Green Advertising

建智，王	錫賢，沈	維聖，鍾
110062144	110062130	110062261

韡勳，林	信勇，景	偉祥，黃
110062117	X1135070	X1136010

***Abstract*—One of the most effective ways to improve our planet's sustainability is by raising awareness of environmental conditions. However, awareness alone is insufficient; advertisements for sustainability must also inspire action. This paper explores the development of an AI-driven Green Advertising Model that automates the creation of sustainability focused advertisements, including posters, slogans, and short video scripts. By leveraging large language models (LLMs) and image generation models like Stable Diffusion, the AI system will generate impactful content trained on real-world sustainability data and successful green marketing campaigns. This approach aims to enhance environmental advocacy while reducing the costs and carbon footprint of content production.**

I. Purpose and Intent

Humanity currently has only one planet to call home. Since the Industrial Revolution, technological advancements have significantly improved quality of life—but often at the cost of environmental degradation. As stewards of the 21st century, we now bear the critical responsibility to protect our shared habitat, often referred to as "Spaceship Earth." Intelligent, forward-thinking decisions are needed to safeguard the planet, its ecosystems, and the future of humankind.

There are countless ways in which consumer behavior contributes to environmental harm: littering, excessive plastic use, carbon emissions, and deforestation, to name a few. Addressing these challenges requires a multifaceted, globally coordinated approach that goes beyond policy. Real change must come not only from programs but from people.

In the 21st century, advertising is one of the most powerful tools for capturing attention and shaping behavior. With this in mind, we propose the development of an artificial intelligence system designed to generate compelling green advertisements. This AI will create tailored, impactful content to encourage environmentally responsible behavior among individuals, businesses, and policymakers alike.

Our goal is to inspire action—not just awareness—by promoting eco-consciousness through emotionally resonant and data-driven messaging. Through this initiative, we hope to contribute meaningfully to global environmental preservation efforts by leveraging the persuasive power of advertising for the greater good.

II. Relevance to "AI for Sustainability"

In the past few years, the use of Artificial Intelligence has transformed the way we see, the way we think, and ultimately, how we live our life. By empowering the power of AI, we have the chance to improve our way of addressing sustainability challenges. In its forefront, AI can help us optimize resource usage, model environmental impacts, and even suggest sustainable policies. In the context of this project, AI acts as both a creative generator and a strategic influencer. By combining deep data analysis with scalable content generation, AI enables the creation of a personalized, precised, and emotionally resonant messages that can influence public attitudes and behaviors on a global scale.

Our idea of AI-driven green advertising system aligns directly with the objectives of "AI for Sustainability" in which it can explore how machine learning, data science, and intelligent automation can help mitigate environmental issues such as climate change, ecosystem protection, and sustainable development. This initiative applies AI not as a passive analytical tool, but as an active agent of change. By tailoring persuasive eco-messages to specific audiences using demographic, psychographic, and behavioral insights, the system fosters greater engagement with sustainability initiatives. The use of natural language generation (NLG), sentiment analysis, and reinforcement learning can further optimize messaging strategies in real time, ensuring effectiveness and adaptability.

Moreover, the integration of user feedback into the learning loop of the AI model introduces a powerful mechanism for tailoring and refining messages in real-time, ensuring that environmental communication remains relevant, engaging, and effective. In this way, our AI agent becomes not only a design assistant but also a learning partner that adapts to changing narratives and user expectations around sustainability.

III. Goal and Challenges

Our goal is to use the least call/rounds of API to get a user satisfied image, image need to be relevant to green image or the other word – sustainability relevant image. In the other word, we want our AI agent to learn what kind of prompt/API combination will use less API calls to get a user satisfied image.

Challenges may include:

1. How to get a better prompt for different image generation models
    a. What kind of prompting method can be used by all different types of image generation models?
    b. How to change user input into an effective prompt for the models?
    c. How to get the user's needs in at least words?
2. Different API (image generation model) may have different efficiencies on different topics
    a. Different models may have different performance on different topics
3. Users have different needs
    a. Every user may have different preferences and needs
4. Very large state space
    a. Have a very large state space, every possible combination of RGB or other image generation method can be a state (need to relevant to sustainability)
5. Time consuming & cost consuming (may not free)
    a. Not every API is free
    b. AI agent may need a lot of time to learn user's preferences
6. How to design an efficient reward mechanism
    a. What kind of RL method can be used?
    b. How to give reward to the agent and let the agent learn user's preferences in at least time?

IV. Related Work

The intersection of AI, design, and sustainability is an emerging area of research with growing practical interest. Numerous of previous studies have explored the use of generative models for visual content creation, such as DALL-E, Midjourney, and Stable Diffusion, but few have focused on their application in sustainability communication. These models have demonstrated strong capabilities in synthesizing high-quality visual content from textual prompts, which lays the groundwork for our system's approach.

A. Exploring AI-enabled green marketing and green intention: An integrated PLS-SEM and NCA approach

One of the research paper we found explores the relational model of the integration of AI into green marketing and its influence on consumer behaviour. Their study examined how AI-enabled green marketing strategies—categorized into strategic, tactical, and internal orientations—impact consumer trust and satisfaction, which are key mediators in shaping green intention.

Their method of using an integrated approach that combines Partial Least Squares Structural Equation Modeling (PLS-SEM) and Necessary Condition Analysis (NCA) allows the authors to analyze data collected from consumers in the United Arab Emirates. Their findings indicate that AI-driven marketing strategies significantly enhance trust and satisfaction among environmentally conscious consumers, and these factors, in turn, positively influence their willingness to purchase sustainable products.

Notably, trust emerged as the most influential factor in fostering green intention, highlighting the importance of credibility and transparency in AI-enabled green communication. Additionally, the study's use of Importance-Performance Map Analysis (IPMA) provided actionable insights for managers seeking to optimize the effectiveness of AI-driven sustainability initiatives. This research contributes to the growing body of literature on sustainable consumer behavior by demonstrating how AI technologies can enhance the effectiveness of green marketing and deepen consumer engagement with environmentally responsible brands.

https://www.sciencedirect.com/science/article/pii/S2666784325000208#:~:text=AI's%20ability%20to%20leverage%20big,time%20adjustments%20and%20tailored%20communication.

B. Leveraging AI To Enhance Green Marketing Strategies

Another paper we found presents a more cohesive approach to green advertising. While earlier reports focus primarily on how AI supports decision-making and enhance the effectiveness of green marketing strategies, it does not mention of AI being used to generate the marketing content itself. The AI functions described are more about data-driven insights rather than content creation. This paper on the other hand, also utilizes AI for generating the advertising content. Their key highlight is how AI-generated sustainability content can be more effective rather than traditional marketing approach. They also mentioned "Virtual Influencers" which can promote eco-friendly brands. These strategies alongside with a marketing message and trending environmental topics can help personalize communication for eco-conscious customers.

Additionally, their study underscores AI's transformative potential in driving sustainability by integrating tools such as predictive analytics, machine learning, and automation into marketing practices. Drawing from interviews, case studies, and secondary data, the authors examine the impact of AI on improving consumer engagement, streamlining operational efficiency, and optimizing sustainability performance measurements. The research also applies the Technology Acceptance Model (TAM) and Stakeholder Theory to explore adoption drivers and barriers, highlighting factors like perceived usefulness, consumer trust, and regulatory environments. Notably, the study reveals that while AI improves personalization and transparency in green campaigns, challenges such as high implementation costs, algorithmic bias, greenwashing risks, and limited infrastructure in emerging markets still hinder widespread adoption. By proposing a holistic framework for AI-driven green marketing, the study offers valuable insights into the intersection of digital innovation and environmental responsibility, making it a significant contribution to both academic discourse and practical policy design.

https://www.researchgate.net/publication/387962242_Leveraging_AI_To_Enhance_Green_Marketing_Strategies

V. Problem Formulation

Initial state : Empty image

Successor function : S(X) = set of <Call API with pre-prompt, returned image from API> pairs

e.g. S(topic/elements) = {<Call API1 with prompt1,returned image from API1>,<Call API1 with prompt2,returned image from API1>, <Call API2 with prompt1,returned image from API2>, <Call API2 with prompt2,returned image from API2>,...}

Goal test : User acceptance

e.g. User click accept button to accept the image

Path cost : User reject/add step

e.g. How many call/rounds to get user acceptance

VI. Planned method

To build this AI system, we will design a prompt to query the APIs and generate green ads corresponding to the user's needs. After generating and showing the ads, based on user's feedback, our system will keep adjusting the API parameters or prompt and regenerating refined output ads until meeting user's satisfaction. More detailed explanation for each element in our system will be discussed in the following sections.

The first element is the prompt as a query of the APIs. We plan to design our prompt as a code-styled string, which compared to the prompt of natural language form, is easier to read and maintain for us CS students. Moreover, we can also extend the prompt simply by adding a new function in the prompt or adjusting the parameters or return values. For what kind of language styles, we will use to design the prompt, we are now choosing Lisp or Python. With Lisp-style prompt, we can utilize one of its famous features – homoiconicity, or code as data, which means the program written in this language can be manipulated as data and the representation can thus be inferred by reading the program. With this feature, we expect to improve the explainability both to APIs and human beings, therefore improving the performance of the prompt. While for python-style prompt, the reason why we choose it is simple – its simplicity and our familiarity because it is one of the most widely used languages and use of the language in homework 1.

The second element is the parameter adjustment based on user's feedback. There are many parameters in API configuration, such as temperature, top-p, top-k, etc. From the beginning, we may select parameters which may produce results with higher variety, then based on the user's feedback, we can manipulate on the parameters, making the refined output ads more stable gradually.

The final element is the prompt adjustment. As mentioned above, we plan to design a code-style prompt. Because of the feature of code, we can design multiple "functions" in our prompt and choose what function we are going to choose to generate a new result based on user feedback.

With these implementations, our expected AI system will be easy to maintain, extend, and at the same time have a high flexibility to meet various users' satisfaction automatically.

VII. Expected results

This final project aims to develop an intelligent system capable of rapidly and creatively generating advertisements and posters of sustainable development. By combining artificial intelligence with visual design technologies, the system will help users in automatically producing promotional materials that are visually appealing and rich in sustainable content. The goal is to propagate and practice of sustainable concepts, and extend the conversation from domain-specific experts to everyday life, ultimately encourage global engagement and awareness.

The system will automate the entire process, from entering key ideas to generating visual outputs. Users can simply input essential information, recommended phrases, and specific sustainability topics (such as climate change, energy conservation and carbon reduction, green consumption, or circular economy). Based on these inputs, the system will produce beautiful and communicative posters. This user-friendly process requires no prior experience in design or visual arts, which significantly lower the barrier of participation in sustainable-related marketing. And then, even individuals without a design background can easily create promotional materials, enhance the knowledge of sustainable concepts in public. These advertisements will be transmitted to the world by social media, company's presentations, academic conferences and so on.

We expect the completion of this system to generate significant value in advancing sustainable promotion. In the past, many non-profit organizations, campus, and small businesses startup have struggled to produce impactful promotional content due to a lack of professional design resources. With the support of this system, they will be able to create consistent, eye-catching, and meaningful marketing materials, which allow sustainable messages to better reach target audiences and public.

Furthermore, as the user base grows and more visual content is produced, the generated advertiesments can be used to iteratively refine the models. This creates a feedback-driven design ecosystem that thrives on community engagement and positive reinforcement. In the long run, this system has the potential to become a central tool in sustainable marketing. It will help sustainable policy and academic to build fostering green economic development and enhencing consumer consciousness.

Overall, the expected outcomes of this project extend far beyond the technical implementation of a product. The project aims to establish an innovative mechanism for sustainable idea promotion to social values, making the ideal sustainable environment.

References

[1] United Nations Statistics Division, "SDG API", [Online]. Available: https://unstats.un.org/sdgapi/swagger/. [Accessed: Mar. 16, 2025].

[2] Green Business Journal, "Green marketing vs generative AI: An environmental dilemma", [Online]. Available: https://greenbusinessjournal.co.uk/green-marketing-vs-generative-ai-an-environmental-dilemma/. [Accessed: Mar. 16, 2025].

[3] The World Bank, "Data API for Open World Bank", [Online]. Available: https://data.worldbank.org/about/get-started. [Accessed: Mar. 16, 2025].

[4] SB Insight, "SB Insight FAQ", [Online]. Available: https://www.sb-insight.com/methodology. [Accessed: Mar. 16, 2025].

[5] Google Trends, "Discovering Trend", [Online]. Available: https://trends.google.com/trends/. [Accessed: Mar. 16, 2025].