



Generative AI-Enabled Disaster Scene Computing for Climate Risk-Informed Communication

- a case study of using ChatGPT for Tornado Disasters

ZhiQiang Chen, Ph.D.
Professor of Civil Engineering, Ph.D.
Division of Natural and Built
Environments (NBE)
UMKC | chenzhiq@umkc.edu

Kailynn Barnt, Undergraduate Student,
UMKC

Bandana Kar
Technology Policy Fellow @ U.S. DOE |
Energy Resilience, Decarbonization,
Science Policy, Geospatial Scientist and
Educator, Science Communicator
Email: bandana.kar@ee.doe.gov



Disclaimer:

- A GPT4 based customized ChatGPT hub is created for this work. <https://chat.openai.com/g-8RoKPe6Xr-disaster-risk-communication-through-generative-ai>
- The Hub was used to conduct this study, including customization, prompting, code generation, and scene generation.
- Several publicly available documents and a review based on a published journal paper are used to augment the contents of the Hub. No copyright protected materials were used.

Risk Communication of Urban Flood through Augmented Reality

Risk Communication using AR/XR and Challenges – *presented during CPASW 2023*

- AR/XR provides an immersive human-'machine' interfacing where physical environment, simulated scenes and analytics are integrated.
- However, the generation is human (expert) based and takes time to prepare.

Technology Highlights

- **Truly immersive** – physical scenes, virtual scenes of floods, and landmarks are frame-by-frame updated as a user walks.

- **QR code based public AR app access and scalable to any location**

Two AR modes:

- 2D flood hazard maps with dynamic display of water depth
- 3D parametric flood effects at designated flood frequencies.



What if we use Generative AI (GenAI) to generate risk contents in the real-time, as prompting in ChatGPT?



Outline

- ❖ Generative AI Technologies
- ❖ Disaster Risk Communication Hub
- ❖ Evaluation of General Tornado Knowledge
- ❖ Evaluation of Tornado Scene Machine Understanding
- ❖ Evaluation of Tornado Scene Machine Generation
- ❖ Implication of misinformation or disinformation-bearing generation
- ❖ Conclusions

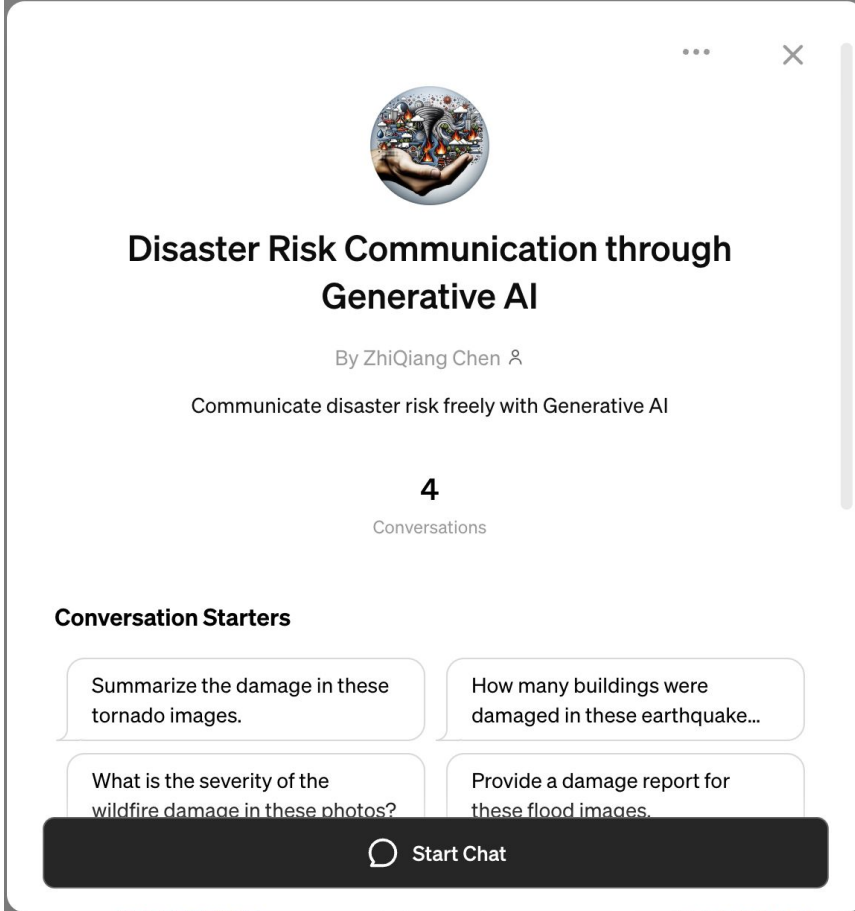


Generative AI: Foundational Learning Technologies

- Natural Language understanding and generation
 - Text generation, language translation, summarization, and answering (a few-shot / zero-shot learning); programming code generation
 - **Foundational Learning Models:** Transformer architecture; self-supervised pre-training; transfer learning; Human Reinforcement Learning; **prompting and in-context learning; RAG and fine-tuning**
- Natural Vision understanding and generation
 - Image/video understanding (e.g., zero-shot detection/segmentation); text to image (video) generation
 - **Foundational Learning Models:** Vision Transformers (ViTs); Generative Adversarial Networks; **Diffusion Models; Variational Diffusion Models; CLIP for language embedding**

Design the Hub

- ❖ *Disaster Risk Communication through Generative AI is tailored for first responders and the general public to inform risk arising from natural disasters that are further dependent on climate changes, hazards, exposures, post-disaster recovery, and socioeconomic measures from all dimensions.*
- ❖ <https://chat.openai.com/g/g-8RoKPe6Xr-disaster-risk-communication-through-generative-ai>



The screenshot shows a chat hub interface with a circular profile picture of a hand holding a globe with disaster icons. The title is 'Disaster Risk Communication through Generative AI' by ZhiQiang Chen. It indicates 4 conversations and lists four conversation starters: 'Summarize the damage in these tornado images.', 'How many buildings were damaged in these earthquake...', 'What is the severity of the wildfire damage in these photos?', and 'Provide a damage report for these flood images.' A 'Start Chat' button is at the bottom.

Disaster Risk Communication through Generative AI

By ZhiQiang Chen

Communicate disaster risk freely with Generative AI

4 Conversations

Conversation Starters

- Summarize the damage in these tornado images.
- How many buildings were damaged in these earthquake...
- What is the severity of the wildfire damage in these photos?
- Provide a damage report for these flood images.

Start Chat

Design the Hub

- Promoted first that the GPT 4 is 'aware of'
 - The Fifth National Climate Assessment
 - NOAA's **Enhanced Fujita Scale Report** through uploading the 'et-ttu.pdf' document
- Not aware of
 - A recent publication by by Gensini & Brooks (2018) "'[Spatial trends in United States tornado frequency](#)'".
 - An image database from the 2013 Moore Tornado

Updates pending ... Share Update

Preview

You
are you aware of the document titled et-ttu.pdf content?

Disaster Risk Communication through Generative AI
Yes, I have access to the document titled "et-ttu.pdf" which is a recommendation for an Enhanced Fujita Scale. The document contains information about the Fujita Scale, development, and proposals for the EF Scale, original Fujita Scale for rating tornado intensity indicators (DIs) and degrees of damage (DOD) proposed EF Scale wind speed ranges. Additionally, it includes a protocol for rating individual building structure damage for a tornado event. The document contains information about the Fujita Scale ratings of DODs by a NWS panel.

Message Disaster Risk Communication through Generative AI...

You
Do you access this journal paper ' Spatial trends in United States tornado frequency' authored by Gensini & Brooks 2018?

Disaster Risk Communication through Generative AI
I found several sources mentioning the journal paper "Spatial trends in United States tornado frequency" authored by Gensini & Brooks in 2018. However, accessing the full text directly requires visiting specific scientific repositories or journal websites. You can find detailed information and analyses on this topic through platforms such as ProQuest, ScienceOpen, and others, which discuss the findings and implications of the study regarding changes in tornado frequency across the United States.

Message Disaster Risk Communication through Generative AI...

Tornado Knowledge Prompting and Evaluation

We designed a set of five experiments to evaluate the LLM capacity

1. Tornado case history
2. Tornado and climate change
3. Tornado scale and damage
4. Tornado response and recovery
5. Specific contextual-adding prompting

| General Tornado Knowledge | Questions (parallel or sequential) | Answers | Rating |
|---|--|---------|--------|
| 1. Tornado case history | Are you aware of the Joplin Tornado, 2011? Give a general description about its scale, location, damage and loss, and recovery status? | | |
| | Are you aware of the Moore Tornado, 2013? Give a general description about its scale, location, damage and loss, and recovery status? | | |
| | Are you aware of the tornado outbreak sequence of May 2019? Give a general description about its scale, location, damage and loss, and recovery status for the tornado outbreak in Lawrence, Kansas? | | |
| 2. Tornado and Climate change | How climate change affect tornado hazards in the middle west (tornado valley), for example the general trend about its location, frequency, and intensity? | | |
| | Is there the latest literature that supports your argument above? | | |
| | Can we do regional climate modeling or downscaling to forecast tornado hazards? If yes, how could one do that? | | |
| | Can we use machine learning or generative AI to do downscaling to predict tornado hazards in the next year or next 50 years in a way similar to the regional/global temperature or sea rising prediction? | | |
| 3. Tornado scale and damage | Define the EF tornado scale. | | |
| | Given the Fujita scale and the enhanced Fujita scale, what is their relation? | | |
| | Elaborate how to assess the EF scale in the field or using field data in terms of damage indicators. | | |
| | At an EF0 to EF1 tornado, what typical damage would be observed? | | |
| | At an EF2-3 tornado, what typical damage would be observed? | | |
| | At an EF4-5 tornado, what typical damage would be observed? | | |
| | Are you aware of the degree of damage (DOT)– eight levels? If not, can I upload a document? | | |
| 4. Tornado response and recovery | Remember that given the three damage scales: level 1 for EF0 and 1; level 2 for EF2 and 3; and level 3 for EF4 and 5. I will use these levels and ask you to classify damage given an image. | | |
| | What tornado response measures are proven effective in terms of reducing human losses and mitigating property losses? | | |
| | What technologies are useful immediately before a tornado landing? | | |
| | What technologies and responses are useful during a tornado strike? | | |
| | What communities should do after a tornado disaster? | | |
| 5. Specific contextual-adding prompting | Are you aware of any federal funding for a tornado recovery? | | |
| | Before uploading the review of the 'Gensini & Brooks (2018)' paper. Comment that how tornado hazard changes (1) temporal changes in terms of annual frequencies, (2) spatial varying frequencies in different locations in the US; and (3) are these changes due to anthropogenic forcing? | | |
| | After uploading the review of the 'Gensini & Brooks (2018)' paper. Comment that how tornado hazard changes (1) temporal changes in terms of annual frequencies, (2) spatial varying frequencies in different locations in the US; and (3) are these changes due to anthropogenic forcing? | | |

Results

| General Tornado Knowledge | Questions (parallel or sequential) | Comment | Rating |
|--|---|--|--------|
| 1. Tornado case history | Are you aware of the Joplin Tornado, 2011? Give a general description about its scale, location, damage and loss, and recovery status? | Facts and description are correct. | 10 |
| | Are you aware of the Moore Tornado, 2013? Give a general description about its scale, location, damage and loss, and recovery status? | Facts and description are correct | 10 |
| | Are you aware of the tornado outbreak sequence of May 2019? Give a general description about its scale, location, damage and loss, and recovery status for the tornado outbreak in Lawrence, Kansas? | Facts and description are correct | 10 |
| 1a. Specific contextual-adding prompting | Specific prompts with and without uploading a closed-source report? (1) Can you summarize what technologies were used for the field reconnaissance? (2) When the UAS was used to create 3D Photogrammetric products, what are the resolutions? (3) What are the recommended damage assessment steps? | <ul style="list-style-type: none"> Uploaded a closed source report I coauthored. Excellent document information retrieval and summary capabilities | 10 |

| | | | |
|--|---|--|----|
| 2. Tornado and Climate change | How climate change affect tornado hazards in the middle west (tornado valley), for example the general trend about its location, frequency, and intensity? | Consistent with my knowledge. | 10 |
| | What are the sources or are there the latest literatures that support your argument above? | All citations are checked and correct. | 10 |
| 2a. Specific contextual-adding prompting | Uploading the review of the 'Gensini & Brooks (2018)' paper, (1) Comment that how tornado hazard changes Are the findings in this paper aligned with your previous answers? (2) Combining your previous knowledge and this paper, are these changes due to anthropogenic forcing? | Amazing textual and comparison capability given a newly uploaded document against its saved 'knowledge'? | 10 |

| 3. Tornado scale and damage | Define the EF tornado scale. | | 10 |
|-----------------------------|--|---|----|
| | Given the Fujita scale and the Enhanced Fujita scale, what is their relation? - Do you access the NOAA Enhanced Fujita Scale Report document? I recall there is a regression-based relation. - Uploaded above. now answer the last question about the statistical relation. | | 7 |
| | Elaborate how to assess the EF scale in the field or using field data in terms of damage indicators. | Correct description | 10 |
| | At an EF0 to EF1 tornado, what typical damage would be observed? | Correct description | 10 |
| | At an EF2-3 tornado, what typical damage would be observed? | Correct description | 10 |
| | At an EF4-5 tornado, what typical damage would be observed? | Correct description | 10 |
| | Remember the categorization above, and I will define my own degree of damage (DoD) levels : level 1 for EF0 and 1; level 2 for EF2 and 3; and level 3 for EV4 and 5. I will use these levels and ask you to classify damage given an image. Can you keep this definition in context? | It promised to keep the customized context! | 10 |

| 4. Tornado response and recovery | What technologies and other social/economic measures are useful for preparing before a tornado landing? | Complete answer. | 10 |
|----------------------------------|--|------------------|----|
| | What technologies and other social/economic measures are useful for responding during a tornado strike? | Complete answer. | 10 |
| | What communities should do after a tornado disaster for achieving rapid recovery and in the long term tornado resilience for future tornadoes? | Complete answer. | 10 |
| | Are you aware of any federal funding for a tornado recovery? | Complete answer. | 10 |

| 5. Advanced simulation questions | Can we do regional climate modeling or downscaling to forecast tornado hazards? | Consistent with my knowledge | 10 |
|----------------------------------|---|--|----|
| | Are you aware of some recent large AI models for weather forecast? | Great summary yet knowledge up to 2023 | 10 |
| | Can we use these AI models to predict tornado hazards in the next year or nest 50 years in a way similar to the regional/global temperature or sea rising prediction? | Reach the cap limit!!! | 10 |



Remarks

1. Excellent general knowledge about tornados: Hazard, disaster response, technology and socioeconomical measures, climate change and attribution, and latest advance in simulation.
2. Excellent document comparison and summary when providing ‘new’ documents
 - A disaster recon report, when uploaded, it can quick summary and information retrieval [1].
 - For specific knowledge (e.g., statistical relation between the F-scale and the EF-scale), a few prompts with uploading a document are necessary.
3. Comprehensive knowledge about latest advances in large AI models for weather and climate simulation yet up to 2023.
4. The hub can keep context in one session, including what I asked to define a new of DoD levels.



Recognized Challenge and Solution

- When a large volume of non-open data (documents and multi-media) data need to be uploaded and analyzed, using the customized GPT Hub is practically difficult.
- Advanced fine-tuning and RAG techniques may be used using opensource Large Language Models (LLMs) and Large Multi-modality Models (LMMs).



Tornado Scene: Machine Understanding

- Disaster scene understanding using images (social networks, professional recon, and other crowdsourcing means) is a significant approach for disaster risk understanding and for rapid disaster severity/loss estimation/mapping.
- Our previous work using a deep learning technique proved that machine can understand multi-hazard disasters and infer damage levels [2, 3].
 - Can the GPT4-based 'Hub' realize this?

² Tang, S., & Chen, Z. (2021). Understanding natural disaster scenes from mobile images using deep learning. *Applied Sciences*, 11(9), 3952.

³ Klerings, A., Tang, S., & Chen, Z. (2019, November). Structuralizing Disaster-scene Data through Auto-captioning. In *Proceedings of the 2nd ACM SIGSPATIAL International Workshop on Advances on Resilient and Intelligent Cities* (pp. 29-32).



Dataset – Moore Tornado, 2013 Ground Recon Data

- 441 ground recon images; and all images were lost in the Internet [4]. Therefore, the 'Hub' would do 'zero-shot' learning.
- We prompted that for each input image, it should output
 - **Image to text:** General description in long text, including apparent tornado-indicator objects (buildings, vehicles, trees) **Image to text:** A short description as a caption.
 - **Detection and classification:** Count the number of buildings in the image
 - **Detection and classification :**
 - Damage rating using newly defined DoD levels (3: complete; 2: substantial/major; 1 light/intact)
 - We have visual ground truth!

⁴ Graettinger, A., Ramseyer, C., Freyne, S., Prevatt, D., Myers, L., Dao, T., ... & Alfano, C. (2014). Tornado damage assessment in the aftermath of the May 20th 2013 Moore Oklahoma tornado.

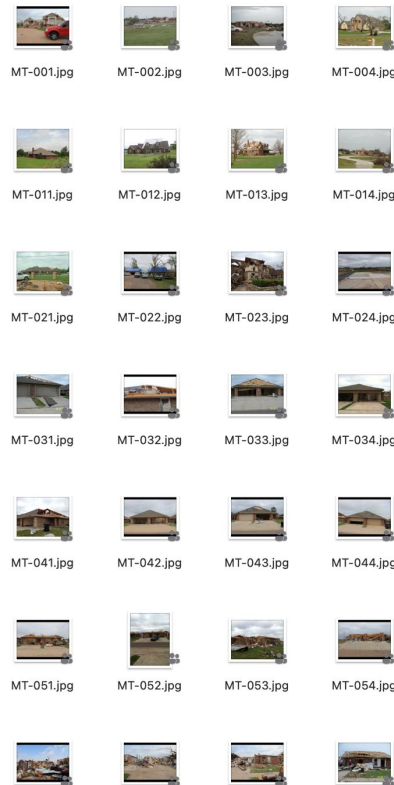
Dataset

| | A | B | C | D | E |
|----|----|--|------------|---|--|
| 1 | No | s (not others will be 'commende 3, substantial | | | Description (less than five descriptive words; not necessary a |
| 2 | 1 | http:// | Residence | 4 | back half demolished, roof collapsed |
| 3 | 2 | http:// | Residence | 2 | surrounding debris but little structural damage |
| 4 | 3 | http:// | Residence | 4 | frame partially remains |
| 5 | 4 | http:// | Residence | 1 | minimal portion of brick, roof and windows affected |
| 6 | 5 | http:// | Residence | 2 | central portion and garage destroyed |
| 7 | 6 | http:// | Residence | 1 | roof tiling destroyed |
| 8 | 7 | http:// | Residence | 2 | minimal damage to roof and side |
| 9 | 8 | http:// | Residence | 1 | negligible roof damage |
| 10 | 9 | http:// | Residence | 1 | negligible roof damage |
| 11 | 10 | http:// | Residence | 1 | negligible roof damage |
| 12 | 11 | http:// | Residence | 1 | negligible roof damage |
| 13 | 12 | http:// | Residence | 1 | negligible roof damage |
| 14 | 13 | http:// | Residence | 3 | intermediate roof damage and broken windows |
| 15 | 14 | http:// | Residence | 2 | frame intact, various surrounding debris |
| 16 | 15 | http:// | Residence | 2 | partial collapse, substantial debris |
| 17 | 16 | http:// | Residence | 2 | frame standing, roof obliterated |
| 18 | 17 | http:// | Residence | 1 | negligible roof damage |
| 19 | 18 | http:// | Residence | 1 | negligible roof damage |
| 20 | 19 | http:// | Residence | 1 | negligible roof damage |
| 21 | 20 | http:// | Residence | 1 | negligible debris and roof damage |
| 22 | 21 | http:// | Residence | 1 | negligible roof damage and tree collapse |
| 23 | 22 | http:// | Residence | 1 | Negligible roof damage |
| 24 | 23 | http:// | Residence | 2 | considerable damage to upper back floor |
| 25 | 24 | http:// | Commercial | 4 | leveled |
| 26 | 25 | http:// | Building | 1 | barn with stripped roof |
| 27 | 26 | http:// | Building | 2 | bark with front damaged |
| 28 | 27 | http:// | Residence | 1 | brick column knocked over |
| 29 | 28 | http:// | Residence | 1 | damaged garage doors and roofing shingles |
| 30 | 29 | http:// | Residence | 2 | damaged roof baffle |
| 31 | 30 | http:// | Residence | 2 | collapsed roof beams |
| 32 | 31 | http:// | Residence | 2 | damaged roof baffle |
| 33 | 32 | http:// | Residence | 2 | damaged roof baffle |
| 34 | 33 | http:// | Residence | 1 | roof tiling partially stripped |
| 35 | 34 | http:// | Residence | 1 | negligible roof damage |
| 36 | 35 | http:// | Residence | 1 | roof baffling partially stripped |
| 37 | 36 | http:// | Residence | 2 | roof tiling partially stripped |
| 38 | 37 | http:// | Residence | 1 | negligible roof damage |
| 39 | 38 | http:// | Residence | 1 | negligible roof and garage door damage |
| 40 | 39 | http:// | Residence | 1 | collapsed tree |
| 41 | 40 | http:// | Residence | 1 | negligible roof damage |
| 42 | 41 | http:// | Residence | 2 | roof baffle partially destroyed |
| 43 | 42 | http:// | Residence | 1 | garage doors destroyed |
| 44 | 43 | http:// | Residence | 1 | negligible roof damage |
| 45 | 44 | http:// | Residence | 1 | negligible roof damage |
| 46 | 45 | http:// | Residence | 1 | negligible roof damage and debris |
| 47 | 46 | http:// | Residence | 2 | collaoosed roof |

-016



MT-398



Steps:

1. Recall the DoD levels
2. Prompt image by image – and request for output into a CSV file for each image including attributes:

- Long description
- Short description as a caption
- # of buildings
- DoD classification

ZQ

You

Do you still remember the three DoD levels I designed above?



Disaster Risk Communication through Generative AI

Yes, I remember the three Degrees of Damage (DoD) levels you designed:

- **DoD Level 1:** For damage typically associated with EF0 and EF1 tornadoes, which includes minor to moderate damage.
- **DoD Level 2:** For damage typically seen with EF2 and EF3 tornadoes, which involves considerable to severe damage.
- **DoD Level 3:** For the most severe damage caused by EF4 and EF5 tornadoes, which includes devastating to incredible damage.

You mentioned that you would use these levels to ask me to classify damage given an image.

Please go ahead with the image, and I will classify the damage according to these levels.



ZQ

You

Great. I will upload many disaster scene image; one by one. For each image, please provide : (1) a long description about the scene, describing major tornado scale damage indicator (DI) objects; (2) a short description as a caption; (3) number of buildings in the image; and (4) classification of damage using the DoD level above. Can you do this? also can you save them into a CSV file hence I can download (or you can go back same all of them into one CSV file given many images I will upload one by one)?



Disaster Risk Communication through Generative AI

Certainly, I can provide the descriptions and classifications as you've requested. Once you've uploaded the images, I will analyze each one and compile the information into a CSV file for download. Please start by uploading the first image.



Sample Results



- **Long Description:** The image shows a single-story residential brick house with a multi-pitched roof and a prominent chimney. The structure of the house appears intact with no evident structural damage. The surrounding lawn is well-kept but features a few small fallen branches, which could indicate minor wind damage. There is no discernible damage to the windows, doors, or the main structure of the house.
- **Short Description:** Well-maintained brick house with minimal debris on the lawn, indicating minor wind damage.
- **Number of Buildings in the Image:** 1
- **Classification of Damage (DoD Level):** 1 (minor to moderate damage)



- **Long Description:** The image depicts a residential neighborhood after a tornado event. In the foreground, there is an unharmed red pickup truck on the left. The focus of the image is a house that has sustained severe damage: the roof is largely missing, with only the trusses partially intact; walls have collapsed or are severely damaged, with debris scattered around; bricks and construction materials are strewn across the scene. Remarkably, there's spray paint on one of the remaining walls of the house that reads 'ALL OK', indicating a safety check or that no one was harmed in this specific residence.
- **Short Description:** Severely damaged house with roof and walls collapsed post-tornado, next to an untouched red truck, marked with 'ALL OK'.
- **Number of Buildings in the Image:** 1 (visible damaged house)
- **Classification of Damage (DoD Level):** 2 (considerable to severe damage)



Remarks

- Excellent tornado understanding in general
 - Superb image-to-text capabilities
 - Read perfectly text in images
 - Superb detection and counting accuracy in identifying building structures.
 - Good accuracy in damage classification (90% overall accuracy with human interpretation)
- The overall performance meets the general tornado disaster scene understanding needs for the public.
- Supports only image-by-image input, and the output to CVS can be interrupted.
 - GPT APIs may overcome this and provides a batch mode – hence a collective tool for disaster scene understanding (description and damage classification), eventually **GIS based damage mapping**.

Tornado Scene: Machine Generation

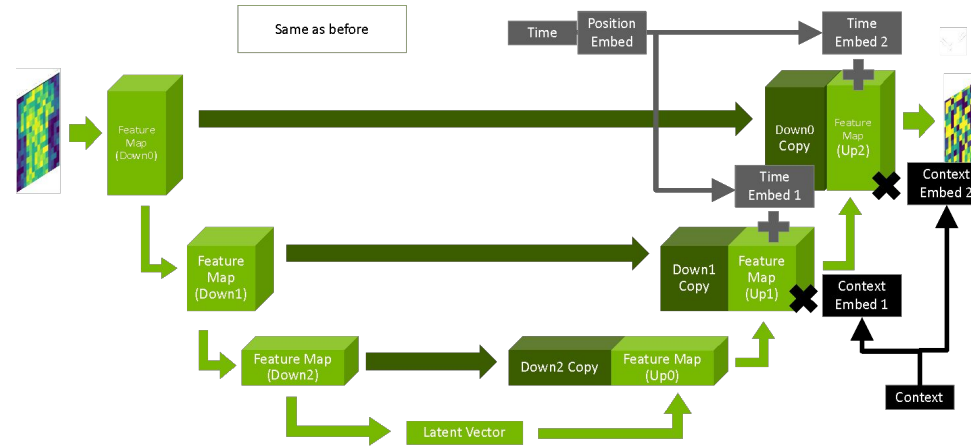
- Image generation is the most difficult generative AI task to this end;
 - Spatial reasoning and embedding are extremely hard to encode in the image generation process.
 - SORA represents the most ADVANCED GenAI capability
- From this 'golden-rush' SORA generated video
 - **Generative AI can generate built-environment scene in terms of all photorealistic criteria?**
 - How about the tornado mechanics?
 - **How about the spatial-temporal mechanics criteria?**



Prompt: Historical footage of California during the gold rush.
<https://openai.com/sora?video=gold-rush>

No one accesses SORA yet.

- The solution is to use DALL.E2 (DALL.E3 is ready; but not available in ChatGPT 4)
- The solution is to manually create *chronologically* sequenced disaster landing and striking scenes.
 - This is a 'mock-up' of the **underlying time-embedding** in the reverse diffusion process.



Courtesy of NVIDIA DL Diffusion Workshop

P1. Generate a photorealistic scene showing a tornado approaching a rural town.



P2. Continue the scene above and generate a scene that the tornado touches down the ground in the town.



P3. Continue the scene above and generate a closer scene that the tornado **destroys the roof** of a house.



P4. Continue the scene above and generate a closer scene that the tornado damages an adjacent structure with a different pattern.



P5. Continue the scene above and generate a closer scene that the tornado damages an adjacent structure with another different pattern.



P6. Continue the scene above and generate a closer scene that the tornado damages an adjacent structure with another different pattern.



P7. Continue the scene above and generate a closer scene that the tornado damages an adjacent structure with another different pattern. Show the path based on the last generation.



P8. Continue the scene above and generate a closer scene that the tornado damages an adjacent structure with another different pattern. Show the path based on the last generation.



Pg. Continue the scene above and generate a **bird view scene** that the tornado damages an adjacent structure with another different pattern. **Show the path based on the last generation.**



P10. Continue the scene above and generate a closer scene again that the tornado damages **an adjacent school building with another different damage pattern.**



P11. Continue the scene above and generate a closer scene that the tornado damages an adjacent residential building with a parking garage with another different pattern.



P12. Continue the scene above, which shows an adjacent **community**, and generate a closer scene that the tornado damages the community **with various patterns**.



P13. Now generate that the tornado **starts decaying and leaves the rural town.**



P14. The final (test), generate an airborne remote sensing like view showing the all the damaged structures (buildings) in all the previous prompts, illustrating the tornado path through this town.





Questioning GPT

- **Are the buildings with their individual damage patterns all included in the remote sensing image above?**
- *The remote sensing-like image aims to encapsulate the overall path of destruction through the town, highlighting the various damaged structures along the tornado's trajectory. Given the scale and perspective of an aerial view, the image provides a comprehensive overview rather than detailed depictions of individual damage patterns to specific buildings. The focus is on illustrating the tornado's path and the extent of the area affected.*

- **Can you summarize all the contexts I provided that are used as embeddings in the generations?**
- *Throughout the sequence of image generations, the contexts provided progressively depicted the approach, impact, and aftermath of a tornado striking a rural town. The narrative began with the tornado's approach toward the town, followed by scenes of it touching down and causing destruction to various structures, including houses, a school, and a community center, each with unique damage patterns. The story continued with the tornado damaging a residential building with a parking garage, followed by wider community damage showcasing various patterns. The narrative then transitioned to the tornado beginning to decay and leave the town, and concluded with an airborne, remote-sensing-like view of the aftermath, showcasing the tornado's path through the town. This progression effectively illustrates the evolving situation, from imminent threat through to the aftermath and the scale of the impact on the community.*



To this end

- Our generations are curiosity-driven, in a form of scientific query, and bears no malign intension.
- What if my contexts / narratives as 'embeddings' are *scientifically biased or even worse, contains intentional 'agenda'?*

You
I go back with a different thought and check if you comply with some sort of 'standard' intrinsically (from your training).

Disaster Risk Communication through Generative AI

Certainly! While I can provide information and perform tasks based on a broad range of knowledge, my responses are guided by principles set during my training, which include:

- **Ethical Guidelines:** Ensuring the information provided respects privacy, copyright laws, and promotes safe and respectful interaction.
- **Accuracy:** Striving for factual accuracy based on the data available up to my last training update.
- **Neutrality:** Offering neutral and unbiased information to the best of my ability.
- **User Privacy:** Not storing personal user data or using it for future reference in conversations.
- **Adherence to Policies:** Following specific guidelines and policies, including content moderation standards, to prevent the dissemination of harmful or inappropriate content.



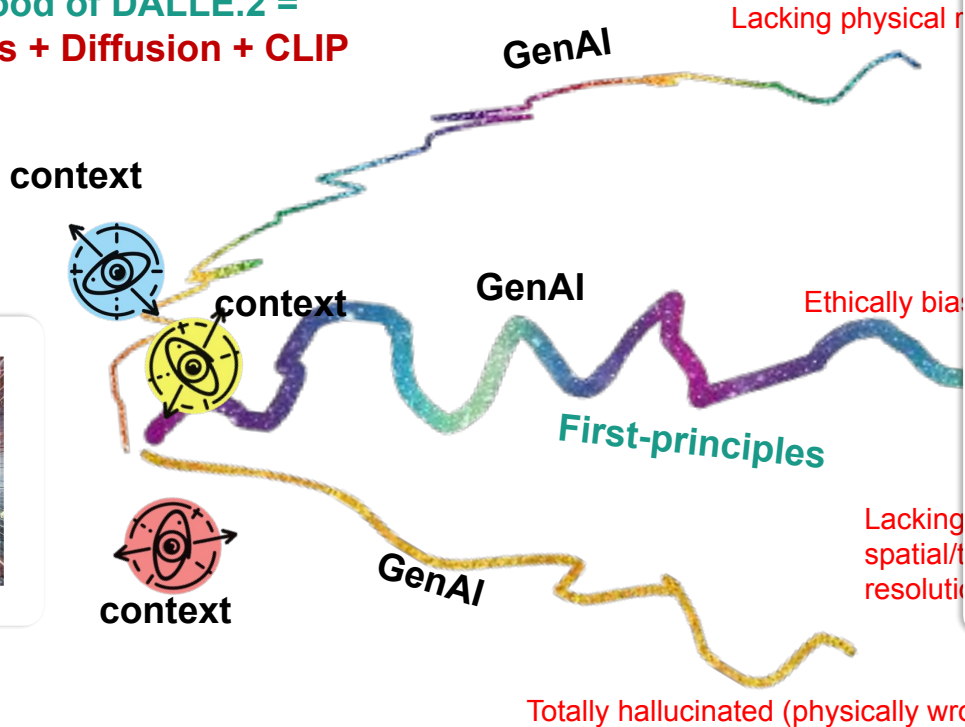
Prompt: Generate a tornado scene showing a township with upper- and lower-income communities and *damage is confined in the lower-income communities.*

■ *I took multiple 'malicious' prompts to generate this ...*



Explaining the GenAI – context, context, context ...

Under the hood of DALL·E.2 =
Transformers + Diffusion + CLIP





Technical Remarks

- Impressive generation of general disaster striking scenes chronologically.
 - Spatial shapes and inter-relations of tornado, townships, buildings, and other objects are minimally satisfactory
- Spatial-temporal 'mechanics' as manifested in the generation significantly lacks scientific logic and fidelity.
 - Temporal progressing between different chronologic generation does not follow physics; and spatial 'memory' is not found
 - Tornado-structure interaction and impact mechanics are NOT in the knowledge of the generation or in the reverse diffusion process.
- **Calling for PHYSICS-informed Generative Simulation**



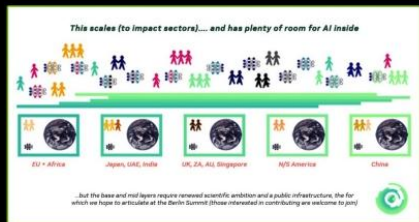
Legal/Ethical Concern and Opinion towards climate/disaster RISK Communication

- The possibility of generating misinformation and disinformation using GAI relevant to disaster risk communication does exist!
- The legal and ethical implications need to be examined from different user and stakeholder perspectives, if a GenAI enabled disaster risk communication tool is developed.
- **We argue that human experts should be in the loop who oversee content generation, including correcting and tuning the AI models and making the final call on the objectiveness of generative content.**
- **This in turns calls for PHYSICS-informed Generative Simulation**



EARTH-2

Earth Climate Digital Twin



EARTH-2

DATA SOURCES / INITIAL CONDITIONS



<https://www.nvidia.com/en-us/high-performance-computing/earth-2/>

- Higher Resolution and Large-Scale AI Training with kilometer (km)-scale climate simulations and Low-latency interactivity.
- Foundational Models: Numerical models like ICON and IFS; machine learning models such as FourCastNet, GraphCast, and DLWP through **NVIDIA Modulus**
- Data federation and visualization: **NVIDIA Omniverse™**



Conclusions

- **Generative AI provides powerful tool for possibly generating scientific contents regarding disaster risk communication.**
 - In the case of tornado disasters, GPT4 based LLM provides impressive knowledge base regarding tornado hazards, climate change, and disaster response measures.
 - The GPT4 vision engine provides impressive zero-shot learning capability of understanding tornado scene images toward recognizing damage and damage classification.
 - The GPT4 image generation (DALL·E2) generally performs well to generate individual tornado scene image depending on objective prompting. Yet, it significantly lacks rigor/logic in spatial-reasoning reasoning when generating an event chronologically.
- **User contexts via prompting serve as ‘embeddings’ in the diffusion based generation. Therefore, ethical and legal misconduct leading to disinformation or misinformation is concerning.**

Thanks much!

Contact: chenzhiq@umkc.edu