MSC INDIVIDUAL PROJECT

University of the Arts London

Creative Computing Institute

Dream Catcher Holo

A therapeutic sleep companion AI drone designed for recording, storing, invoking, and regenerating dreams with specific fashion functionalities

---

Anthor: Supervisor:

Yuyang Ma Dr. Tom Keene

Video: https://youtu.be/9h2M6tUwzHQ

November 21, 20

Abstract

This study aims to explore an innovative technological solution aimed at mitigating the prevalent issue of individuals forgetting their dreams upon waking. Drawing inspiration from the profound emotional expressions depicted in films such as 《Interstellar》， 《Peaky Blinders》, and 《007: No Time to Die》, the project has devised a system that seamlessly integrates multimodal sensors, data analysis, and image generation technologies. This integrated system is designed to meticulously record, analyze, and recreate the dream content of users.

In terms of technological contributions, this project has accomplished preliminary facial detection and implemented a text-to-image conversion mechanism, complemented by a data analysis framework for capturing and visualizing dream data. While only a fraction of the system's functionalities has been implemented currently, these advancements have showcased the potential to transmute dreams into tangible memories. In the domain of aesthetic contributions, the project delves into the visual and emotional representation of dreams through digital art creation, with the aim of enriching the user experience and fostering emotional resonance.

Looking forward, the project will concentrate on refining dream capture algorithms for greater accuracy, enhancing the quality of image generation, and optimizing the user interface design to create a more profound and captivating user experience. This research not only pushes the boundaries of sleep science and artificial intelligence but also forges new paths in the digital preservation of human emotions and memories.

Keywords: Dream Recording, Data Analysis, Image Generation, User Experience, Emotional Resonance

Acknowledgements

It has been an absolute privilege to spend the last year at the Creative Computing Institute among such a welcoming group of tutors and students. I’d like to thank our course leader, for showing the deep relationship between art and play. I’d like to thank my professors, whose thoughtful introduction to the world of creative AI gave me the technical and theoretical foundation for the work in this project. And finally, I’d like to thank my advisor whose sound advice helped guide this project at every turn. Hanging out in your office to talk freely about art, culture, technology, or whatever else happened to be on my mind that week has been a highlight of my academic career. I would also like to thank my boyfriend, Cayman, for his invaluable support during this time. His encouragement has been a cornerstone of my journey. I look forward to our future together, hopefully starting with marriage soon.

Content

List of Figures

Chapter1 Introduction

Love is the one thing we're capable of perceiving that transcends dimensions of time and space.

Maybe we should trust that, even if we can't understand it yet.

---Movie 《Interstellar》【xx】

1.1 Motivation

Embarking on the exploration of the convergence of art and technology, we frequently encounter the challenge of applying advanced technology to pragmatic issues in our daily lives. This project endeavors to create a therapeutic sleep companion AI drone that not only records and reproduces our dreams but also integrates a fashion model feature, introducing a new layer of significance to the sleep experience. This concept emerges from the escalating concern for the sleep quality of contemporary individuals and the quest for those meaningful memories lost in dreams.

In personal experiences, the inability to retain dreams and the yearning to reunite with deeply loved ones in dreams serve as the genesis of this project. Through technological intervention, we can not only capture these fleeting moments of dreams but also revisit them at any time in the future, offering a unique perspective for personal emotional experiences.

In the exploration of dreams and memories, as depicted in cultural works such as the film 《Interstellar》, a universal need emerges for the preservation and portrayal of dreams. This project tackles this issue through technological means, not only providing practical value but also establishing a profound emotional connection with users.

The objective of this research is to develop an innovative therapeutic sleep companion AI drone that, employing advanced detection technology and artificial intelligence analysis, aids users in recording, storing, processing, and reproducing dreams. The genesis of this product is grounded in contemporary demands for sleep quality and emotional well-being. The paper delves into the significance of dreams in our lives and specifically emphasizes the deep connection between dreams and love. These research findings guide the development of a therapeutic sleep companion AI drone capable of recording, analyzing, reproducing, and reshaping dreams. Its purpose is to offer a unique perspective for comprehending and healing our emotional world. By integrating IRT imagery rehearsal therapy and the theoretical foundations of NDR nightmare deconstruction and reprocessing, this product not only introduces a novel approach to dream capture and analysis but also provides users with an entirely new avenue for emotional healing.

1.2 Research Objectives

Issues to Address：

1． Connection Between Dreams and Emotions: Explore how dreams intricately reflect and impact our emotional states, serving as a pivotal avenue for comprehending both ourselves and others.

2． Application of Neuroscience and Medicine: Leverage the latest breakthroughs in neuroscience and medicine to enhance the precision and efficiency of the AI drone in capturing and analyzing dreams.

3． Integration of Art and Dreams: Investigate the representation of dreams in artistic creations, integrating these concepts into product design to transform it into a tool for fostering creative thought and emotional expression.

4． Fusion of Fashion Functionality and Dreams: Unite the aesthetics of fashion design with dream content, probing how dream elements can be infused into the fashion domain, thereby offering novel design inspirations and avenues for expression.

Implementation Approaches:

1．Technical Implementation and Data Analysis: Develop advanced sleep monitoring technology and sophisticated data analysis methods to achieve a profound understanding and storage of dreams.

2．Creative Dream Reproduction: Employ text-to-image conversion technology based on diffusion models, empowering the AI to extend and transform dreams.

3．Interactive Effects and Display: Incorporate keyword-driven interactive effects using Touch Designer, providing diverse ways to showcase dreams.

4．Development of the Fashion Functionality Module: Integrate code model theory and fashion design aesthetics to explore the potential incorporation of dream content into fashion design.

Chapter2 Creative Computing Content

2.1Diffusion Model

In my research, I employed the sophisticated Latent Diffusion Models (LDMs), a complex multimodal generative model, for high-resolution image synthesis. This step was crucial in realizing dream generation for the project. The process proved challenging, demanding a significant investment of time to grasp advanced concepts in deep learning, probability models, and image processing. Additionally, I grappled with the limitation of hardware resources, substantially amplifying the complexity of both learning and practical

In the field of deep learning, the Stable Diffusion model represents a novel paradigm in text-to-image latent diffusion models, leading a new trend in image generation technology. Built upon the latent diffusion model proposed by Rombach et al. in the paper "High-Resolution Image Synthesis with Latent Diffusion Models" presented at CVPR '22, it was realized through collaboration with Stability AI and Runway, and optimized by training on a subset of the LAION-5B database.

The model employs a frozen CLIP ViT-L/14 text encoder for conditional training based on text prompts, similar to Google's Imagen model. The Stable Diffusion v1 version specifically uses a downsampling-factor 8 autoencoder, coupled with an 860M UNet and CLIP ViT-L/14 text encoder, making it a relatively lightweight model capable of running on GPUs with at least 10GB VRAM.

To successfully operate the Stable Diffusion model, one must create and activate a suitable conda environment named ldm. Additionally, dependencies such as the transformers and diffusers libraries, along with invisible-watermark, must be installed via pip. The model's weights are available under the CompVis organization at Hugging Face, which allows commercial use but comes with specific use-based restrictions to prevent misuse and harm.

In practice, to run the Stable Diffusion model and integrate it into the dream analysis project, I spent considerable time studying the related mathematical principles and deep learning algorithms. After numerous experiments and parameter adjustments, I finally achieved the transformation from a rough concept to a detailed artwork. This process required not only profound knowledge of machine learning but also substantial computational resources and patient debugging.

2.2Target Recognition

Using the YOLOv5 model, I trained it with facial detection data to discern the user’s sleep state.

This research project utilizes the YOLOv5 deep learning model for facial recognition and detection. As an efficient object detection model, YOLOv5 simultaneously performs object localization and classification tasks within a single network. The model is highly flexible and adaptable, suitable for diverse datasets of various sizes and types.

In the implementation of the project, the dataset was first preprocessed, including image resizing and format conversion, to meet the input requirements of the YOLOv5 model. Furthermore, data augmentation techniques such as rotation, scaling, and color adjustment were employed to increase the diversity of training samples, thereby enhancing the model's generalization ability.

For model training, specific hyperparameters suitable for facial detection were chosen, such as learning rate, batch size, and training epochs. With extensive training, the model learned to recognize facial features under different conditions. The stochastic gradient descent (SGD) optimization algorithm was used during this process to effectively avoid overfitting and ensure the model's performance on new data.

After completing the model training, a series of evaluations were conducted, including metrics like mean Average Precision (mAP), to ensure the accuracy and robustness of the model. The successful implementation of the project is attributed to a deep understanding of the YOLOv5 model and a comprehensive analysis of the dataset characteristics.

2.3Data Analysis

The data analysis process involved importing and scrutinizing the 'Sleep_health_and_lifestyle_dataset.csv' dataset. This effectively discerned and visually represented users' sleep patterns and related health indicators, establishing a scientific foundation for further enhancements in sleep quality and personalized health recommendations.

In this project, the data processing stage was crucial. We employed Python programming language along with pandas library for efficient data reading, cleaning, and transformation, ensuring the accuracy and applicability of the data. By thoroughly analyzing the structure and content of the dataset, we identified and addressed missing values, outliers, and duplicate records, thus enhancing the quality and reliability of the data.

Additionally, data visualization played a significant role in our data processing. Utilizing libraries such as matplotlib and seaborn, we created various types of charts, including bar graphs, box plots, and scatter plots. These charts provided intuitive displays of data distribution, trends, and correlations. This not only helped us to better understand the data but also provided crucial insights for subsequent model training and analysis.

During the data processing phase, we also employed advanced statistical methods like hierarchical clustering to explore the underlying structure of the data. Utilizing functions from the SciPy library, we were able to analyze the data in multiple dimensions, revealing inherent patterns and relationships.

Overall, our data processing steps focused not only on the precise execution of techniques but also on a deep understanding of the essence of the data. This phase laid a solid foundation for effective model training and accurate generation of results.

Chapter3 Methodology

3.1 Project Overview

This project has developed a comprehensive and sophisticated product system that focuses on monitoring and analyzing human sleep and dream information. Since the project is in its early stages, the functional implementation prioritizes areas where I have expertise and considers them crucial, ensuring the efficiency of the system and the accuracy of its objectives.

3.2Functional Implementation Strategy

In the initial phases, the focus was on implementing core functions such as the diffusion model for text-to-image conversion, facial detection, and data analysis. These functions lay the foundation for constructing a complete system and are crucial for enhancing the user experience.

3.3Design and Technology Selection

Considering individual strengths and project objectives, technologies that best showcase system innovation and user interactivity were selected. These technologies include artificial intelligence in coding, modeling, rendering, TouchDesigner interactive design, and service design.

3.4System Completeness and Phased Objectives

While the system design requires a high degree of completeness, acknowledging the developmental nature of the project, a gradual implementation strategy is adopted. Priority is given to developing functional modules crucial for the overall goals and long-term vision.

3.5Early Research and Experimental Validation

In the initial stages, a series of experiments will validate the effectiveness of the selected functionalities and explore their potential applications in addressing emotional healing pain points.

Chapter4 Theoretical Foundation

4.1 Dreams and Neuroscience

The exploration of dreams carries profound significance in the realm of neuroscience. Drawing from Jungian theory and Hobson and McCarley’s activation-synthesis hypothesis (Hobson, J. A., & McCarley, R. W. (1977). “The Brain as a Dream State Generator: An Activation-Synthesis Hypothesis of the Dream Process”, American Journal of Psychiatry), dreams are posited as the brain's subjective interpretation and synthesis of random electroencephalographic activity during sleep. In our product design, we consider this theory, intending to capture these electroencephalographic activities and interpret their significance through algorithms to faithfully reproduce users' dream experiences.

4.2 Technical Analysis of Product Implementation

Research by Mark Solms (Solms, M. (2000). “Dreaming and REM Sleep Are Controlled by Different Brain Mechanisms”, Behavioral and Brain Sciences) indicates that dreams and REM sleep are governed by distinct brain mechanisms. The system design of this project is based on this finding, employing diverse strategies to manage data collected during both REM and non-REM sleep stages, ensuring the effective capture and analysis of dreams.

4.3The Specific Functionality Module

Research conducted by Stickgold et al. (Stickgold, R., Malia, A., Fosse, R., Propper, R., & Hobson, J. A. (2001). “Brain-mind states: I. Longitudinal Field Study of Sleep/Wake Factors Influencing Mentation Report Length”, Sleep) explores the impact of sleep/wake states on the length of reports on mental activity. Aligned with this research, our project investigates how to translate creative elements from dreams into the field of fashion design, leveraging the richness of mental activity to inspire novel perspectives in the realm of fashion creation.

Chapter5 Design Sections

5.1 Design Sections

The design and functionality of this product are grounded in two fundamental psychotherapeutic theories: IRT (Imagery Rehearsal Therapy) and NDR (Nightmare Deconstruction and Reprocessing). Both approaches prioritize the treatment of psychological trauma and sleep disorders by modifying dream content. Our product analyzes users' dream data, applying these theories to offer personalized emotional healing solutions. This approach not only aids users in comprehending and reshaping their dreams but also assists them in addressing underlying psychological issues.

5.2 Service Design Envisioned Process

5.2.1 Service Design Overview

The service design for this project follows a user-centric approach, ensuring that each functional module aligns closely with user experience design principles. At the core of service design is the management and simplification of the interaction process between users and the drone, as well as the data analysis system, ensuring a seamless and responsive service.

5.2.2 User Experience Design

To enhance the user experience, a highly intuitive User Interface (UI) will be implemented to streamline interactions between users and the drone. Furthermore, UI design will undergo iterations through user testing to ensure it meets users' intuitive usability needs. User journey maps will be crafted through qualitative and quantitative user research. By conducting user interviews and observations, we can identify and address pain points in the user operation process, such as minimizing manual input through automated sleep state detection.

5.2.3 Interactive Service Touchpoints

All service touchpoints are meticulously designed to enable users to navigate and interact with the system effortlessly. For example, data visualization employs user-friendly charts and color coding to assist users in comprehending complex dream data.

5.2.4 Dynamic Service Blueprint

We will delve into the backend service processes and every user front-end touchpoint, ensuring seamless connections between them. For instance, the data analysis module will automatically generate visual results, reducing user wait times.

5.2.5 User Interaction Design

We have optimized the interaction design to ensure users feel comfortable and natural when describing dreams and receiving analysis results. By adopting voice input and smart prompts, we've simplified the user input process and accelerated the delivery of analysis feedback. Interaction design will revolve around Natural Language Processing (NLP), enabling users to describe dreams through natural conversation while providing instant feedback to confirm the system's correct understanding.

5.2.6 Sustainable Development Strategy

To ensure the long-term sustainability of the system, we will leverage cloud computing resources. This not only handles large-scale data but also dynamically scales resources according to demand. We will establish an embedded feedback mechanism, allowing users to submit feedback at any time during usage. This feedback will be utilized for continuous service optimization, such as adjusting the accuracy of data analysis through machine learning algorithms.

5.3 Interaction Design - Description of Product Interaction with Users

In the later stages of product usage, users immerse themselves in scenarios where they repeatedly read and showcase stored dreams or observe generated dream forms. In the initial phase of this product, I believe TouchDesigner can fulfill a segment of the dream forms and consciousness art displays. Therefore, drawing upon the knowledge gained in CCI classes, I reacquainted myself with TouchDesigner, employing more advanced skills and implementing the effects of four simulated scenarios, as outlined below:

1. Petals Move with Gestures - Gesture Recognition
2. Heartbeat - Arduino Sensor + Experiencing Heartbeats
3. Flowing Balls - Head Movement Recognition
4. Squeezing a Ball - Gesture Recognition

Squeezing a Ball - Gesture Recognition

1.Petals Move with Gestures - Sense of romance.

2.Heartbeat - A profound experience of life’s vitality.

3.Flowing Balls - Alleviating stress and promoting relaxation.

4.Squeezing a Ball - Stress-relief.

The effects are as follows

Figure 0.1 Petal Gesture Effect

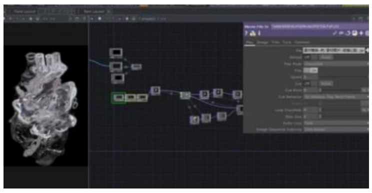

Figure 0.2 Arduino Sensing + Experience a Heartbeat3.

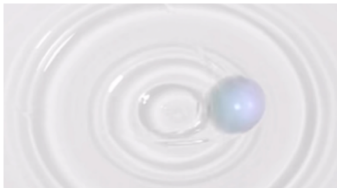

Figure 0.3 Streaming Balls - Head Motion Recognition

Figure 0.4 Pinch ball - gesture recognition

5.4 Product Design

I referred to two viable design concepts—one inspired by the humanoid mushroom figure of a healing lamp and the other derived from a conventional drone. Aligning with the product's positioning, I selected five color schemes that evoke dreaminess, relaxation, stress relief, and youthfulness. This process yielded a total of 2x5 designs for my product.

Figure 0.5 Fantasy Colour Matching Reference 1

Figure 0.6 Fantasy Colour Matching Reference 2

Figure 0.7 Fantasy Colour Matching Reference 3

Figure 0.8 Fantasy Colour Matching Reference 4

Figure 0.9 Fantasy Colour Matching Reference 5

Figure 0.10 Flying Machine Product Colour Matching Reference 1

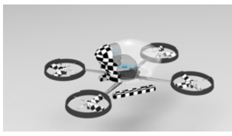

Figure 0.11 Flying Machine Product Colour Matching Reference 2

Figure 0.12 Flying Machine Product Colour Matching Reference 3

Figure 0.13 Flying Machine Product Colour Matching Reference 4

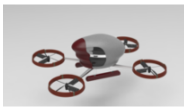

Figure 0.14 Flying Machine Product Colour Matching Reference 5

Figure 0.15 Space Shape Product Colour Matching Reference 1

Figure 0.16 Space Shape Product Colour Matching Reference 2

Figure 0.17 Space Shape Product Colour Matching Reference 3

Figure 0.18 Space Shape Product Colour Matching Reference 4

Figure 0.19 Space Shape Product Colour Matching Reference 5

In the initial stages of the project, I refrained from delving into the significance and aesthetics of the design, reserving this for future planning. In the meantime, I have included below some AI-generated product images based on my concepts.

Figure 0.20 Predictive modelling 1

Figure 0.21 Predictive modelling 2

Figure 0.22 Ideal Model

After the iteration of the product, the envisioned product style and atmosphere are depicted in the following image:

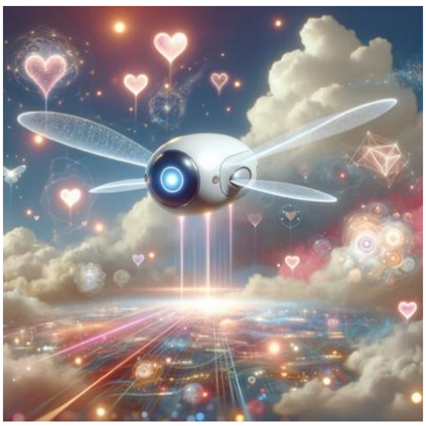

Figure 0.23 Diagrams for understanding products with dreamy overtones 1

Figure 0.24 Diagrams for understanding products with dreamy overtones 2

5.5Product Usage Scenarios

5.5.1Scenario Analysis and Understanding User Behavior

Before users rest for the night, the product initiates sleep monitoring through a streamlined interaction process. We utilize a pre-set sleep pattern detection algorithm to gather real-time sleep data, including movement frequency, breathing patterns, etc., in order to evaluate sleep quality.

5.5.2Data-Driven User Feedback

Upon waking up, the product presents a succinct sleep report that includes deep sleep periods, REM sleep cycles, and potential interruptions. Additionally, the product conducts a dream analysis based on nighttime activities, providing potential predictions for dream themes.

5.5.3Construction and Optimization of Predictive Models

By leveraging machine learning techniques, the product analyzes the user's sleep history and dream logs to establish personalized sleep and dream patterns. This model can predict future sleep quality and potential dreams, aiding users in enhancing sleep environments and habits.

5.5.4Personalized Recommendations and Interventions

Through a combination of sleep analysis and user feedback, the product offers personalized suggestions for sleep improvement, such as adjusting sleep environments, modifying dietary habits, or employing relaxation techniques. For frequently occurring dream themes, the product also provides professional interpretations and emotional support.

Figure 5.25 Imagined usage scenarios

Chapter6 Discussion and Future Work

6.1 Technical Contribution

The central technological contribution of this project lies in addressing the common issue where individuals often forget the content of their dreams despite their desire to remember. By integrating interdisciplinary technologies acquired at CCI, we have successfully developed a system capable of recording and analyzing dreams. Although the current system has only implemented partial functionalities, it can already confirm the user’s sleep state through facial detection and capture/recreate dream elements using text-to-image conversion technology. These initial achievements lay the foundation for future, more comprehensive dream capture and analysis technologies.

6.2 Aesthetic Contribution

In terms of aesthetics, this project aims to translate the fluidity and variability of dreams into visual art. Drawing inspiration from cinematic expressions of profound emotions related to the loss of loved ones in films like 《Interstellar》 and 《007: No Time to Die》, our system aspires not only to reproduce dream content but also to distill the emotions and aesthetic values of dreams, creating a visually immersive experience with depth. Currently, we are striving to enhance the quality of image generation and emotional expression to convey the beauty of dreams more realistically.

6.3 Future Work

Future work will be dedicated to improving the overall system and user experience. Technologically, we will explore advanced algorithms and machine learning techniques to enhance the accuracy of dream recording and the depth of analysis. Additionally, we plan to iterate on the user interface design to make it more intuitive and emotionally engaging. Aesthetically, we will delve deeper into how to transform the abstract aesthetics of dreams into concrete visual expressions. Simultaneously, we will study how users interact with the system, ensuring that our service not only provides functionality but also offers emotional support and healing.

6.4 Closing Remarks

In our exploration of the convergence of memory and dreams, our project embarks on a dedicated journey to capture and preserve our most ephemeral memory fragments.

Much like the poignant scenes in films such as "Interstellar," "The Departed," and "Skyfall," we aspire to leverage technology to safeguard those cherished moments with loved ones in our dreams. Although we have only realized a small portion of our established goals, our commitment to this dream remains steadfast. I am confident in the application of the knowledge acquired and the future potential of the project, eagerly anticipating the continuous overcoming of technical barriers, enhancement of aesthetic expression, and improvement of the user experience. Ultimately, our vision is to transform dreams into precious memories that we can tangibly touch and savor.

Chapter7 Conclusion

This project represents not only a practical pursuit of technological innovation but also a profound exploration of universal human emotions. Through the examination of sleep and dreams, our goal is to tap into the deepest emotional experiences of humanity, addressing the regret stemming from the swift evanescence of dreams. Confronted with numerous technological challenges and the imperative to enhance user experiences, we will persist in deepening our research, refining system functionalities, enhancing aesthetic elements, and optimizing interactive design. In the future, we steadfastly believe that this project will aid individuals in preserving the exquisite moments within their dreams, perhaps even capturing those unspoken words, thus engendering truly meaningful value in each of our lives.

List of Computing Project

DreamCatcher-Holo-text2image

https://github.com/Maria0413/DreamCatcher-Holo-text2image/archive/refs/heads/main.zip

DreamCatcher-Holo-touchdesigner

https://github.com/Maria0413/DreamCatcher-Holo-touchdesigner/archive/refs/heads/main.zip

DreamCatcher-Holo-sleep_health

https://github.com/Maria0413/DreamCatcher-Holo-sleep_health/archive/refs/heads/main.zip

DreamCatcher-Holo-FaceDetect

https://github.com/Maria0413/DreamCatcher-Holo-FaceDetect/archive/refs/heads/main.zip

Bibliography

[1] Foulkes D. What do we know about dreams- and how did we learn it? Presented at 13th annual meeting of Association for the Psychophysiological Study of Sleep, San Diego, CA, 1973 121.

[2] Antrobus JS. Dreaming for cognition. In: Arkin AM, Antrobus JS, Ellman SJ, eds. The mind in sleep: psychology and psychophysiology. Hillsdale, NJ: Lawrence Erlbaum Associates, 1978:569-81. 122.

[3] Antrobus JS, ed. Cognition and affect. Boston: Little, Brown, 1970. 123.

[4] Hobson JA, McCarley RW. The brain as a dream state generator: an activation-synthesis hypothesis of the dream process. Am J Psychiatry 1977;134:1335-48. 124.

[5] Vogel GW. An alternative view of the neurobiology of dreaming. Am J Psychiatry 1978;135:1531-5. 125.

[6] Brylowski A, Levitan L, LaBerge S. H-refiex suppression and autonomic activation during lucid REM sleep: a case study. Sleep 1989;12:374-8. 126.

[7] Antrobus JS. The neurocognition of sleep mentation: rapid eye movements, visual imagery, and dreaming. In: Bootzin RR, Kihlstrom JF, Schacter DL, eds. Sleep and cognition. Washington, DC: American Psychological Association, 1990:3-24. 127.

[8] Hobson JA. The dreaming brain. New York: Basic Books, 1988. 128.

[9] Resnick J, Stickgold R, Rittenhouse C, Hobson JA. Fonnal properties of dream reports collected in the home setting from children 4-5 and 8-10 years old. Sleep Res 1993;22: 124. 129.

[10] Resnick J, Stickgold R, Rittenhouse CD, Hobson JA. Selfrepresentation and bizarreness in children's dream reports collected in the home setting. Consciousness Cognition 1994;3: 30-45. 130.

[11] Faraday A. Dream power. New York: Coward, McCann & Geoghegan, 1972. 131.

[12] FaradayA. The dream game. New York: Harper & Row, 1974. 132.

[13] Garfield P. Creative dreaming. New York: Simon & Schuster, 1974. 133.

[14] Antrobus JS. Dreaming: cortical activation and perceptual thresholds. J Mind Behav 1986;7:193-211. 134.

[15] Cipolli C. The narrative structure of dreams: linguistic tools of analysis. In: Horne JA, ed. Sleep 1990. Bochum: Pontenagel, 1990:281-4. 135.

[16] Kuiken D, Nielsen T, Thomas S, McTaggart D. Comparison of the story structure of myths, extraordinary dreams, and mundane dreams. Sleep Res 1983;12:196. 136.

[17] HaIl CS. The two provinces of dreams. Dreaming 1991;1:91-3. 137.

[18] Breger L. Function of dreams. J Abnorm Psychol Monogr 1967;641. 138.

[19] Breger L, Lane I, Hunter RW. The effect of stress on dreams. Psychollssues 1971;7:3. 139.

[20] Foulkes D. Dreaming and consciousness. Eur J Cognit Psychol 1990;2:39-55. 140.

[21] Anderson JR. The architecture of cognition. Cambridge, MA: Harvard University Press, 1983. 141.

[22] Antrobus J. Dreaming: cognitive processes during cortical activation and high afferent thresholds. Psychol Rev 1991;98:96- 121.

[23] A. Krizhevsky, I. Sutskever, and G. Hinton, "Imagenet classification with deep convolutional neural networks," NIPS, 2012.

[24] M. Lin, Q. Chen, and S. Yan, "Network in network," arXiv preprint arXiv:1312.4400, 2013.

[25] K. He, X. Zhang, S. Ren, and J. Sun, "Deep residual learning for image recognition," CoRR, vol. abs/1512.03385, 2015.

[26] T. Mikolov, K. Chen, G. Corrado, and J. Dean, "Efficient estimation of word representations in vector space," arXiv preprint arXiv:1301.3781, 2013.

[27] J. Pennington, R. Socher, and C. D. Manning, "Glove: Global vectors for word representation," in Empirical Methods in Natural Language Processing (EMNLP), 2014, pp. 1532–1543.

[28] K. Cho, A. Courville, and Y. Bengio, "Describing multimedia content using attention-based encoder-decoder networks," Multimedia, IEEE Transactions on, vol. 17, no. 11, pp. 1875–1886, 2015.

[29] C. N. dos Santos and M. Gatti, "Deep convolutional neural networks for sentiment analysis of short texts." in COLING, 2014, pp. 69–78.

[30] T. Mikolov, M. Karafiat, L. Burget, J. Cernock ´ y, and S. Khudanpur, ` "Recurrent neural network based language model." in INTERSPEECH, 2010.

[31] J. Tang, S. Yan, R. Hong, G.-J. Qi, and T.-S. Chua, "Inferring semantic concepts from community-contributed images and noisy tags," in Proceedings of the 17th ACM international conference on Multimedia. ACM, 2009, pp. 223–232.

[32] M. Naphade, J. R. Smith, J. Tesic, S.-F. Chang, W. Hsu, A. L. Kennedy, A. Hauptmann, and J. Curtis, "Large-scale concept ontology for multimedia," MultiMedia, IEEE, vol. 13, no. 3, pp. 86–91, 2006.

[33] M. Wang, X.-S. Hua, J. Tang, and R. Hong, "Beyond distance measurement: constructing neighborhood similarity for video annotation," Multimedia, IEEE Transactions on, vol. 11, no. 3, pp. 465–476, 2009.

[34] J. Smith, L. Cao, N. Codella, M. Hill, M. Merler, Q.-B. Nguyen, E. Pring, and R. Uceda-Sosa, "Massive-scale learning of image and video semantic concepts," IBM Journal of Research and Development, vol. 59, no. 2/3, pp. 7–1, 2015.

[35] D. Cao, R. Ji, D. Lin, and S. Li, "A cross-media public sentiment analysis system for microblog," Multimedia Systems, pp. 1–8, 2014.

[36] Q. You, J. Luo, H. Jin, and J. Yang, "Cross-modality consistent regression for joint visual-textual sentiment analysis of social multimedia," in Proceedings of the Ninth ACM International Conference on Web Search and Data Mining (WSDM), 2016, pp. 13–22.

[37] A. P. Schaum and B. J. Daniel, "Continuum fusion methods of spectral detec- tion," Opt. Eng.,

vol. 5, no. 2, pp. 1–11, Nov. 2012.

[38] G. Healey and D. Slater, "Models and methods for automated material iden- tification in hyperspectral imagery acquired under unknown illumination and atmospheric conditions," IEEE Trans. Geosci. Remote Sensing, vol. 37, no. 6, pp. 2706–2717, Nov. 1999.

[39] G. Camps-Valls, L. Gomez-Chova, J. Muoz-Mari, J. Vila-Frances, and J. Calpe- Maravilla, "Composite kernels for hyperspectral image classification," IEEE Trans. Geosci. Remote Sensing Lett., vol. 3, no. 1, pp. 93–97, Jan. 2006.

[40] C. Chen, N. M. Nasrabadi, and T. D. Tran, "Kernel sparse representation for hyperspectral target detection," in Proc. SPIE, Baltimore, MD, May 2012, vol. 8390, Article ID 839005.

[41] A. P. Schaum, "Continuum fusion, a theory of inference, with applications to hyperspectral detection," Opt. Express, vol. 18, no. 8, pp. 8171–8181, Nov. 2010.

[42] A. Berk, G. P. Anderson, L. S. Bernstein, P. K. Acharya, H. Dothe, M. W. Matthew, S. M. Adler-Golden, J. H. Chetwynd, S. C. Richtsmeier, B. Pukall, C. L. Allred, L. S. Jeong, and M. L. Hoke, "MODTRAN4: Radiative transfer mod- eling for atmospheric correction," in Proc. SPIE, Orlando, FL, 1999, vol. 3756, pp. 348–353.

[43] E. J. Ientilucci and P. Bajorski, "Stochastic modeling of physically derived sig- nature spaces," J. Appl. Remote Sensing, vol. 2, no. 1, pp. 023532(1–10), Aug. 2008.

[44] J. Theiler, G. Cao, L. R. Bachega, and C. A. Bouman, "Sparse matrix transform for hyperspectral imagery processing," IEEE J. Select. Topics Signal Processing, vol. 5, no. 3, pp. 424–437, Mar. 2011.

[45] C. E. Caefer, J. Silvermana, O. Orthalb, D. Antonellib, Y. Sharonib, and S. R. Rotman, "Improved covariance matrices for point target detection in hyper- spectral data," Opt. Eng., vol. 47, no. 7, pp. 076402(1–13), July 2008.

[46] N. M. Nasrabadi, "Regularized spectral matched filter for target recognition in hyperspectral imagery," IEEE Signal Processing Lett., vol. 15, pp. 317–320, 2008.

[47] J. Wright, A. Y. Yang, A. Ganesh, S. Sastry, and Y. Ma, "Robust face recognition via sparse representation," IEEE Trans. Pattern Anal. Mach. Intell., vol. 31, no. 2, pp. 210–227, Feb. 2009.

[48] M. Elad, Sparse and Redundant Representations: From Theory to Applications in Signal Processing. New York: Springer, 2010.

[49] S. Boyd and L. Vandenberghe, Convex Optimization. Cambridge, U.K.: Cambridge Univ. Press, 2004.

[50] Y. Chen, N. M. Nasrabadi, and T. D. Tran, "Sparse representation for target detection in hyperspectral imagery," IEEE J. Select. Topics Signal Processing, vol. 5, no. 3, pp. 629–640, Mar. 2011.

[51] Y. Chen, N. M. Nasrabadi, and T. D. Tran, "Simultaneous joint sparsity model for target detection in hyperspectral imagery," IEEE Trans. Geosci. Remote Sens- ing Lett., vol. 8, no. 4, pp. 676–680, July 2011.

[52] Eirikur Agustsson and Radu Timofte. NTIRE 2017 challenge on single image super-resolution:

Dataset and study. In 2017 IEEE Conference on Computer Vision and Pattern Recognition Workshops, CVPR Workshops 2017, Honolulu, HI, USA, July 21-26, 2017, pages 1122–1131. IEEE Computer Society, 2017. 1

[53] Martin Arjovsky, Soumith Chintala, and Leon Bottou. ´ Wasserstein gan, 2017. 3

[54] Andrew Brock, Jeff Donahue, and Karen Simonyan. Large scale GAN training for high fidelity natural image synthesis. In Int. Conf. Learn. Represent., 2019. 1, 2, 7, 8, 22, 28

[55] Holger Caesar, Jasper R. R. Uijlings, and Vittorio Ferrari. Coco-stuff: Thing and stuff classes in context. In 2018 IEEE Conference on Computer Vision and Pattern Recognition, CVPR 2018, Salt Lake City, UT, USA, June 18- 22, 2018, pages 1209–1218. Computer Vision Foundation / IEEE Computer Society, 2018. 7, 20, 22

[56] Nicholas Carlini, Florian Tramer, Eric Wallace, Matthew Jagielski, Ariel Herbert-Voss, Katherine Lee, Adam Roberts, Tom Brown, Dawn Song, Ulfar Erlingsson, et al. Extracting training data from large language models. In 30th USENIX Security Symposium (USENIX Security 21), pages 2633–2650, 2021. 9

[57] Mark Chen, Alec Radford, Rewon Child, Jeffrey Wu, Heewoo Jun, David Luan, and Ilya Sutskever. Generative pretraining from pixels. In ICML, volume 119 of Proceedings of Machine Learning Research, pages 1691–1703. PMLR, 2020. 3

[58] Nanxin Chen, Yu Zhang, Heiga Zen, Ron J. Weiss, Mohammad Norouzi, and William Chan. Wavegrad: Estimating gradients for waveform generation. In ICLR. OpenReview.net, 2021. 1

[59] Lu Chi, Borui Jiang, and Yadong Mu. Fast fourier convolution. In NeurIPS, 2020. 8

[60] Rewon Child. Very deep vaes generalize autoregressive models and can outperform them on images. CoRR, abs/2011.10650, 2020. 3

[61] Rewon Child, Scott Gray, Alec Radford, and Ilya Sutskever. Generating long sequences with sparse transformers. CoRR, abs/1904.10509, 2019. 3

[62] Bin Dai and David P. Wipf. Diagnosing and enhancing VAE models. In ICLR (Poster). OpenReview.net, 2019. 2, 3

[63] Jia Deng, Wei Dong, Richard Socher, Li-Jia Li, Kai Li, and Fei-Fei Li. Imagenet: A large-scale hierarchical image database. In CVPR, pages 248–255. IEEE Computer Society, 2009. 1, 5, 7, 22

[64] Emily Denton. Ethical considerations of generative ai. AI for Content Creation Workshop, CVPR, 2021. 9

[65] Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. BERT: pre-training of deep bidirectional transformers for language understanding. CoRR, abs/1810.04805, 2018. 7

[66] Prafulla Dhariwal and Alex Nichol. Diffusion models beat gans on image synthesis. CoRR, abs/2105.05233, 2021. 1, 2, 3, 4, 6, 7, 8, 18, 22, 25, 26, 28

[67] Luke Metz, Ben Poole, David Pfau, and Jascha SohlDickstein. Unrolled generative adversarial networks. In 5th International Conference on Learning Representations, ICLR 2017, Toulon, France, April 24-26, 2017, Conference Track Proceedings. OpenReview.net, 2017. 3

[68] Mehdi Mirza and Simon Osindero. Conditional generative adversarial nets. CoRR, abs/1411.1784, 2014. 4

[69] Gautam Mittal, Jesse H. Engel, Curtis Hawthorne, and Ian Simon. Symbolic music generation with diffusion models. CoRR, abs/2103.16091, 2021. 1

[70] [58] Kamyar Nazeri, Eric Ng, Tony Joseph, Faisal Z. Qureshi, and Mehran Ebrahimi. Edgeconnect: Generative image inpainting with adversarial edge learning. ArXiv, abs/1901.00212, 2019. 9

[71] Alex Nichol, Prafulla Dhariwal, Aditya Ramesh, Pranav Shyam, Pamela Mishkin, Bob McGrew, Ilya Sutskever, and Mark Chen. GLIDE: towards photorealistic image generation and editing with text-guided diffusion models. CoRR, abs/2112.10741, 2021. 6, 7, 16

[72] Aditya Ramesh, Mikhail Pavlov, Gabriel Goh, Scott Gray, Chelsea Voss, Alec Radford, Mark Chen, and Ilya Sutskever. Zero-shot text-to-image generation. CoRR, abs/2102.12092, 2021. 1, 2, 3, 4, 7, 21, 27

[73] Ali Razavi, Aaron van den Oord, and Oriol Vinyals. Gen- ¨ erating diverse high-fidelity images with VQ-VAE-2. In NeurIPS, pages 14837–14847, 2019. 1, 2, 3, 22

[74] Scott E. Reed, Zeynep Akata, Xinchen Yan, Lajanugen Logeswaran, Bernt Schiele, and Honglak Lee. Generative adversarial text to image synthesis. In ICML, 2016. 4

[75] Danilo Jimenez Rezende, Shakir Mohamed, and Daan Wierstra. Stochastic backpropagation and approximate inference in deep generative models. In Proceedings of the 31st International Conference on International Conference on Machine Learning, ICML, 2014. 1, 4, 29

[76] Robin Rombach, Patrick Esser, and Bjorn Ommer. ¨ Network-to-network translation with conditional invertible neural networks. In NeurIPS, 2020. 3

[77] Olaf Ronneberger, Philipp Fischer, and Thomas Brox. Unet: Convolutional networks for biomedical image segmentation. In MICCAI (3), volume 9351 of Lecture Notes in Computer Science, pages 234–241. Springer, 2015. 2, 3, 4

[78] Chitwan Saharia, Jonathan Ho, William Chan, Tim Salimans, David J. Fleet, and Mohammad Norouzi. Image super-resolution via iterative refinement. CoRR, abs/2104.07636, 2021. 1, 4, 8, 16, 22, 23, 27