To further improve the quality of the hidden 3D images, I plan to experiment with other depth estimation models that might offer better accuracy for more intricate or complex images.
- **Mirroring Effect:** Currently, I'm encountering a mirroring effect in which parts of the hidden objects are repeated twice in the autostereogram. In the future, I plan to fine-tune the pattern tiling or explore advanced image processing techniques to reduce this mirroring effect, creating a more seamless viewing experience.
- **Interactive Web Interface:** A more interactive user interface could allow users to easily input prompts and view/download their autostereograms in real time.

Conclusion

This project demonstrated the powerful combination of DALL-E and MiDaS to create dynamic and customizable autostereograms. Through this approach, I was able to generate unique, engaging optical illusions based on user input. The project offers exciting possibilities for personalized art. Moving forward, I aim to refine the depth map generation and pattern alignment to further enhance the quality and versatility of the autostereograms.

References

[1]. https://magiceye.ecksdee.co.uk/#google_vignette
[2]. https://en.wikipedia.org/wiki/Autostereogram
[3]. https://ironicsans.substack.com/p/24-adventures-in-stereograms
[4]. https://pytorch.org/hub/intelisl_midas_v2/